Multinodal Urban Structures,

A comparative analysis and strategies for design

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To my father
for who giving up is not an option

7 ACCESSIBILITY AND FUNCTIONAL STRUCTURE

8 THE DESIGN OF MULTINODAL STRUCTURES

9 CONCLUSIONS

1.1 Changing Cities

It is wrong to assume that a grouping of high-rise office buildings defining the skyline of a city will always mark the city center.

Dallas, May 1994

On that Sunday, I was confronted with my own fixed idea of the city. Having recovered from the long flight of the previous day, I set out without having so much as opened the guidebook in search of a place to have some coffee. I strolled in the direction of the highest point on the skyline, heading toward the spot where I was sure to find the center of this city, in which I was still a stranger. For a while I wandered among the gleaming skyscrapers before realizing that my inner compass had given me a bum steer. The classic image of the city has a single center, forming a collage of urban functions, including a place to get a cup of coffee. Duly disoriented, I asked a passerby for directions and then began to see the light. I was right to assume that this was the city center. But as she pointed out, it was one of many, each with its own specialization. Places to eat and drink were spread over various centers. But in this particular one, cafés were few and far between. Following her directions to those precious few establishments, I devoted the rest of the day to a careful study of the tourist brochures.

Cities change. We are continually building new houses, offices, and shopping centers while putting in streets, squares, and parks. Even the way in which functions like employment and retailing are situated in the city is not cast in stone. The image that people generally hold of the city, a place with a single core, is gradually becoming an illusion. As that image dissipates, we see complex urban regions with many and diverse centers for activities of all kinds. Urban elements like shopping malls, furniture outlets, and concentrations of businesses and offices along highways have become common place. As a result, many cities no longer have an easily identifiable center; they are no longer single-nodal cities, where the main offices, stores, and other organizations can be found. They have turned into cities with multiple cores and a diversity of centers. In short, they have taken on a multinodal structure. The new urban regions are multi-centered, with third-, fourth-, and fifth-generation cores, located in and beyond edge cities, high-tech corridors and large-scale private master-planned communities (Berry and Kim, 1993). In the course of this transition, cities are subject to processes of deconcentration and decentralization (Dickinson, 1947, p. 96). The big city, long synonymous for a recognizable, delimited area, having metropolitan functions in the form of major economic, political, administrative, and cultural elements, thus recedes to make way for complex urban networks with comparable metropolitan functions (Buys et al., 1992).

The observation that a large number of cities now have a multinodal structure is no longer open to debate. In his 1991 book called Edge City, Garreau argued that the normal image of the present-day city is one of a multi-nodal structure. In my opinion, the rise of multinodal structures is one of the most intriguing events in the history of modern urban design. It represents a fundamental change in the development and significance of the city. Indeed, such structures warrant more attention; a technical and scientific discipline like urban design should go beyond a critical analysis of multinodal structures. The discipline should also operate on the assumption that other alternatives exist for the structure of a city. The emergence of multinodal structures might be the most likely development. But would it also be the most desirable or even the only possible one?

Insight in the desirability of a given type of structure, and specifically in a multinodal structure, must be built upon insight in the characteristics of different structures. At present, insight into multinodal structures seems to be insufficiently developed. That is the assessment of Lynch, who writes that the idea [a polynucleated city region or multinodal city, MJ] is not clearly developed. It provides neither a testable hypothesis of how cities work, nor a clear idea of how they should do so (1981, p. 390). This thesis examines the factors that lead to change in the functional structure of the city. Subsequently, some characteristic features of the multinodal city are explained. The aim is to shed light on the structures that are at least technically possible and to show how an existing structure can be changed through spatial interventions.

1.2 The City: a Definition

The image of the city that we entertain sets the stage for any discussion that can take place on the topic. The notion that the city is built up in a particular way which is captured in the concept of structure is grounded in the assumption that the city can be understood as a whole. Not everyone would subscribe to that assumption. Even those who do perceive the city as a single entity prove to hold divergent opinions of its identity. Among geographers in scholarly circles and among practitioners in the fields of urban design and planning, the range of approaches to the city is wide. Likewise, their perception of the metropolitan area, the urban network, or the metropolis is highly diverse. One tack borrows imagery from biology; Branch (1975), for instance, says that Cities are dynamic organisms (p. 5). Another tack uses a mechanical analogy, calling the city a social machine (Tafuri, 1978). Then there are approaches that focus on the spatial pattern (form, shape) of the city. For instance, the Dutch architect Neutelings perceives the Dutch conurbation between The Hague and Rotterdam as a metropolitan tapestry, whereby this metropolis consists of separate units that are pieced together to form a patchwork (Heynen, 1990). In the same vein, Rotterdam is seen as a dynamic urbanized landscape (Palmboom, 1987, p. 74).

Each and every definition of the city seems to carry connotations reflecting the purposes of the people using or working with the city. It is quite conceivable that an architect will look to that definition for inspiration for the design of a new building. A social scientist, in contrast, might use a definition that gives a grip on the social aspects of the city. And people who live in a city might define it as a place of residence with which to identify themselves. The purpose of defining the city, from a scientific standpoint, is to make the enormous complexity and diversity of the city understandable, malleable, and ultimately researchable (see also: Allaert, 1999). It should be kept in mind that the city hosts a large proportion of a society's cultural manifestations, a great diversity of lifestyles, and numerous complex economic functions, to name just a few of its features. In that light, the very idea of an all-encompassing approach to the city seems an unrealistic ambition. As Spreiregen (1975) puts it, The city is as much a physical object in three dimensions as it is anything else (p. 109).

Hulsbergen (1992) looks beyond the differences in approach to the concept of the city and holds up the notion of space itself for closer examination. He argues that space can be defined in terms of six simple spatial concepts: including functional space (where use is central) and space defined by form. As he sees it, these simple concepts prove to be inadequate as soon as more complex problems are raised. Thus, complex problems call for a combination of (simple) spatial concepts (Hulsbergen, 1992, p. 33). Kevin Lynch (1981) does just that. His aggregate definition covers both physical and functional aspects of the city. In his own words, "I will take the view that settlement form is the spatial arrangement of persons doing things, the resulting spatial flows of persons, goods and information and the physical features which modify space in some way significant to those actions, including enclosures, surfaces, channels, ambiences and objects". From that perspective, the city as a physical object can be considered as the material precipitation of a spatial system (Klaasen and Witberg, 1993). Or more specifically, it may be defined as the daily urban system and be circumscribed by daily activity patterns. In this manner, the concept of the city is separated from the shape (form) with which it is generally associated. Both the walled Medieval city and the sprawling metropolis are types of cities, each with its own shape. And all these different types may be considered as the material expression of an urban system.

The emergence of the city as a staple market, the construction of infrastructure such as waterways, railroads, and tram lines, and the process of industrialization are examples of innovations that have influenced our lives over the past several centuries. Moreover, these changes have had a concrete impact on the way our cities are organized in a spatial and functional sense. All these inputs have something in common. To a greater or lesser degree, all have played a role in the development of a single city and have strengthened that one unique center. In the process, they have made the traditional nodal, monocentric (or mononuclear) structure ever more optimal, so that

urban growth was accompanied by concentration and centralization of urban functions (Dickinson, 1947, p. 94-97). This thesis devotes special attention to the problem of spelling out the relationships between all kinds of spatial processes and the development of the functional structure, that is, the way in which diverse activities are arranged in space as well as to the way the city is built up in a physical sense, taking the definitions of Lynch and Klaasen as a basis. The reason to give these relationships and forms special attention is that insight into that interaction can offer new grounds for strategies to change the functional structure by spatial interventions.

1.3 Context of the Development of Functional Structures

A functional structure arises as soon as a group of people undertake some joint activity on a regular basis. The collective character of that activity is crucial, in that it makes it possible to speak of that undertaking as a whole; and the concept of structure is only applicable to a whole. A functional structure implies that there is some activity that has a given function for a group.[1] The size of the territory of that group, or the extent of the activity pattern, determines the scale at which that activity has a function. A museum draws its visitors from the entire city and thus deserves to be called an urban function. In contrast, a small shopping center drawing its clientele from the immediate vicinity may be said to have a neighborhood function. In view of the fact that the concept of structure presumes the existence of a whole, it is imperative to determine the range of that entity from the outset, be it the entire city or a neighborhood. Only then can we rightly speak of a functional structure. The reason is that scale is an intrinsic feature of a functional structure.

Ever since people started to undertake joint activities on a regular basis, functional structures have been developing. In that sense, the rise of cities can be seen as the creation of specific spatial conditions though also non-spatial ones within which collective activities can take place as part of a functional structure. Non-spatial conditions could include local fiscal advantages, for example, whereas spatial conditions refer to the system of artefacts to facilitate activities and the relations between them. An ensemble of buildings (places for particular activities) and roads (channels for relationships) might well represent an incipient urban form. It is conceivable that a city would provide otherwise unavailable spatial conditions for activities. The difference in spatial conditions, both between that city and its surrounding area, but also within that city, might be the key factor in the development of functional structures.

It should be pointed out that there is no universal path of urban development, nor a single trajectory for the formation of functional structures. Berry (1978) believes that a value-free theory about processes of this type would be unrealistic. He feels that we should review the value-specific taxonomy of urbanization processes, providing the setting in which it is possible to evaluate the nature and consequences of behavior change (Berry, 1978, p. 26). Berry argues that urban development in the United States within a liberal-capitalistic context and predicated upon a free-market economy shows a different pattern than urban development in Maoist China. Besides differing in terms of economic system, other deep-seated concepts can also influence urban development. Consider, for example, the concepts whereby numerous activities are given a fixed place in the city in accordance with strict rules. The concept of nested boxes (Fig. 1.1) is a case in point. As applied in planning according to Hindu principles, the center is

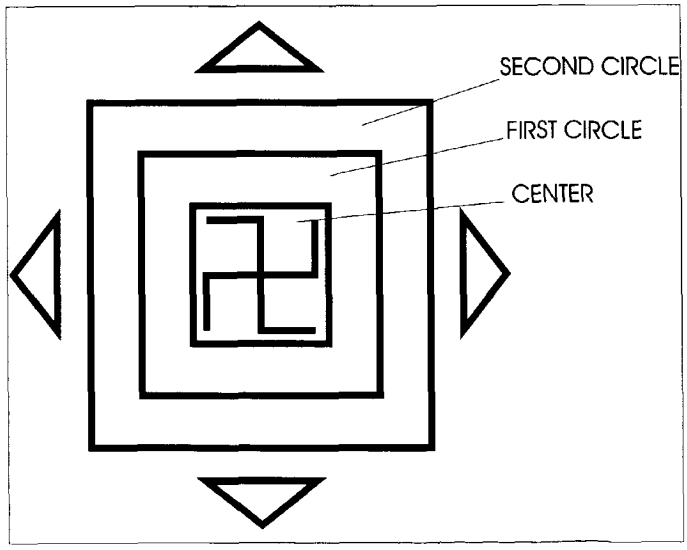


Figure 1.1 Nested box principle of Hindu cities

designated for the god, while each concentric circle is dedicated to a particular caste; the traffic pattern is tangential (Lynch 1981, p. 385).
These concepts may conflict with the tendency to search for the best location for activities, a procedure that continually leads to making the greatest possible use of the spatial potentials. Then too, the study of cities, even the design and planning of cities, may be based on concepts that have been made obsolete by changing circumstances. Urban theory remains beset by a particular image of urbanization. This image encompasses the concentrated core-oriented metropolis that emerged to solve the problem of slow and expensive transportation by agglomerating industry and employment in a single center and packing the population around that center and along radiating transport networks. This urban form was at its zenith by World War II, but since has been eroded by suburbanization, decentralization and dispersion (Berry, 1993; Roberts et al, 1999).

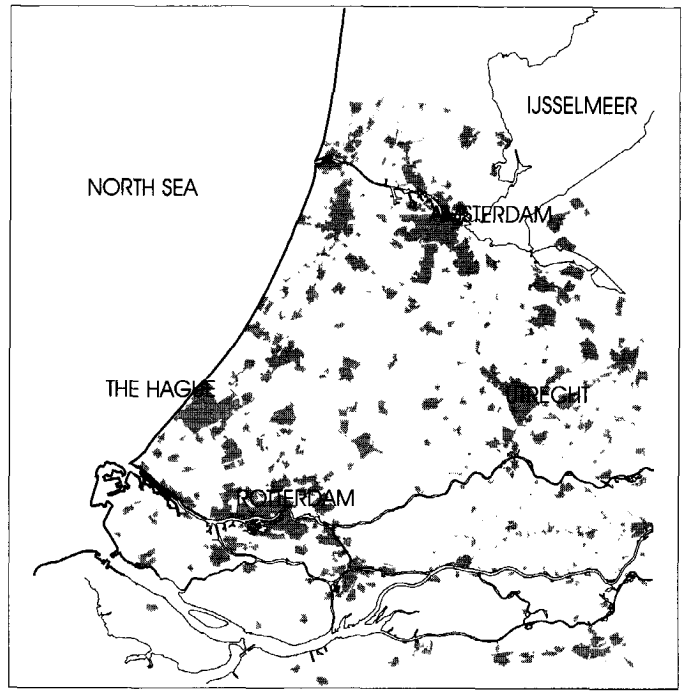


Figure 1.2 Randstad-Holland

When conducting any study on the formation of the functional structure of the city, it will thus be necessary to take the context into account. The context within which a city develops is determined by ecological, technological, economic, cultural, and political opportunities as well as constraints (N.A. de Boer, 1982; De Jong, 1992). Randstad Holland (Fig. 1.2) is often mentioned as an example of a multinodal or polynuclear metropolis (Burke, 1966; Van der Cammen, 1988). One of the factors that has shaped Randstad Holland is the formidable challenge of building on the waterlogged soils of this Dutch region. This ecological constraint has been overcome by the introduction of better construction methods. Nevertheless, a political restriction is still in place. The plans adopted by the Dutch government stipulate that any town or village expansion will have to be restricted as much as possible in order to spare the rural area known as the Green Heart of Holland (Ministry of VROM, 1988). In this respect, the context is crucial to an explanation of the present structure. The structure of Randstad Holland is a case in point. There, the developments might be explained as emanating from the process of forming a structure. That process could possibly apply to the Dutch context, but also to the Western European context or that of all predominantly capitalistic countries. Besides the structural factors, the developments could also be partly explained by the specific conditions under which they have taken place. On the grounds of mainly economic but also societal and cultural similarities between Western Europe and North America, it seems obvious that the context for the development of the functional structure of the cities would be the same on both continents. In that light, a comparison between urban areas on either side of the Atlantic forms the core of the present investigation.

1.4 Multinodal Structure: a Definition

Before we can determine which factors are involved in the development of a multinodal structure, we have to define the concept of multinodal. The root word is node, which literally means knot. In this thesis, the word node is defined as a concentration of collective activities. Thus defined, it is analogous to the concept of center.[2] Say that an area of 100 by 100 kilometers contains five cities. These cities would be considered nodes. At another scale, namely the urbanized area, the concentrations of collective activities that perform a function for the city as a whole would be seen as nodes within that area. Nodal and multinodal refer to concentrations (i.e., one or multiple) whereby the scale determines the nature of the structure in question.

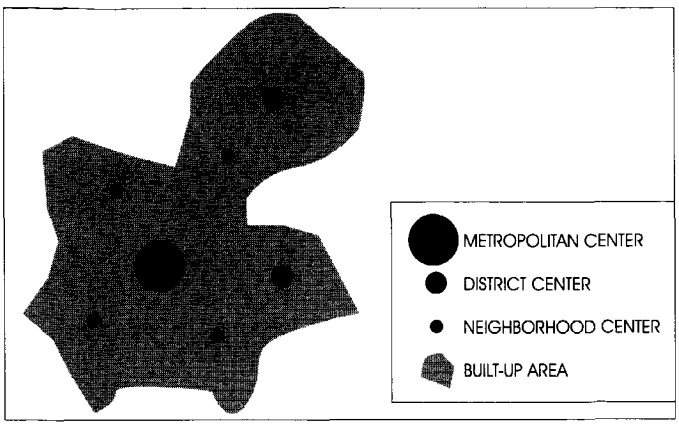


Figure 1.3 Hierarchy of centers

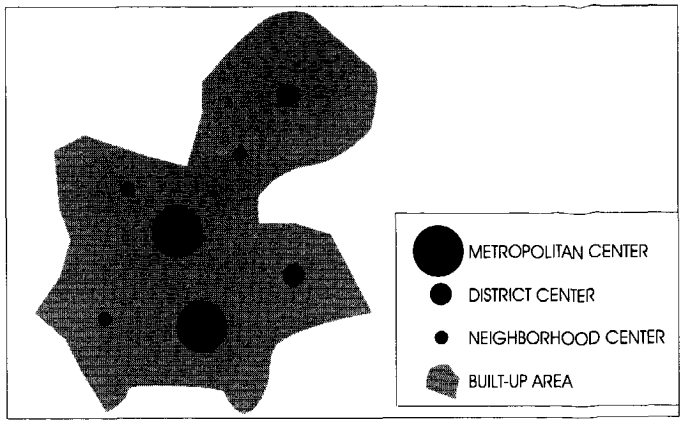
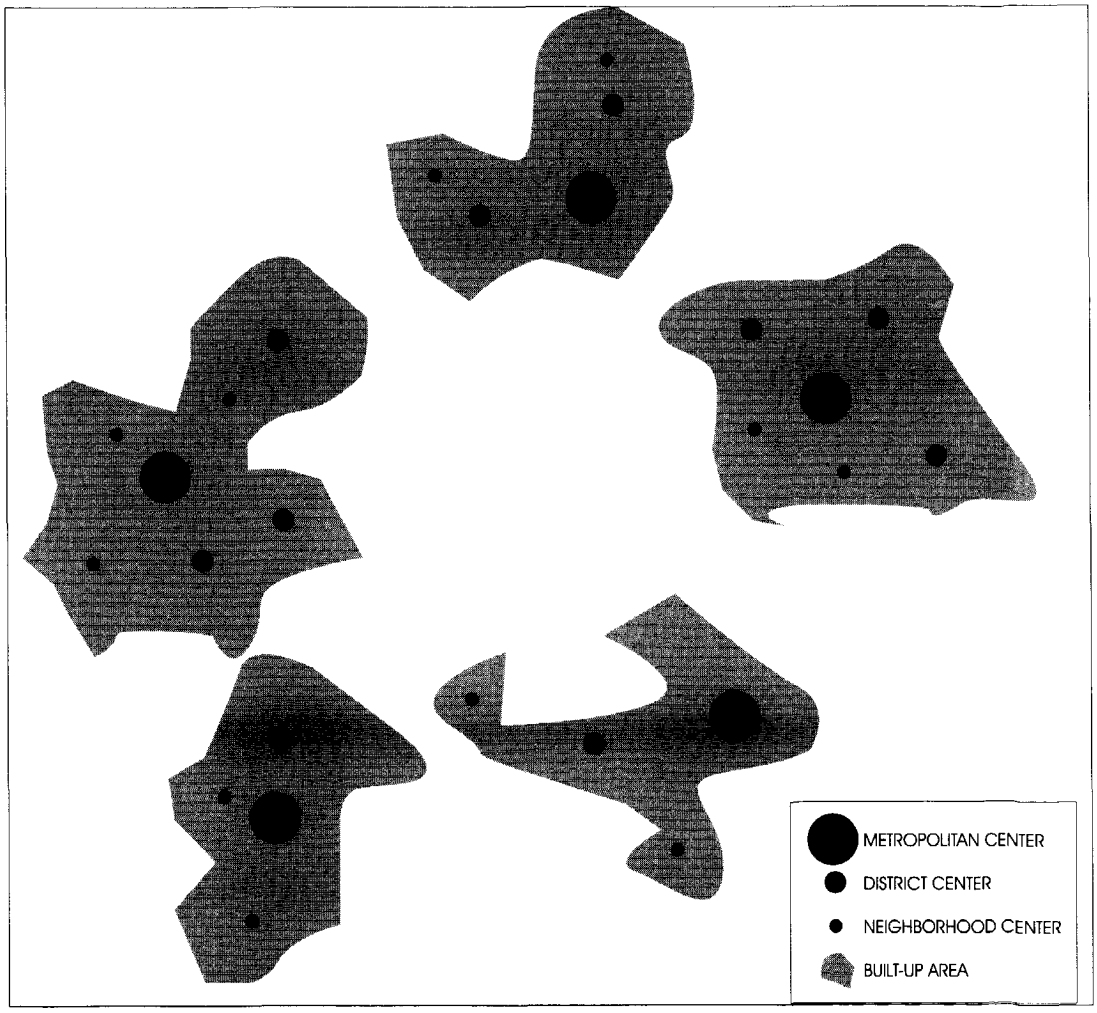


Figure 1.4 Two city-regional centers

Figure 1.5 Multinodal region



Example: Figure 1.3 depicts a city with a hierarchy of centers. These range from neighborhood centers to district centers all the way up to a center for the metropolitan area. The city-regional center represents the only concentration of collective activities (both services and jobs) with a function for the whole city. This city thus has a single nodal functional structure. In contrast, the city depicted in Figure 1.4 has two city-regional centers. One is the central business district, the other a shopping mall. Thus, the functional structure of this city is multinodal. Figure 1.5 shows a settlement pattern whereby there are five cities of equal rank (roughly the same amount of inhabitants, whereby the

centers are comparable in their amount of square meters or number of jobs). Here too, we may speak of a multinodal structure. However, if these cities, or rather nodes, do not perform any function for the area whereby that area cannot be considered as a whole the concept of multinodal structure does not apply.

Definition:
Multinodal refers to the presence at a specified level of scale of more than one concentration of collective activities that pertain to that scale.

Within this conceptual framework, it is conceivable that a hierarchy of centers could exist within a particular settlement. Each district would then have only one center. But at the levels of the borough, the city, or the region, there would be several centers. Thus, at the district level, the structure would be nodal, whereas it would be multinodal at the level of the borough and the city. The urban system is manifest in the creation of new centers of employment and retail trade at the scale of the metropolitan area in particular. Because we observe a shift of the functional structure at that level, we have decided to emphasize the creation of the multinodal structure at the scale of the metropolitan area. Thus, in this thesis, the concept of multinodal is used to denote the presence of more than one concentration of collective activities that pertain to the whole urban system. Cortie (1994) calls a city polycentric (i.e., multinodal) when it meets two criteria. It must be part of a daily urban system, and the centers must distinguish themselves by their specialization. The latter criterion would exclude the possibility of a structure consisting of two or more centers with an identical set of activities. That restriction seems rather strange. If those centers perform a function at the scale of the urban system, they would clearly constitute a structure with two centers. Then, regardless of whether these centers have the same set of activities or have their own specialties, we would have to call them polycentric (or multinodal). Incidentally, it is not inconceivable that within a given area and thus at a particular level of scale there may be no concentration of collective activities whatsoever. Even the language of polycentricity [or multicentricity or multinodality, MJ] may be too confining to adequately conceptualize the degree to which the dispersion of employment and population has already occurred (Waddell and Shukla, 1993). In this quotation, we find the principle on which all conceivable structures should be based: a continuum from absolute dispersal to complete concentration. The term multinodal carries the connotation of centrality. Therefore, it implicitly denotes a core-oriented metropolis. In principle, then, the concept of multinodality refers to all functional structures in which no one area can be singled out as the exclusive center in this case, with a regional function.

Center: a point where the entire world seems within reach (Lynch, 1981):
It is not easy to give an exact definition of the concept of center. Even Lynch (1981) goes no further than an operational definition of the phenomenon, describing an array of different centers, such as shopping centers and business centers. A center can be defined as a contiguous area with collective functions, bounded by the reach of pedestrians. This is a direct reference to existing centers, including specific qualities that seem to be attached to the characteristics of pedestrian traffic. With a note of nostalgia for Paris or Berlin as they were back at the turn of the century, it is said that a center only exists when there is a continuous facade of shops and beautifully paved sidewalks where buskers and paper boys jostle for the best spot. Definitions of this type are too limited. They exclude a world of possibilities; a thoroughbred is a horse, but not all horses are thoroughbred. In the same vein, centers more broadly defined that are tailored to meet the needs of the automobile warrant recognition of their specific features within that definition.
A center is defined as a concentration of activities. Figure 1.6 gives some examples of all kinds of concentration, thereby covering all kinds of centers. Figure 1.6 'dipolar gradation' for example depicts two concentrations and is thereby multinodal in principle. Figure 1.6 'sprawl' depicts complete dispersal; it shows no concentrations and therefore no centers.

The identification of centers as concentration points for collective activities must not be based on their qualities, nor on normative criteria associated with such features. Rather, centers should be identified as such on the grounds of the dispersion pattern of collective activities.

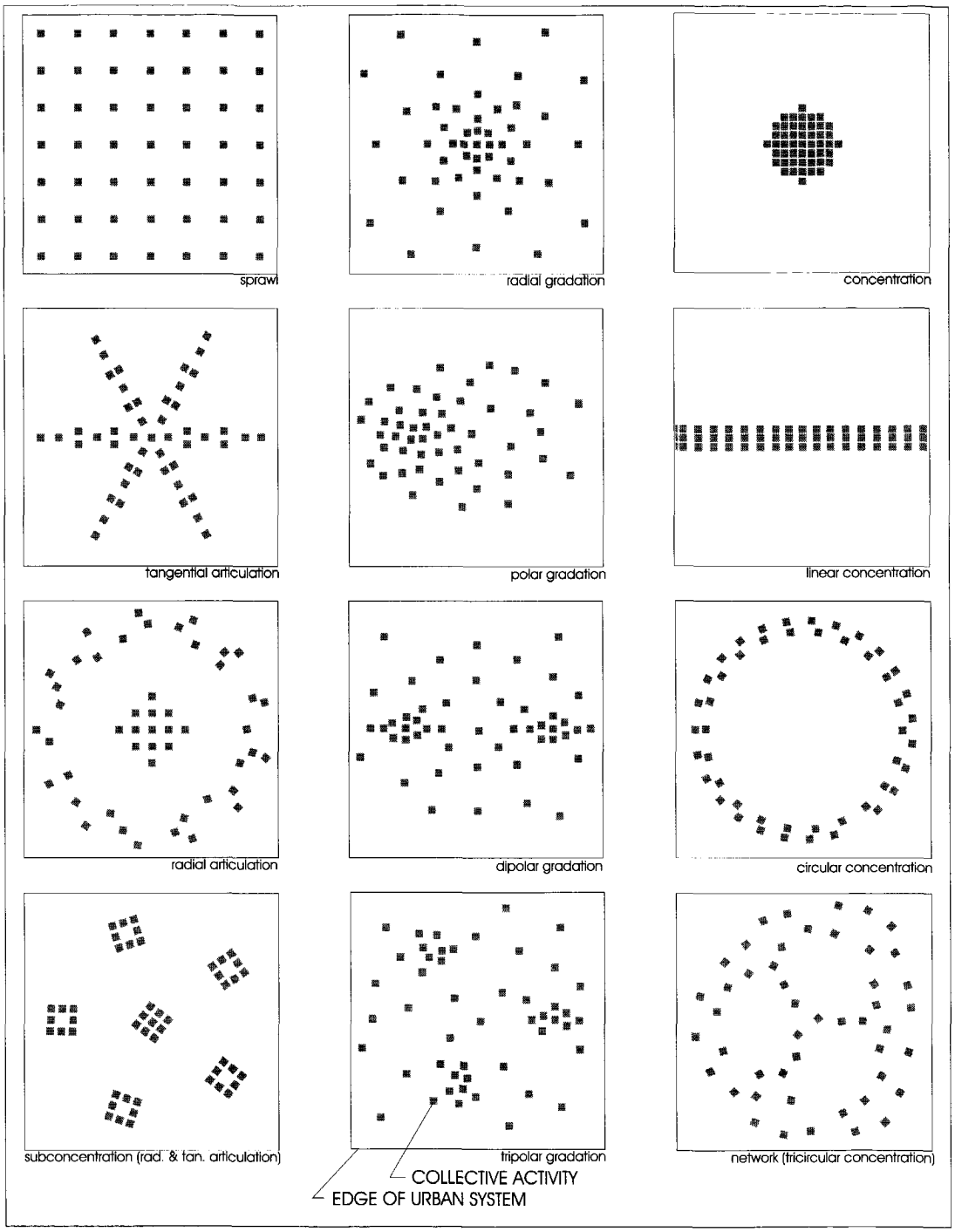


Figure 1.6
Sprawl and concentration
based upon De Jong, 1981

1.5 Design, Transformation, and Emergence of Conurbations

The multinodal city is generally seen in relation to change in one single city, whereby the nodal structure becomes multinodal as a consequence of dispersal and decentralization. Theories such as those formulated by Dickinson (1947), Blumenfeld (1967), Johnson (1972), Berry and Kim (1993), and Waddell and Shukla (1993) all have the same point of departure. They all assume that multinodality is the result of a process of change in a nodal structure. Indeed, the change observed in countless large cities seems to confirm this standpoint. However, this point of view is limited if previously observed developments are taken as a basis on which to generalize upon multinodal structures. Let us look at the

issue from the perspective taken by De Jong (1992), who sees the key to urban design as making use of opportunities and in this case, any conceivable functional structures.[3] Only when this virtually inexhaustible source of structures has been charted can the question of their origin be broached. How could such structures be realized? What kind of interventions would be needed to create them? From this perspective, it is not necessary for a multinodal structure to originate in a nodal structure. In fact, all conceivable processes of change would have to be charted, along with every imaginable structure. The concept of the multinodal structure can be applied in the design and construction of a new city, on the basis of a broad spectrum of possible structures and the processes of change associated with them. Of course, it must be kept in mind that as long as the planning is based on limited regulation and the principle of allocation, what is being built is not a functional structure. It might look good on paper. But in practice, all we can do is set the (spatial) conditions for development.

The multinodal structure of one single urban system can theoretically arise in one or two ways. The first and perhaps the most well-known way is by a process in which a nodal structure changes into a multinodal one. I call that process transformation. The second way is when a city has had a multinodal structure from the start, whether so intended or not. Thus, the city does not need not to have undergone a transformation.

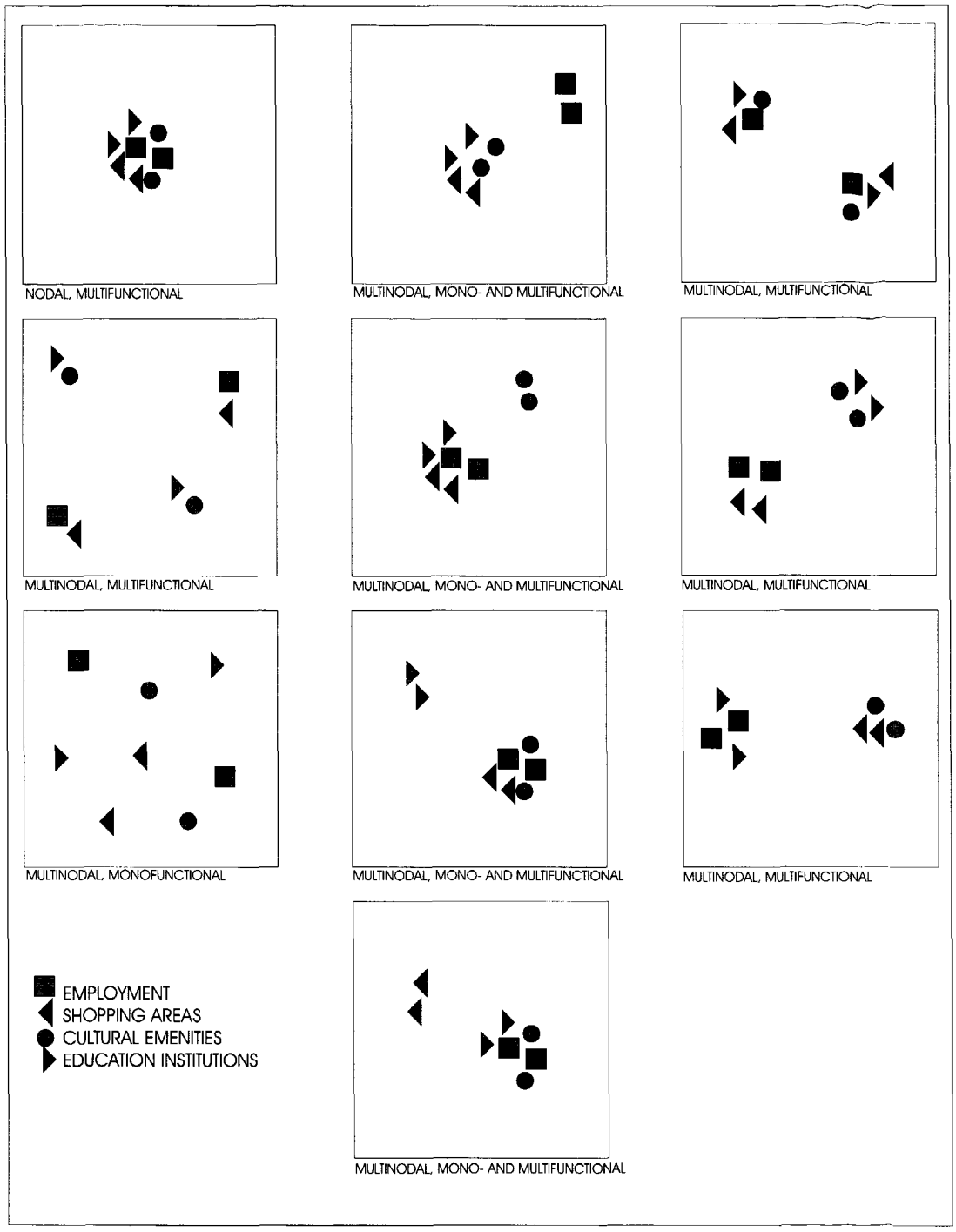
In the book Cities in Evolution (originally published in 1915, reprinted 1949), Geddes describes the urbanization process in various parts of Great Britain. He refers to the new areas that he perceives to be emerging such as Manchester-Liverpool and Greater London as conurbations. We should recall that Geddes does not actually describe this urbanization primarily in a functional-spatial sense; rather, he accentuates the morphological form. Nonetheless, he observes the emergence of urban areas where it is no longer clear just which one of the old cores is really the center. For example, he is not comfortable with a name like Greater Manchester because it does not do justice to the importance of Liverpool and other cities. His proposal to coin new names such as Lancaston (Lancashire) and Midlanton (Midlands) illustrates the multinodal character of the conurbations he describes (p. 9-21). From Geddes point of view, multinodal structures also arise as a result of the merger of two or more single nodal cities, of two or more multinodal cities, or any other conceivable combination. The main point is the process by which two or more systems in the context of this thesis, urban systems merge to form one new system with a new functional structure, which can have either a single node or be multinodal. I call this process the emergence of conurbation.

Let us reiterate the three ways in which a multinodal structure emerges:
— Multinodality: The point of departure either imposed by the design or already in place when the city was founded;
— Transformation: The process by which a single nodal structure changes into a multinodal structure;
— Emergence of conurbation: The amalgamation of two or more urban systems to create one urban system with a new multinodal structure.

1.6 An Overview of Possible Structures

The term multinodal merely denotes the existence of several centers. The activities that take place in those centers may be different in each multinodal structure. For instance, one structure may consist of a main shopping area and a business district; another structure may comprise two multifunctional centers. The factors that lead to the formation of a multinodal structure with a particular functional differentiation may be dependent on the nature of the collective activities in each of those various centers. A concentration of hotels may be prompted by other factors than those leading to the rise of a business district. Before we can determine which factors lead to a multinodal structure, it is important to distinguish various possible multinodal structures. A classification of possible structure types is essential if we want to determine the characteristics peculiar to a given structure. Figure 1.7 gives an overview of possible multinodal structures. The four kinds of collective activity that are cited in the examples are employment, shopping areas, cultural amenities, and educational institutions (such as universities).

Figure 1.7
Possible structures



The examples given in Figure 1.7 are based on the principle of a nodal structure (Jacobs, 1990). According to that principle, there is one concentration of collective activities within a multifunctional center. Multinodal structures are derived from that situation by dividing the collective activities that take place in that one center over two or more (multifunctional) centers that are similar in quality (i.e., range of activities) but also in size. Another way to derive multinodal structures from that situation is by separating different kinds of collective activity. This separation leads to multinodal structures consisting of (monofunctional) specialized centers. Each of the distinctive urban areas has its own specialty. It may have the campus of a big university, or it may have an office center. Combining the two categories at either end of the spectrum the monofunctional and

the multifunctional structures generates a large number of possible structures. A center does not normally consist exclusively of elements that perform a regional or inter-regional function. Certainly in the case of multifunctional centers, the functions are layered. Together, local, district, urban, and regional functions form one layered whole. In principle, as long as the urban system is the critical level of scale and the structure is built up exclusively of elements that have a function at that level, it is important to the determination of the characteristics of various centers, as well as structures, to how that center is composed of elements from various levels of scale. Does a center comprise only a cluster of museums? Or does it combine that cluster with a subregional shopping center, including the lunchrooms and restaurants usually associated with such facilities? Because this difference is critical to the ways in which the center can be used and therefore to the characteristics of various structural types it warrants closer examination.

1.7 Examples of Multinodal Structures

With the rise of diverse urban functions, the groundwork is laid for a multinodal structure. The ancient town of Pompeii (I) is a case in point. Early in the present era, that settlement had three recognizable concentrations of urban activity. One was the forum, surrounded by all the important urban functions such as the capitol and the treasury. The second concentration was the theater district, and the third was the amphitheater and the palaestra (Maiuri, 1994). Pompeii was founded in the eighth century B.C. The administration buildings and theaters were presumably not built until the first century B.C., when Pompeii became a Roman settlement. These more recent structures were built around the old market, some on open sites inside the city walls. There are countless examples of small settlements where functions such as industry and administration each have their own place in the city.

The main factors leading to a functional separation are a dependence on a specific infrastructure (a harbor), the need for water (textiles industry), and the desire to abate nuisance (odors and noise). Until the twentieth century, the separation of functions as a means to restrict the mutual nuisance caused by these activities has been a key principle of city planning, culminating in the movement known as functionalism. According to the plans of the Dutch Ministry of Housing, Physical Planning and Environment (VROM, 1988), the first deliberate endeavor to foster multinodality and the characteristics presumed to accompany it was couched in the plans for the design (or actually the guidelines for further development) of the Randstad conurbation. Those plans constitute one of the few examples of multinodality as the basis for design.

Examples of transformation, on the other hand, are rife in cities small and large. The change in the functional structure of Paris (F), London (GB), and San Francisco (USA) is characteristic of transformation, but so is the change in a smaller city such as Amsterdam (NL). In particular, new office concentrations such as La Defense in Paris are exemplary of the new centers that form a multinodal structure alongside the existing and often historical center.

Randstad Holland (NL), the Rhine-Ruhr Area (D), and the Flemish Triangle (Antwerp – Brussels – Ghent) (B) are given special recognition by Dutch planners as multinodal urban areas (Ministry of VROM, 1991). Even more than the increased interaction between those cities, the spatial pattern has contributed to their renown as multinodal urban areas. One might typify the development in these areas as the emergent conurbation. That being said, it should be noted that in many of these areas, the formation of a multinodal structure is still in its infancy. Other examples of the emergence of conurbation are found in Manchester – Liverpool (GB), Frankfurt am Main – Wiesbaden (D), Minneapolis – Saint Paul (USA), and Dallas – Fort Worth (USA).[4] We see that in these areas, more than elsewhere, a new urban system is already in place or that the process of forming one has been underway for quite some time. For that reason, the multinodal structure is usually easily detectable.

Notes

1.
A concert – in which a group of people gather to listen to music – is thus a collective activity with a cultural and/or recreational function (at least for the purpose of this example).

2.
Center: a place where activity is concentrated (Dickinson, 1947; Lynch, 1981).

3.
In the program leading to an engineering degree in urban design at Delft University of Technology, one part of the curriculum involves designing a series of possible (or rather conceivable) cities. All designs generated over a ten-year period (1985-1995) may be divided into two groups. Some fall in the category of nodal, monocentric cities; this group includes concepts such as the "finger-shaped city". The rest fall into the category of multinodal cities, consisting of one or more agglomerations and their centers, and sometimes derives from a nodal concept (Jacobs, 1990).

4.
Besides these examples, the list might include areas covered by the term magalopolis (Gottman, 1990). These include the Tokaido Megalopolis in Japan (Tokyo-Kobe) (Nagashima, 1967; 1981) and the East-Coast Megalopolis in the USA (Boston, New York, Philadelphia, Baltimore and Washington D.C.). With regard to the concept of megalopolis, it is questionable wether there really is a functionally coherent system, such as an urban system or a system of cities. In most cases, the pattern, namely a cluster of urban areas, is the hallmark of a megalopolis.

"The fact that people create the big city does not mean that the result is what they want"
(Hans Blumenfeld, 1967).

2.1 The Dilemma of Design and Research

In the Netherlands, urban design is an engineering discipline. This discipline forms the context in which research is done on multinodal structures in this thesis. The core of this discipline is designing urban areas, such as residential neighborhoods, city centers, office sites, and the layout of public spaces such as squares and streets. Thus, the field of urban design is broad in scope, ranging from the detailed layout of public space, down to the design of street furniture and the ground plan for the city, and sometimes for the larger urban area. The fact that this requires the application of know-how is the main reason why urban design falls under an engineering discipline. In engineering, the design is generally a means to integrate elements of knowledge. City planning has been practiced in the Netherlands, in which knowledge was either the product of programmatic research (especially surveys) till well into the 1960s (Vakgroep Stedebouwkunde, 1994) or of research in other disciplines, such as geography, sociology, or economics. The design was then the means by which possible, probable and desirable developments (the analysis) were translated (synthesis) into a spatial proposal for structure and design.

In the field of urban design, the work of De Jong (1981, 1992), more than others has led to a break with the traditional approach. His work centers on examining opportunities. For instance, every conceivable way in which 200 dwellings can be placed on a site. The design process itself then becomes a research method. All possible solutions are reviewed and subsequently studied with respect to their effects. These solutions are also examined with an eye to the spatial and non-spatial interventions required to actually reach those solutions. When studying multinodal structures, this implies that all possible (including improbable and undesirable) structures would have to be worked out. Their effects would also have to be tested, and the interventions required for actually creating those structures would have to be identified. Ultimately, the result is a set of solutions including their anticipated effects and the necessary interventions for reaching those solutions. This approach is based on the assumption that the solutions are doable. But can a functional structure be made?

A functional structure is the expression of a set of collective activities and the relationships among them at a given level of scale. To say that a functional structure can be made presumes the ability to create all manner of activities and spatial processes. In my opinion, this assumption is untenable; this is not how things work. We must realize that a functional structure is the result of countless individual and collective decisions at all levels of scale. Those decisions ultimately give activities a place, such as a theater, a cafe, a hospital, etc. The city planner does not create these activities. The assumption that a functional structure (and in fact the whole city) is the outcome of innumerable decisions forms a major bottleneck to research in the field of city planning. The makeability of the functional structure belongs to the domain of all actors who are associated in some way with a city. The city planner's role with respect to functional structures may thereby be defined as providing insight into the consequences of the actions of all those individuals, designing (alternative) possible functional structures, and offering insight into spatial changes, especially those that can lead to the realization of those possible structures.

The process of gaining insight into the implications of actions taken by actors who deal with a city is complex. For example, consider trying to explain a city like Paris or to study its functional structure. The investigator might draw the conclusion that virtually all the residents, as well as the visitors and investors, would have to be interviewed in depth. But also the decisions and standpoints that prevailed in generations before them would have to be scrutinized. Assuming that Paris has a cause, it would have to be an instance of multicausality and thereby hardly researchable. Moreover, other than enriching our knowledge about Paris, what predictive value would that knowledge have?

Even if the cause of the city is virtually unresearchable, it is possible to describe the development of the city in various ways. Subsequently, a comparison with the development of other cities can lay the foundation for a law of the city of sorts.
From this point of view, an explanation may be given for the emergence of certain functional structures. In formulating that explanation, it is crucial to investigate by taking measurements and comparing different cities whether or not a given mechanism applies to every one of these cities. This mechanism comprises the underlying principles for the law of the functional structure and can offer insight into the possibilities within the scope of the discipline of urban design to steer spatial development in the city. Indeed, managing spatial development could well be the essence of the practice of urban design. A practice in which we induce change in the city because we do not like what we see when we look ahead toward the future.

With regard to this thesis, these considerations have some concrete implications. In a broad scope, it means that we should try to elucidate how functional structures develop, to identify the characteristics of possible functional structures, and to provide insight in spatial interventions that could influence the development of a functional structure.

2.2 The City is Unique

No two cities are identical. Obviously, the global reach of McDonald's, the glass skyscrapers, and the ubiquitous accommodations for automobile traffic seem to make all cities look alike. But we have to take a closer look at the spatial structure of the city, its architecture, and its cultural and historical heritage. We have to consider the special events that take place in a city, such as ringing on newyears eve on Times Square in New York, where crowds gather for the countdown to midnight. It might seem that each city's unique character would obstruct the comparison among cities as well as the application of new knowledge. But this is not necessarily so. Each person is a unique human being. Nevertheless, medical research has produced universally applicable medications such as aspirin. According to Kevin Lynch (1981), the range of opinion on the city has created a gap between two kinds of theory. Elaborating on the theory of a good city form he identifies theories that see each individual settlement as a unique entity. Research using such theories seeks to develop methods to determine situation-specific characteristics. Those studies also attempt to explain the city in terms of the specificity of a particular place. This approach may be called idiosyncratic.[1] The morphological analysis is an example of such an approach. Alternatively, Lynch (1981) identifies theories that distinguish between situation-dependent and situation-independent characteristics. In those theories, the comparison among situation-independent characteristics forms the basis for universally applicable generalizations about the city. This approach may be called nomothetic.[2] A good example is the model-theory approach, in which models such as the finger-shaped city form the basis for the design of an urban area (Klaasen, 1989b).
There seems to be a regularity in the development of the functional structure of cities, whereby the universality of this pattern is narrowly restricted to cities in a liberal capitalistic context. That standpoint, which is based on a nomothetic approach, has implications for the present research. For every city that is drawn into a comparison, it is essential to distinguish between situation-dependent characteristics and those that are situation-independent. Furthermore, when applying knowledge that has been gained from nomothetic research, certain limitations have to be kept in mind. In particular, knowledge so derived cannot be used as grounds for any generalizations on the specific nature of a place or a city. Urban design should therefore be grounded in the reciprocal relation between idiosyncratic and nomothetic knowledge.

2.3 Space as Precondition

The elements of a functional structure that is, the collective activities that take place in an area are by definition immersed in anthropogenic processes.
The very regularity of collective activities makes the functional structure amenable to observation. Because collective activities are embedded in anthropogenic processes, they cannot take place just anywhere. There must be certain spatial conditions present to make those activities possible.

A commercial enterprise might choose to locate at premises in the middle of a pasture. But can that company operate without being hooked up to (technical) infrastructure for water and power? How can they do business without connections to the road system, allowing their personnel, associates, and customers to come and go? Can a meat market survive if the potential customers cannot reach the shop?

Collective activities are dependent upon the spatial conditions of a location. Therefore, it may be assumed that significant differences in those spatial conditions determine the functional structure. The reason is that a difference in spatial conditions called the location value opens up the opportunity or excludes the possibility of collective activity at that location (Klaasen and Jacobs, 1997; 1999). Assuming that certain aspects of a location, which we call location value for the sake of brevity, form a precondition for the possibility of collective activity. I propose that the difference in location value across the entire urban area is critical to the functional structure. The processes that are associated with a change in the functional structure, transformation and the emergence of conurbations would then be based on change in the location value of specific locations. Alternatively, they would be based on a reduction in the difference in the location value at multiple locations, because the activity in question proves to be feasible at more than one place. The main objective of the present research in a nutshell, to gain insight into the emergence of functional structures can be further elaborated at this point.

Objective 1:
To determine the correlation between the differential in location value in an urban area and the functional structure.

Location value may be taken as a condition instead of a causal factor. But then we should be aware that the condition may form a bottleneck in the research process. For instance, measurements might reveal that there are two locations with the same location value, whereas collective activities are situated at only one of these locations. This observation does not falsify the hypothesis that a certain location value is a precondition. Falsification occurs when the converse is found. That is, the hypothesis is rejected when a collective activity is situated at a particular location that presumably has a location value that is too low. Another bottleneck to research is the classic conundrum of which came first, the chicken or the egg. A snapshot of an urban area, in which a relationship is sought between location value and the functional structure, does not confirm that the location value actually constitutes a precondition for

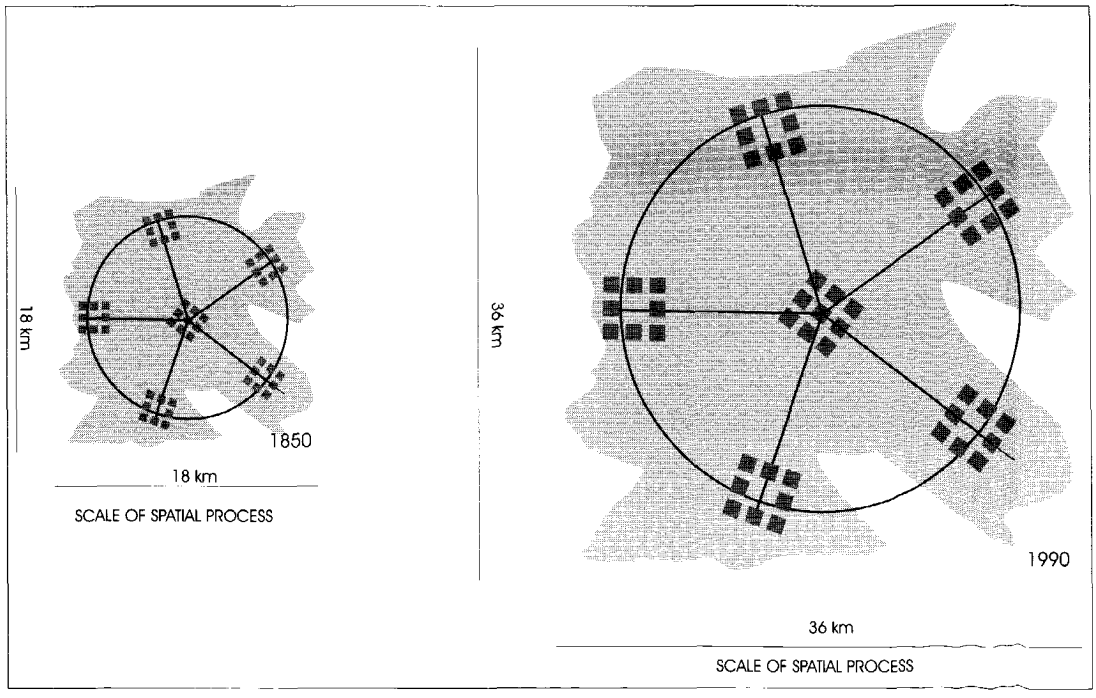


Figure 2.1
Same process, same scale, different size

collective activities. Nor does it confirm that the difference in location value is a determining factor for the functional structure. This problem can be circumvented by replacing the snapshot approach with a close look at how the functional structure changes. That shift in perspective forms the basis for the second objective of this thesis.

Objective 2:
To investigate the relationship between the change in the location value differentials and the change in the functional structure.

In this objective, we are specifically concerned with the processes of transformation and emergent conurbation. When studying change in the functional structure, it is necessary to take the emergence of new collective activities into account. Each of these new activities will seek its own place in the city. At the same time, we must also take note of the change in the locational requirements of existing collective activities. If we look at the change in the functional structure over a period of several decades, we must also take the growth of the city itself into account. As it grows, the territory to which that structure pertains will also expand. It should be kept in mind that the urban system in which the change takes place can itself change in size. The level of scale is defined by that system as well as by the spatial processes that take place within it. Therefore, the level of scale does not change (see Fig. 2.1).
In the process of conurbation formation which may be roughly defined as two or more cities growing together to form one new city it is crucial to continually specify the level of scale at which any observation takes place. When defining a baseline situation for two urban systems, there are two functional structures. Each one is at the level of scale of the respective cities. When defining the endpoint of the process, there is one single (new) functional structure for the developed urban system. In the interim the phase, in which that new system does not yet exist, we still have two functional structures. But we also have a functional structure at a higher level of scale. That higher structure pertains to two urban systems: either the urban network or the system of cities. Spatial processes at that higher level of scale give that system its legitimacy and justify the associated functional structure.

In this thesis, the accent is placed on spatial factors. It should be kept in mind that processes such as transformation and conurbation formation are not necessarily determined by spatial factors. Non-spatial factors can also have an effect. A combination of the two types of influence would seem most obvious. For instance, if we consider a new highway as a possible spatial factor, the effect of this factor will be partly due to the mobility of the residents of that area. The location value of that location and in this case, the issue is *accessibility is determined by diverse factors. Thus, the* increase in prosperity can be attributed in part to the new highway. But the increased mobility, in turn, can also make a location more accessible.

2.4 Characteristics of Functional Structures

Insight into the factors that lead to a given functional structure opens up possibilities for intervention, geared to the development of a desirable functional structure. The intervention might consist of a series of spatial measures in the area of sector policy or facet policy. Otherwise, it might consist of a combination of policy instruments. Government may intervene by way of a series of spatial measures, couched in a spatial design, which might be based on the spatial factors under review. On the other hand, the non-spatial factors might form a basis for flanking policy. Intervention only becomes fruitful if it can be clearly determined what effect the measures would have on the functional structure. In short, the question is, what will the intervention do for spatial quality?

Notions such as desirability and quality call for a normative approach to the characteristics of functional structures. Although these notions are key concepts in the practice of planning, it is my opinion that it is not technology but politics that will play a decisive role with regard to norms and values. Thus, political issues will also have a decisive influence on urban quality. The task of the city planner is thus to provide a backdrop against which political decisions can be made. By no means does that imply that the knowledge thus provided would be value-free. The very selection of characteristics to be investigated is biased, being based on opinions about the quality of the city. Obviously, it is conceivable that

the choice of those characteristics would be inspired by the political agenda. The effect of a functional structure on the promotion of public transport could well dominate the research agenda for the rest of the decade. In that case, countless conceivable effects both desirable and undesirable do not come into the picture.

Kevin Lynch (1981) also deals with the problem of the quality of the city, trying to ascertain the degree to which the practice of urban design can actually be value-free. Yet he cannot break the stalemate. It is not that he tries to ignore the problem; he just tries to resolve it by formulating a normative theory. In doing so, he takes the standpoint that the root of the problem is not the normative character of a theory. Rather, the problem comes from concealing the normative aspects in an attempt to construct a value-free theory. Taking this standpoint as a point of departure, this research should seek to formulate all conceivable effects of functional structures. It should be realized at the outset that the full range of effects will never be known and that the selection of effects to be investigated will never be value-free.
The characteristics of a functional structure may be studied in terms of the difference in structure and the likelihood of (selected) effects. It should be noted that these are dependent on the overall functional structure.

For example: Let us consider two urban elements: a hospital and a large department store. Both elements can function in a city with approximately 100,000 inhabitants. When these two elements are situated far from each other (decentralization) as well as when they are in close proximity (concentration), it is conceivable that both elements can function because of the size of the city. In that case, the difference in structure says nothing about the survival or even the existence of these two elements. In the event of concentration, people using the hospital and people working there can take care of their shopping needs in the department store, either before or after going to the hospital. It is also conceivable that as a result of the influx of people into that concentration of destinations, other urban elements, such as a lunchroom, could be established. In contrast, in the event of decentralization, the separate flows of people would be insufficient to support new elements. The size of the influx also determines the feasibility of collective transport. In this example, concentration leads to an improvement in the working environment of the hospital personnel. Furthermore, the department store profits from its proximity to the hospital. New urban elements emerge and collective transportation becomes feasible. On the other hand, it should be realized that concentration has a negative effect on accessibility by automobile (for instance, affecting emergency vehicles or delivery trucks).

The characteristics of the functional structure described in the above example cover the functioning of individual urban elements such as the hospital and the department store. In that example, the differences do not determine the feasibility or infeasibility of these elements. On the other hand, the same example refers to the functioning of urban elements that are only possible because of that structure. That effect is described by the term symbiosis (N.A. de Boer, 1982; Jacobs, 1990). The third effect to be distinguished here concerns the resulting pattern of mobility. The key concepts used to describe that pattern are congestion and the possibility for collective transportation. In this thesis, we make an explicit choice to restrict the characteristics of functional structures to the effects of symbiosis and the effects on transport flows. This choice leads us to formulate the following objective:

Objective 3:
To determine the characteristics of different functional structures on the basis of the effect of those structures on symbiotic activities as well as the effects on flows of transport.

The point of departure for determining the characteristics of all conceivable functional structures is inspired by a comparison of observable differences between existing functional structures, supplemented with findings from the research literature.

2.5 The Design of Functional Structures

Urban design forms the framework for integration in the process of developing spatial objects, including public space (N.A. de Boer, 1982). In principle, the design will deal with how spatial objects are to be located in space, while it will not deal with the functional structure. On the

basis of insight into the relation between the physical space and the functional structure, the urban design can make a contribution to the development of a (desirable) functional structure. Its effect would be indirect, by way of the realization of spatial objects.

Various instruments of spatial planning are commonly applied in the Netherlands. These include the structure plan, the land use plan, urban structure models, planning concepts[3] and so forth. These instruments pertain to the functional structure. Specifically, they refer to locations for industry and services. In particular, the legal validity of the land use plan guarantees an opportunity to realize the desired functional structure to the greatest extent possible. Its utility lies partly in the fact that it provides a frame of reference for decisions on granting permits, both for construction and for the right to operate a business. Part of the strength of the land use plan lies in the fact that it is a framework in which the kinds of functions to be allowed can be precisely stipulated. However, in many instances, there is no empirical underpinning of the concepts (Zonneveld, 1991) that form the foundation for the land use plan. For that reason, the location that has been designated for a particular activity might not concur with the location preferences expressed by those involved in that activity. As a result, the designated location will remain unused for a long time. Furthermore, the wrong activities will be situated at specific locations, leaving a trail of missed opportunities.[4] Insight into (changed) locational preferences and into the features peculiar to a given location are preconditions for planning whereby locations are designated for specific functions.

The applicability of the insight in those factors that can lead to a given functional structure is constrained by the means that can be used in a given situation. This is especially evident in the absence of an extensive set of legal instruments. In many cases, these means consist only of public works, such as infrastructure and the development of nature preserves and recreational areas. The urban design, as the framework in which to realize those means, should be geared toward management in such cases. Then, the means that are to be realized would have to provide the conditions for the development of the desired functional structure. This would require insight in those spatial interventions that have a guiding but also a restricting effect on the development of the structure. At the same time, that insight should also be profound enough to form the basis for an analysis of diverse sectoral and integral spatial plans. The above considerations coalesce to form a point of departure namely, to make any insights into those factors that determine the functional structure applicable in the urban design for another aspect of this thesis. That point of departure forms the basis for the following objective:

Objective 4:
To develop a series of spatial interventions on the basis of factors that determine the changes in the functional structures at the level of scale of the system of cities. Those interventions would be designed to influence this process of change. Also, to develop an instrument with which to analyze diverse sectoral and integral spatial proposals.

This objective will be pursued on the basis of research into the relation between differences in location value and the functional structure. Those results will be used to find ways in which the location value differentials in a given area might be changed by applying spatial measures. This objective revolves around the manipulation of those spatial objects that are determining factors for the location value and the evaluation of the effect on the functional structure. In addition, this thesis considers how the realization of certain spatial objects can promote or hinder the development of collective activities at a particular location and thereby strengthen or weaken the functional structure.

2.6 Design of this Thesis

Scientific research in the field of urban design cannot be done by experimentation. This is especially evident when studying functional structures. The chief reason is the lack of control over all the various factors in play in a city. But another reason is the wide scope of causality. The great majority of urban developments cannot be explained directly by spatial factors. Also we have not even broached the topic of mono-causality or multi-

causality. In many instances, the context in which a development transpires plays a role that must not be ignored. The lack of control over many factors and the influence of the context itself have implications for the study design. One is that methodology of research in urban design is not analogous to the scientific method as applied in the natural sciences. Despite the technical nature of the field, urban design cannot comply with the principles of hard science. The reason is that researchers in the natural sciences in many cases, at least do have control over the factors and are actually able to study a phenomenon detached from its context under experimental conditions.

The research method is determined not only by the above-mentioned issue of control over the factors and the context. In fact, the most critical issue is the nature of the research objective. The way the question is formulated presupposes a different approach. It makes a big difference if we ask how many multinodal structures exist in Europe or if we want to know when the conurbation Randstad Holland came into existence. Yin (1989, p. 17) has made a global classification of the kinds of research questions and the most appropriate method of research. Let us consider how this classification would apply to this thesis. With respect to the main question of how functional structures arise and the objective to explain that development, the work of Yin suggests that the case study would be the most appropriate method. Yin defines this method as follows: A case study investigates a contemporary phenomenon within its real-life context when the boundaries between phenomenon and context are not clearly evident and multiple sources of evidence are used (p. 23).
The case study was chosen as the research method for the first two objectives of this thesis. There were several motives for that choice. The first reason was the exploratory nature of this thesis, which reflects the dearth of knowledge about the development of functional structures. The second reason was the diverse nature of the objectives. Objective number one is concerned with the relationship between structure and the differences in location value. That question calls for a different approach than objective number two, which deals with how structures change. Furthermore, the problem of the context within which a functional structure develops was another reason to choose the case study as the research method.

In the part of the investigation devoted to case studies, a distinction is made between single cases and multiple cases. The former refer to events that occur only once. The fall of the Berlin Wall is a case in point. Yin (1989) calls this a unique case. The single case also applies to a critical case and to a relevatory case.[5] The category of multiple cases consists of two types. In the first type, the situations are similar; hence the name replication. The second type refers to cases whereby more than one unique event is studied. In the latter type, the aim is usually to find an explanation in a wider context. A good example is research on various events, all of which took place under a communist regime.
On the basis of a nomothetic approach to the development of functional structures in a context of the liberal capitalist economy, it is tacitly assumed that we are dealing with similar situations, which make a multiple case study possible. However, there is one limiting factor. The number of factors that determine the location value, and thereby also the differential in location values, appears to be too large for a multiple case. Thus, the preliminary step is to define which factors are important and to ascertain whether or not there is a conditional series. On the basis of a literature study, we therefore first define one or more factors that can then be investigated as two single cases. The study of those cases centers on the development of the functional structure. Subsequently, the findings from those cases are used as the baseline for a study of the relation between location value differentials and the functional structure. That relationship is examined in the form of a multiple case study.

The third and fourth objectives call for a different research method. Number 3 concerns the design of possible functional structures. In that design, the characteristics that are dependent upon the structure are identified on the grounds of existing empirical knowledge. Number 4 concerns the design of a series of spatial measures. These have to be tested to determine their effect on the functional structure, which can be done by the method known as investigative design (De Jong, 1992). This method is not based on causality but

on conditionality. The point of departure for objective number 3 is that each proposed conceivable functional structure sets prerequisites that could lead to certain effects, which we call characteristics. For objective number 4, it is assumed that the spatial measures, that are to be designed on the grounds of the case studies, will lead to changes in the conditions that are critical to the development of a functional structure. The outcome of the investigative design is two overviews: one of functional structures and their characteristics, and one of the spatial measures that can be applied to the development of the functional structure.

Notes

1.
Diosyncrasy: distinguishing characteristics, peculiarities (normally of individuals).

2.
Derived from the Greek word nomos, meaning law.

3.
Zonneveld (1991) described the scope of planning concepts as wider than that of city planning instruments. Draft plans contain a design for spatial development. But in addition, they also cover numerous administrative measures, guidelines for subsidies, and so forth.

4.
See, for example, N.A. de Boer (1983). In that article, the author gives several examples of situations whereby the spatial opportunities are not utilized.

5.
In a critical case, the investigator tries to find out why an event occurred in that one specific situation. In a relevatory case, the purpose is to uncover the possible causes of an event. (Yin, 1989).

"The static concept of the city is no longer valid. It is constantly changing and growing, and, as it grows, it bursts its girdle and overflows into the countryside. The result is universally viewed with alarm as urban sprawl as being neither city nor country. In this fluctuating mass, the old static patterns dissolve. If any pattern can be discerned, it can only be the pattern of flux. This apparent chaos can no longer be grasped as formation but only as transformation, as historical process"
(Hans Blumenfeld, 1967).

3.1 Introduction

The way the big city has changed in the second half of the twentieth century has led to a multitude of explanations and new visions of the phenomenon we call the city. Disparaging remarks about the dispersion of the city, as expressed in the above quotation, have been interspersed with expressions of awe and a prevailing fascination with new concepts such as urban field (Friedman and Miller, 1965) and city of fragments (Rowe, 1994). In addition, there has been a growing awareness that the new concepts of the city are merely an intermediate step on a long trajectory of development and change, which leads to even larger urban complexes (Tjallingii and Zonneveld, 1993). Urban concepts often turn out to be a translation of a development that is already in progress. Thus, these concepts actually reveal how the cities will probably look in the future. Those concepts are formed by extrapolating from present developments and those observed in the recent past. The concept of urban field that was introduced by Friedman and Miller (1965) is also based on observed trends. That concept is predicated upon the spatial development of the urban fringe and inter-urban zones. According to the authors, that development is determined by three observed trends: rising incomes, more leisure time, and increasing mobility (Friedman and Miller, 1965, p. 315). In fact, as the authors point out, the urban field is the urban area as seen from a wider perspective. The size of that new area is not defined exclusively by the commuting flows to and from a central city.

However, it would not be out of character for practitioners of a technical science to take trends as a point of departure. The fact is that urban design is concerned with creating new spatial qualities. Thereby, the plan can be seen as a set of spatial measures that are considered either necessary or desirable to accommodate societal processes (Klaasen and Jacobs, 1997; 1999). This presumes an understanding of the interaction between societal processes and spatial features. That knowledge can foster trends, help manage them, or even reverse them. Insight into urban development can provide that knowledge, as long as the research from which it is derived has asked the right questions. Berry (1978) suggests that in the geographical sciences, the right questions revolve around which changes have taken place and why. However, the basis for knowledge that can be applied in urban design does not come from asking why certain developments have occurred. Rather, it comes from asking how different spatial elements have given direction to those developments.

Which spatial features play a key role in spatial development? This question may seem elementary. But the number of features that together form the basis for the concept of location value is inordinately large. Faced with the overwhelming complexity of the city, trying to identify relevant and applicable features is like trying to find a needle in a haystack. Therefore, it is imperative to devise a theoretical framework that can steer the search in a fruitful direction.

3.2 Space, Activities, and the Urban System

In order to gain some insight into the way the meaning of a spatial feature is interrelated with the change in the functional structure of metropolitan areas, the urban system is taken as the point of departure. In broad strokes, the urban system may be described as a set of localized urban activities: a place to live, work, and shop,

for instance and the relations among those activities (Bourne, 1975; Hansen, 1978). Those relations may involve the exchange of information, money, energy, goods, or persons. An urban system actually, any spatial system is circumscribed in a spatial sense by those exchanges. We must clearly distinguish the number of moves made by persons within an agglomeration from the number of moves people have made between that agglomeration and another area. Moves of the latter type so-called external relations make it possible to delimit the area (see, for example, Jansen and Van Vuren, 1988). Because an urban system is an open system (Pred, 1977), it will necessarily have external relations.

An urban system, including the functional structure, is continually evolving (Pred, 1980; Hall, 1991). Societal processes that form the foundation of the system can change as a result of technological, ecological, economic, or cultural developments. Take, for example, the transition from a manufacturing economy to a service economy. That shift can set off change in the system. Old activities make way for new ones. And the new ones, in turn, have different locational needs, depending on the nature of the activity. The emergence, disappearance, or relocation of activities within an urban system is crucial to changes in the functional structure. All manner of socioeconomic or technological developments can cause the functional system to change. In the present context, however, we are concerned with the change in locational demands and in the change in locational characteristics. It seems fair to say that the change in the urban area as conceptualized by Friedman and Miller is largely determined by shifts in locational demands for a place of residence. The increased mobility has made it possible to reduce the importance of travel time to and from the place of work. Meanwhile, other preferences have become more significant (Deurloo, 1990). Locational demands with respect to the place of work have changed drastically over the past 50 years. Major shifts in the economic structure have sharply decreased the role of industrial locational factors, making companies footloose (Alonso, 1975a).

The activities that make up an urban system do not take place without cause. Countless factors determine whether or not an activity will occur. The following example of planning for a hospital may elucidate a number of those factors:
— There must be a need (though perhaps latent) for this specific form of health care. Even without a demonstrated need, it would still be possible to build a hospital. But nobody would use it; thus, this activity would not take place.
— There must be sufficient financial means.
— The construction of a hospital must be permitted.
— There must be enough room for the building in which the activity would take place.
— The hospital must be accessible to those persons who play a part in the activity (physicians, nurses, patients, visitors). At the same time, there must be room for utilities such as power, water, and materials to support the activity.

The field of urban design is mainly concerned with the last two factors listed above, namely space and accessibility. The aim of the investigative design would be to find locations that provide opportunities for this activity. This would entail studying the location of numerous other activities such as housing, the generation of power, and the supply of purified water. But it would also entail a study of infrastructure, as the channel of diverse relations. Generally speaking, the locations that are suitable for that activity are those that are sufficiently accessible ensuring that the relations necessary for a given activity are actually feasible and can provide sufficient space.

Theories about urban systems are specifically concerned with the reciprocal relations between activities. In those theories, the concept of accessibility is mentioned time and again as the most important criterion (Alonso, 1975a; Bourne, 1975; Hansen, 1978; Pred, 1977). The accessibility of locations in an urban area or city region has changed dramatically over the past 50 years (Carter, 1984; Camstra, Goethals, and Musterd, 1994). That change is the result of the construction of infrastructure, technological developments, and increased mobility. Indirectly, it is also due to rising incomes and new patterns in the way people spend their leisure time.
It is thus obvious that when we study the development of multinodal structures, we must investigate how

accessibility has changed and the extent to which this leads to changes in the structure.

In this context, it is important to point out that the change in a functional structure is not the same as the concept of urban development. Of course, the process of functional change can be connected with urban development. Nonetheless, urban development is mainly geared to economic development. The emphasis on the economic development of the city actually, of the urban system is indicated by Friedman. As he puts it, 'by development of urban system, I mean the structural growth of urban settlement, measured by population and the volume of economic activities' (Friedman, 1975, p. 266). The process of change in a functional structure is not by definition related to a change in population size or the volume of economic activity.

3.3 The Single-Nodal Metropolis

Every innovation in the field of transport of passengers and freight has an influence on accessibility. The horse and wagon, the tow barge, and the steam-powered tram all had an effect on the functional structure of the city. At the time, these modes of transport opened up specific areas of the city for development. In the main, their introduction reinforced the nodal structure.
During the period leading up to the emergence of the present multinodal structures, the great metropolises come into being. Metropolises like London, Paris, New York, and Tokyo grew at a rapid pace as these cities industrialized, but so did somewhat smaller cities such as Milan, Berlin, and Munich. Berry (1993) explains the rise of the traditional metropolises as a response to the minimalization of transport costs. His standpoint that the (nodal) metropolises come into being as a solution to the problem of slow and costly transport confirms the supposition that accessibility was an extremely important factor. The majority of the activities that depend on the whole city as the market for their products, for instance in order to function, are concentrated in the center of the metropolis. London is a case in point, with its concentration of big department stores and newspapers (the latter in Fleet Street).
The development of collective public transport such as the train, the metro, and the tram seems to have set the standard for the development of the functional structure of the big cities from around 1850 to roughly 1950 (Marchetti, 1985).[1] The radial network of infrastructure and with it a hierarchy of nodes in that network is the hallmark of the tram and metro systems that were built in many urban areas. At the very least, it seems fair to say that there is a relation between the development of the urban rail infrastructure and the development of the functional structure of the big cities. But at the same time, one can only wonder if that specific functional structure can really be attributed to the infrastructure. It might be just as plausible to say that the functional structure whether or not it was desired and planned dictated the development of these rail networks. This comes down to a chicken or the egg quibble: what came first, infrastructure or spatial planning?

In an investigation of the structuring effect of infrastructure, Bruinsma and Rietveld (1992) derive a number of pressure points from an overview of a number of European studies. First of all, they indicate that the effects of the construction of infrastructure are only manifest in the long run. As time goes by, it becomes harder and harder to demonstrate a direct relation. Secondly, they bring up the problem of causality. From their point of view, it is important to ascertain whether infrastructure initiates economic development (the topic of interest to them) or is actually the outcome of economic development. Because of the reciprocal relationship, it is generally hard to prove which cause-effect relation is correct (Bruinsma and Rietveld, 1992). As discussed earlier (see Chapter 2), research into the development of functional structures should actually be focused on conditional relations, not causal relations. In that regard, it has to be considered whether or not a given spatial development is possible at the regional level of scale without a specific form of infrastructure. It should be noted that a conditional relation such as this cannot be assumed to run in only one direction. It can be argued that the development of an industrial estate cannot take place without the presence of infrastructure. This does not mean, however, that the existing (or desired) distribution of urban activities would not exert any influence on the construction of infrastructure. The degree to which infrastructure or activities existing or projected are influential in a conditional sense depends

upon the level of scale. Looking at an existing or projected activity at different levels of scale, that activity appears to be a prerequisite for the construction of infrastructure at a lower level of scale. The existence of another city at some distance is the condition for the construction of a road leading to it, just as a country house is a precondition for a private drive or an industrial estate for links to road, rail, and waterway infrastructure. The possibility for activities, in contrast, is determined by infrastructure at the same levels of scale and higher levels. An industrial estate is inconceivable without proximity to and thus the possibility to link up with infrastructure for regional, national, and international connections. Even the country house is inconceivable without a possible link to infrastructure, making it possible to reach the property from places in the surrounding area.

With respect to the conditional nature of the relation between infrastructure and the development of the functional structure, we can draw another conclusion. It seems fair to say that the construction of tram and metro systems mainly in a radial layout was the precondition for the development of the large cities and metropolitan areas from 1850 to 1950.

3.4 Accessibility

Richardson (1988) observed that in the United States, the transition to a service-based economy coincided with the rise of multinodal urban areas. New economic activities high-tech industry and services in particular seem to have different locational preferences than traditional economic activities. The latter especially banks, insurance companies, and office functions of public agencies and private enterprises tend to prefer the main urban centers. The change in the functional structure of the city is explained from this perspective by changes in the locational preferences and locational behavior of companies and organizations. The guiding principle of many studies that take this supposition as their point of departure is the polycentricity hypothesis. The point of departure is the change from a structure comprising a main center and subcenters to a structure consisting of multiple specialized main centers (Gordon and Richardson, 1996; Cortie, 1994). The most renowned critics of this hypothesis are Waddell and Shukla (1993), who argue that the fixation on the concept of centers hampers efforts to find an explanation for the transformation process. Both the proposition that firms prefer specialized centers and the assumptions regarding which firms are suited to each other are questionable. The investigation conducted by these authors themselves deals with changes (sometimes subtle) in locational preferences and locational behavior exhibited by companies. The observations were not fitted to a predetermined typology of centers. Some interesting conclusions may be drawn from that investigation, in which they describe the changes in the structure of the metropolitan area of Dallas-Fort Worth in Texas as well as from the study carried out by Hessels (1992) with regard to Randstad Holland. Both studies identify accessibility as the key locational factor, while the influence of other factors remains limited. This point is illustrated in the table below, in which accessibility by car is compared to the importance assigned to a highly visible location.

	Importance of location factor:	
	car access	high visibility
Urban Area:		
Amsterdam	90.6%	6.9%
Rotterdam	90.8%	9.9%
The Hague	90.4%	9.8%
Utrecht	90.3%	7.7%

Source: Hessels, 1992. Figures apply to business services.

It is worth noting that accessibility is the predominant locational factor for companies and organizations, not only in nodal structures but in multinodal structures too. The point of departure within the economic context, as mentioned earlier, is that people seek a location that meets the spatial conditions under which that organization or company can exist. Along with sufficient space, good accessibility is still the key to survival. This conclusion is reaffirmed by a comparison of the findings of Hessels with those reported over 25 years previously in the study by Bather (1976). In fact, it is fair to say that companies and organizations, generally speaking, have the same requirements regarding accessibility as were current prior to World War II. The role of transport costs, however, proves to be declining. The term footloose has

been used to denote the decreasing importance of the costs of transport for companies. In this regard, Alonso writes, Industries that have no strong locational preferences, and particularly industries that are not transport-oriented, are often called foot-loose , and there is good reason to believe that technical developments are making more industries foot-loose (Alonso, 1975a). Being increasingly footloose does not necessarily imply that merely because the cost factor is declining every location will provide the conditions for a company or organization to function. Accessibility remains a necessary precondition, and one that strongly depends on the kind of company or organization in question. Foot-looseness simply means that transport costs are relatively less important, not that one place is as good as any other (Alonso, 1975a, p. 58).

The fact that accessibility is still one of the most important locational factors leads to the following proposition. It may be said that the changes that have taken place to usher in suburbanization, decentralization, and deconcentration lie less in the area of activities than in the reciprocal relation between physical space and those activities.

3.5 Mobility and Infrastructure

The functional structure, which is the outcome of the interaction between physical space and activities, is determined in an urban system by the differential in location value. In the above discussion, accessibility is one of the characteristics of a location as part of the total location value of that location. Accessibility is determined by the characteristics of a location, to a large extent by the geographical position and the place it occupies in a network of infrastructure, as well as by people's action radius. Obviously, a location along an highway (system) close to the urban fringe (geographical position) might seem to be easy to reach. But its accessibility depends on the mobility of people. If nobody owns a car, then nobody will use the highway; that seemingly good location would then be inaccessible. The question that now arises is how changes in the area of mobility and infrastructure systems steer the transformation of the functional structure.

When we review a century of metropolitan development (from 1850 to roughly 1950), we see that accessibility has been increased for individuals by innovations in public transport. The era of foot traffic made way for a new age of technological change in transportation: the horse-drawn tram was followed by the diesel and the electric tram and eventually by rapid transit in the form of the metro. These consecutive innovations increased the individual action radius from roughly two kilometers to somewhere between ten and fifteen kilometers for a trip taking from 30 to 45 minutes. The train extended people's action radius even further. This growth in mobility boosted the development of the nodal structure. The explanation for the effect on the development of the functional structure lies in the characteristics of the rail systems that were constructed at the time. First of all, the most predominant kind of system was built of radial networks, which led to the emergence of a hierarchy of nodes. The hub is the point at which all lines converge, which is usually the central station. It differs from all other stations mainly in terms of the maximum number of passengers that can reach the central station within an acceptable length of time. A central station generally accommodates more passengers in that time frame than the other stations. At the level of scale of the city, the radial network of rail infrastructure has several more key characteristics. One is that this design leads to a differential in accessibility between diverse nodes. Another is that it reinforces the nodal structure by way of its hierarchical structure (see Fig. 3.1). Moreover, the spatial characteristics of rail

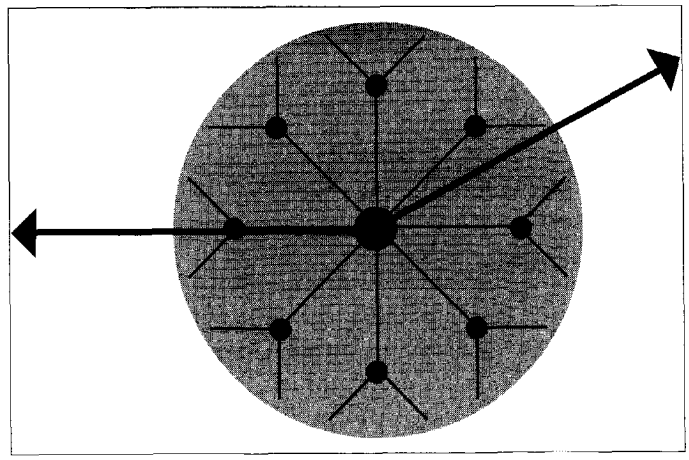


Figure 3.1
Radial network of rail infrastructure and hierarchy of centers

infrastructure do not hamper the development of one single center. It is actually conducive to concentration of activities. The reason is that rail infrastructure requires relatively little space, compared to the present needs of automobile infrastructure.

The increase in individual action radius and personal mobility forms an important precondition for the growth of the metropolises that took place from 1850 to 1950. The fact that the functional structure of these urban systems is for the most part nodal must be attributed to the characteristics of the rail infrastructure. Those features have led to the wide differentiation in accessibility.
In the course of the twentieth century, personal mobility has changed dramatically because of the automobile. This reflects the higher average travel speed possible by car (when there is no congestion) compared to collective modes of transport such as the bus, the tram, and the metro. But it is also the result of building roads of different orders. This has made the action radius of the car considerably wider than that of the train, the tram, and the metro.
Obviously, the location of railroad tracks and stations will have a strong influence on the action radius of a traveller. Therefore, it is primarily this increase in individual accessibility by car that has paved the way for suburbanization the outward diffusion of residential functions (Deurloo, 1990). It cannot, however, be said that the residential function would be primarily situated at the most accessible location in an urban area, even if accessibility were considered the main locational criterion. The reason is that for individuals to function in a city, they must have the opportunity to make use of all kinds of urban amenities. And that implies that those amenities would have to be accessible from the home. For those activities that cannot function without accessibility by individuals, it is fair to say that the most accessible location or rather a sufficiently accessible location would be a precondition. The fact that those urban and regional activities that are embedded in a multinodal structure are spread out over the urban area has an important implication. It suggests that multiple locations are sufficiently accessible, not just one single location as in the case of a nodal structure.

3.6 The Automobile and Public Transport: Differentiating Capacity

The influence of a transport system be it based on the automobile or mass transit is closely tied to the characteristics of such systems. The most important feature of mass transit is that in order for this system to function and thereby to be able to serve people's demand for mobility, concentration is imperative. This refers primarily to concentration in a physical sense. There have to be enough points of origin and destination near (or within reasonable walking distance to) the stops designated by the system. Physical concentration which comes down to a concentration of population is a condition for running mass transit. If this condition is not met, the critical mass at which the system could function will be absent.
Besides concentration in a physical sense, concentration in a temporal sense is also a condition. If a group of people want to travel from point A to point B at the exact same time and if the condition of physical concentration has been met, then mass transit may be feasible. To the extent that the temporal concentration decreases, the degree of individualization of mass transit will increase. In that event, micro-buses and taxicabs would be more appropriate.

In this light, the automobile and mass transit seem to be at opposite ends of the spectrum. Consider the amount of space that is required for road infrastructure and parking. Clearly, there is a need to disperse places of origin and destination as well as to spread trips out in time. Physical dispersal becomes necessary as soon as the supply of space in a place of origin or destination becomes too small with respect to the capacity of roads and parking places. The congestion that arises at that point is also connected with the phenomenon that many people want to be at the same place at the same time. In that sense, congestion is also a problem of too much temporal concentration. Some typical examples are rush hours in the morning and evening and trouble finding a place to park on shopping nights and saturdays. The automobile system can only function when both the physical and temporal congestion has been relieved. However, it is harder to spread trips out over time than in space, due to the way society is organized (hours of

work, the school day, opening times for services). Therefore, the dispersal in space would appear to be the main feature of the automobile system.

On the basis of the conditions for diverse transport systems, we can look into the effect that these systems have on the development of the functional structure. The term differentiating capacity[2] denotes that type of influence. Take any town with 100,000 inhabitants and an arbitrary form as an example (see Fig. 3.2). Without

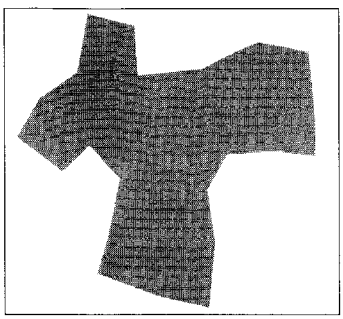


Figure 3.2

taking the need for space for both the mass transit system and for the automobile system into account, and assuming a homogeneous distribution of population and a homogeneous network of roads and railway lines (think of it as an asphalt surface, for example), we may say that the location with the best accessibility for activities that relate to the city as a whole is the city center (see Fig. 3.3). In this hypothetical situation, all modes of transport (by foot, bicycle, car, bus, train) refer to one single point where the sum of all individual travel

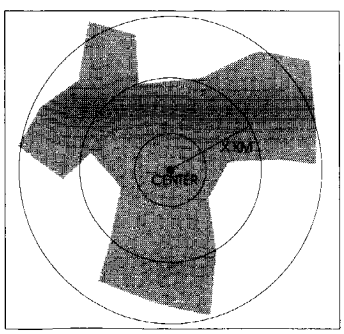


Figure 3.3

times is smallest. (This also applies to the case of two or more urban entities. In that event, the point with the best accessibility may lie outside the corpus of any of these cities.) When we subsequently consider the demand for space, then we see that congestion arises sooner in the automobile system than in systems based on other modes of transport. It may be recalled that mass transit still offers ways to concentrate all urban activities around one point, with the exception of those activities that need a large amount of space. A similar concentration is no longer possible in a system based on the automobile. In a homogeneous situation, a surface will then be created where there is also enough room for the car. Looking at the city as a whole, this surface represents a concentration of activities. At a lower level of scale, however, there is some dispersal. Meanwhile, with regard to mass transit, the situation at the same level of scale shows signs of concentration (see Fig. 3.4). The conclusion that the automobile-based

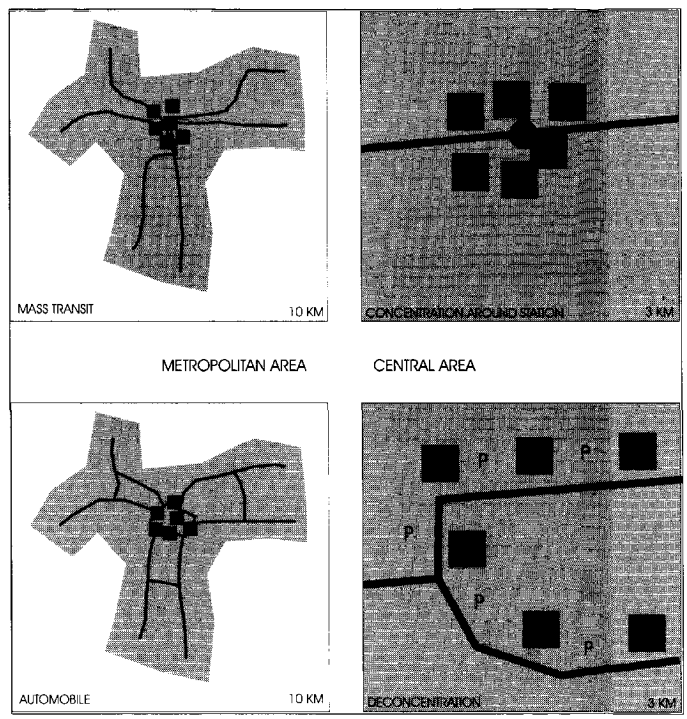


Figure 3.4
Concentration-concentration and concentration-deconcentration

system is conducive to dispersal indicates that the differentiating capacity of the automobile system is smaller than that of the mass transit system. The degree to which the differentiating capacity determines the dispersal versus the concentration of activities and thereby the development of the functional structure will nevertheless also depend on the degree to which those activities are dependent upon a transport system.[3]

With the increase in (automobile) mobility and (automobile) infrastructure, more locations meet the spatial conditions that companies and organizations

need in order to function. Such an increase can be seen as the most important background to the transformation process leading to a multinodal structure characterized by suburbanization, deconcentration, and decentralization. In other words, more locations are adequately accessible. We might say that the increase in mobility and the expansion of infrastructure (through extending the physical system) has created the conditions for dispersal. In particular, they provide the prerequisites for the development of a multinodal structure. However, the actual occurrence of suburbanization, decentralization, and deconcentration and the concomitant transformation into a multinodal structure is determined by numerous push and pull factors. The impetus for these process comes from the desire to live in a suburban area, for instance, or to establish an office at a highly visible location. The physical prerequisites remain paramount, however. If the spatial conditions are not met, the transformation will be impossible.

3.7 Transformation

In Chapter 1, we distinguished three ways in which a multinodal structure can come into being. These were called transformation, emergent conurbation, and multinodality as the starting point for designing or founding a new city. Transformation is probably the most common way in which a multinodal structure arises. The reason is that transformation is a process of change that can apply to all urban systems. In the case of an emergent conurbation, the mutual proximity of two or more urban systems is a condition. Because of that condition, this process will be less usual than transformation. There are no extant examples of multinodality as the point of departure for the design or foundation of a city. Indeed, the designs and concepts for Randstad Holland, the urbanized western part of the Netherlands, were based on multinodality and are manifestations of processes of change (N.A. de Boer, 1996; Van der Cammen, 1988).

Transformation may be distinguished in two developments (see Fig. 3.5). One is decentralization. This term denotes the emergence of one or more new concentrations of activities that have significance for the entire urban system. The other is deconcentration. This term refers to the dispersal of activities that have significance for the urban system as a whole. Formally, decentralization is a kind of deconcentration. But in practice, decentralization may go hand in hand with the emergence of concentrations. The existence of decentralized concentrations suggests that only at the locations of the new centers are the physical and the non-physical conditions met that allow the siting of urban activities. Thus, there is a significant difference between the location value of these central locations and that of other locations. The extreme situation in the case of deconcentration is a complete dispersal of urban activities. This means that it is no longer possible to discern any concentration whatsoever. In that case, the difference in location value and specifically the accessibility score providing the physical precondition for such dispersal would have to have leveled off.

3.7.1 Decentralization

In the event of decentralization, there are apparently enough spatial conditions present at multiple locations within the urban system to allow the siting of activities that relate to the entire system. In a nodal urban system, those conditions are only met at a single location. In a multinodal system, in contrast, those conditions are met at multiple locations. Let us suppose that accessibility within such a system constitutes the main

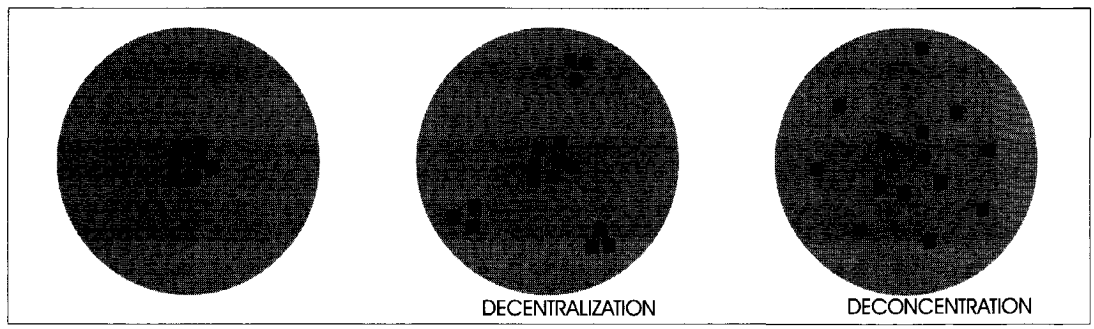


Figure 3.5
Transformation

condition for the siting of urban activities. Then, we may say that given a slight difference in the degree of accessibility of two or more locations within an urban system, whereby these locations are the most easily accessible within the entire urban area, the spatial condition is met for the formation of a multinodal structure. In such a case, when an activity performs a function for the whole urban system, it makes no difference to the accessibility whether the activity is sited at one of those locations.

When all conditions at two different locations are equal, the nature of the activities at those locations might also be the same, more or less. Differences between the conditions for example, a difference in the kind of accessibility (by car or by mass transit), in the cost of land, or in architectural features of the surrounding area (urban fringe or historic inner city) might be determining factors in the emergence of centers that differ with regard to the nature of their activities. Let us suppose that there is just one location in an urban area that can be easily reached by public transport and just one other location that is easily accessible by car. In that event, it is conceivable that urban activities that depend for their functioning primarily on accessibility by public transport will establish their premises at the location that meets their specific needs. Similarly, activities that are dependent upon access by car will choose the other site. The result is then a multinodal structure with centers that differ in terms of their functions (see Fig. 3.6). Shops, entertainment areas, offices, and

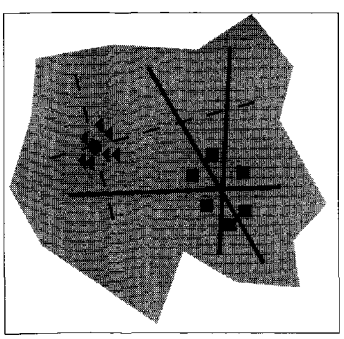


Figure 3.6
Public transport node and automobile node

companies all pose their own particular requirements for accessibility (N.A. de Boer, 1978, 1979; Bongenaar, 1993). Assuming that some activities have only one accessibility requirement that being either by public transport or by car we may say that a situation in which the location that is most easily accessible by public transport is not likely to be the same as the location that is easiest to reach by car will fulfil the physical condition for the formation of a multinodal structure. In that case, the centers will differ with regard to their package of activities. In view of the dependence on the nature of the activities in the formation of the centers, we may conclude that decentralization is dependent not only on the physical conditions that are fulfilled but also on the kind of activities that (could) occur in an urban system.

Decentralization can occur as the result of the increase in mobility. In a situation where the transport system is radial (see Fig. 3.7), it may be true that at a given pattern

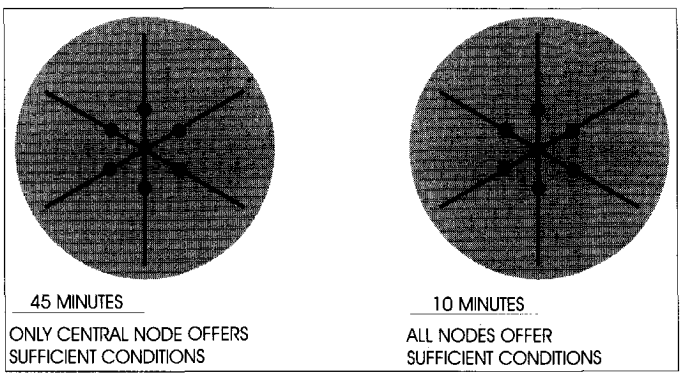


Figure 3.7 Increase in mobility

of mobility, the hub of the rail lines would be the only location in the entire urban area that can be reached within an acceptable amount of travel time. Only that location would then offer sufficient conditions for siting urban activities. If personal mobility were to increase for instance, because the trains start to run at a higher speed or because the amount of available travel time increases it would then be possible that, in the situation described here, stations and stops near the hub could also be reached from anywhere in the urban area within an acceptable amount of travel time. Then, the accessibility of these stations or stops would be sufficient for siting urban activities. In principle, a multinodal structure can then arise.

Building new infrastructure has an even stronger effect on the change in the accessibility of a location. For instance, by building a new rail link or metro line, a new node can be created that offers the same accessibility

conditions as an existing node. This phenomenon is characteristic of the construction of beltways.

3.7.2 Deconcentration

The spatial dispersal of urban functions at the level of the urban area has increased considerably over the past few decades. In that light, deconcentration may be seen as the key development in the formation of multinodal structures. Also according to Allaert (1999), who shows that deconcentration is a common process for large overlapping urban structures. Research by Waddell and Shukla (1993) demonstrates that deconcentration is particularly focused on the dispersal of employment and housing. Activities that are dependent upon a high concentration of walk-in customers, such as retail stores, appear to be less susceptible to deconcentration. Small shops in particular insofar as they perform an urban function exert an insufficient attraction when taken individually. At the same time, individual shops generate relatively many trips among their customers. Concentration in the form of shopping centers and malls boosts their attraction. For larger shopping facilities but also for amenities such as a sports stadium, a theater, or a museum, all of which need to draw visitors in large numbers it may also be true that because of their size, they exert a sufficient attraction to warrant a location at some distance from concentrations of urban activities.

Just as for decentralization, it appears that deconcentration must be grounded in (spatial) conditions that make such a development possible. Taking accessibility as the chief condition, it may thus be said that the difference in accessibility between the existing (old) center and the dispersed locations is limited. For complete deconcentration to take place, the accessibility differentials must be completely leveled off. Deconcentration appears to be restricted to those activities that are less dependent upon public transport. This fact is connected with the characteristics of the public transport system, on the one hand, and the automobile system, on the other. A point discussed earlier should be kept in mind, namely that a public transport system has a high differentiating capacity, whereas an automobile-based system does not. Increased mobility has an effect on deconcentration, just as it does on decentralization. But unlike decentralization where the new locations with urban activities can be observed as concentrations, and therefore a sufficient degree of accessibility is only manifest at those locations the development of employment in particular seems to spread unchecked in the case of deconcentration. The increase in accessibility does not show up at specific spots such as stations. Especially as a result of the increase in automobile traffic and the construction of radial infrastructure that is built for driving at higher speeds, the conditions arise for an expansion of the central area. The construction of tangential infrastructure can lead to further increase in the number of areas in which accessibility is sufficient for the location of urban activities. And that makes further deconcentration possible.

3.8 Emergent Conurbations

3.8.1 System of Cities

The concept of multinodality is often associated with the development of large-scale urbanized areas. The motto seems to be, "the bigger, the better". When the term megalopolis was coined (Gottmann, 1961) to denote the urbanized eastern seaboard of the United States, it seemed to lend legitimacy to the existence of many other metropolitan areas. These include the Tokaido Megalopolis in Japan (Nagashima, 1981), the Ruhr Area in Germany (Van der Cammen, 1988), the Flemish Triangle of Antwerp - Brussels - Ghent in Belgium (Zonneveld, 1989), and Randstad Holland as well as the Netherlands Central Urban Ring (consisting of Randstad and its surrounding area) in the Netherlands (Van der Cammen, 1988; Musterd and De Pater, 1992). In citing those examples, all these authors suggest that the relations between the cities in such an area are increasing. Buys (1992) argues that political, economic, and cultural developments contribute to the formation of networks by pressure from the outside. This amounts to the creation of urban networks. The ensuing development is characterized by a shift away from the traditional relation between the city and its hinterland, as described by Christaller, towards new relations among cities (Musterd and De Pater, 1992).

It is tempting to go along with the new trend and think metropolitan. However, taking a critical scientific

perspective, we must first determine whether or not we are looking at a coherent whole. Are these examples of new urban systems that surpass the existing ones in size? Or are new systems emerging? Before we can answer these questions, we must take a closer look at systems of cities.

A system consists of a set of elements and the relations between the elements or their characteristics. By extension, an urban system comprises a set of urban elements and the relations between them (Pred, 1977; Hansen, 1978). An urban system can exist because of the relations between housing, employment, and services (Blumenfeld, 1949; N.A. de Boer, 1982; Klaasen and Witberg, 1993) as well as the fact that a distinction can be made between the scope of those relations in the territory covered by the urban system and the area outside of it. The urban system (also called the daily urban system) can thereby be circumscribed by noting the difference in the intensity of the regularly occurring relations between place of residence and place of work, between housing and services, and services and jobs in a given area compared to the intensity of the relations elsewhere. The research carried out by Vance (1977) as well as that done by Marchetti (1988) indicates that urban systems in Western countries are delimited by trips that take between 45 minutes and an hour. Vance also demonstrates that this travel time, which he calls the maximum desirable commute, has remained constant for centuries, regardless of the modes of transport that are available. Given that time frame and the present modes of transport, it is unlikely that the areas named at the beginning of this section are really urban systems, in view of their size. This is all the more evident when we recall that the average distance that a person tends to drive on a daily basis is no more than 25 kilometers (Levinson and Kumar, 1994; Schafer and Victor, 1997). This might suggest that we are looking at the development of systems at a higher level of scale, such as urban networks. At that higher level, the urban systems themselves are elements of a spatial system. Therefore, there must be an intensification of relations between urban systems, as described by Buys (1992).

The relations between urban systems constitute an important focus of study in the fields of urban and economic geography (Pred, 1977; Bourne, 1974; Berry, 1973; Friedman and Alonso, 1975). In the research on the system of cities, the central question concerns the influence that the overall system exerts on the economic growth of the elements of the system: the urban systems themselves. Pred (1977) describes a system of cities in the following words: "A system of cities is defined as a national or regional set of cities which are interdependent in such a way that any significant change in the economic activities, occupational structure, total income or population of one set member city will directly or indirectly bring about some modifications in the economic activities, occupational structure, total income or population of one or more other set members." (Pred, 1977, p. 13) In light of this definition, we might think that a system of cities would cover an enormous range. That image could give the impression that what we are looking at is a global system.

In order to gain insight into the way in which a system of cities exerts an influence in a spatial sense, particularly on the development of multinodal structures, priority should be given to the relations between urban systems. This presupposes the existence of a link between those relations and the location of diverse urban activities. Relations between urban systems consist of the exchange of information, capital, goods, services, and people (Pred, 1980). When the exchange takes place on a regular basis, we may say that there is a pattern of relations. Consider an arbitrary large city in Western Europe. There, we will find an enormously complex pattern of all manner of relations between individuals, companies, and organizations, both within the city region and with other cities. Yet studies by Jansen and Van Vuren (1988) and Van der Laan (1994) reveal that especially the traffic flows between urban systems are considerably lower in volume than the flows within the urban systems. Moreover, at a higher level of scale, no coherent spatial entities can be observed. Thus, for the time being, it would be incorrect to speak of a system of cities in a spatial sense. Studies by Bourne (1975), Berry (1973), and Friedman and Alonso (1975) regarding the relations within a system of cities also confirm the existence of reciprocal economic dependency in urban systems. Nonetheless, their findings do not support the idea that systems of cities really exist in a spatial sense.

Parkinson (1992) also approaches the development of urban networks or systems of cities from an economic angle. He has established that the main issue is the development of coalitions between different cities. The key functions involved are knowledge transfer, promotion of technology, and economic cooperation. Meltzer (1984) coined the term 'Metroplex' for what is widely seen as overlapping urban structures that grow into economic networks. The fact that the scale of building such networks can differ widely is demonstrated by the three types of networks that Robson distinguishes. These types are 1) groupings of world cities, specifically London, Paris, and Frankfurt; 2) groupings of big second cities, namely cities that are confronted with economic, social, or spatial problems; and 3) groupings of smaller cities that are confronted with spatial expansion problems (Robson, 1992). When we try to explain the emergence of multinodal structures in a process whereby two or more cities converge to form one, it is more plausible to say that a new urban system is developing. This interpretation is based on the assumption that the location of urban activities in an urban system is influenced by potential relations with elements of a nearby urban system. In the process, the boundaries between urban systems tend to fade, and patterns of relations that we could previously observe separately tend to coalesce into a new entity.

3.8.2 Interacting Urban Systems

In 1915, Geddes wrote Cities in Evolution, in which he described the development of conurbations as a process whereby two or more cities converge to form a new cohesive urban unit. Since then, this topic has received remarkably little attention. Blumenfeld (1967) mentions conurbations as a different form of city but does not elaborate further. All he says is that there exist other metropolitan areas that are poly-nuclear, resulting from a process for which Geddes (1915) coined the term conurbation, the growing together of several independent cities (p. 52). Alonso (1975b) also mentions this phenomenon, describing conurbations succinctly as areas where the zonal boundaries of diverse centers overlap in complex patterns, and a person may be a member of two functional cities. Some of the questions that could be investigated to shed light on the development of strongly urbanized areas concern how these complex patterns have come into being, how a conurbation is formed, and whether or not such processes differ across urban regions.

The point of departure for Geddes (1915) theory of the emergence of a conurbation is that because of the continual increase in means of transport and communication, separate cities will increasingly influence each other and will become more and more of a unit in a social, cultural, and economic sense. On the grounds of that theory, we can expect a conurbation to evolve out of at least two urban systems, whereas the ultimate result is a single and larger urban system. Moreover, the real process of change begins as soon as the separate urban systems start to exert a spatial influence on each other. In the period leading up to that point, we would have to say there are separate urban systems. Between those systems an exchange of information, money, goods, and so forth takes place. That exchange occurs in such a manner that it is not a determining factor in the functional structure of the individual urban systems. This situation may be described as interaction. That term denotes the existence of relations between two or more urban systems, whereby those relations do not determine the functional structure. Theoretically, an urban system devoid of interaction is conceivable. However, the current global exchange of information ensures that virtually every urban system is engaged in interaction.

3.8.3 Interference

The main boundaries of a city system are formed by what Vance (1977) calls the maximum desirable commute, which amounts to roughly 45 minutes. In a typical situation where it takes, say, six hours to travel between two cities we may assume that few if any people make the trip from city A to city B every day. The labor market and the service area of the two cities will not overlap. In view of the time it takes to get from one of

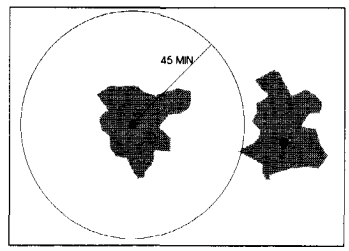


Figure 3.8
Two cities, roughly 1 hour apart

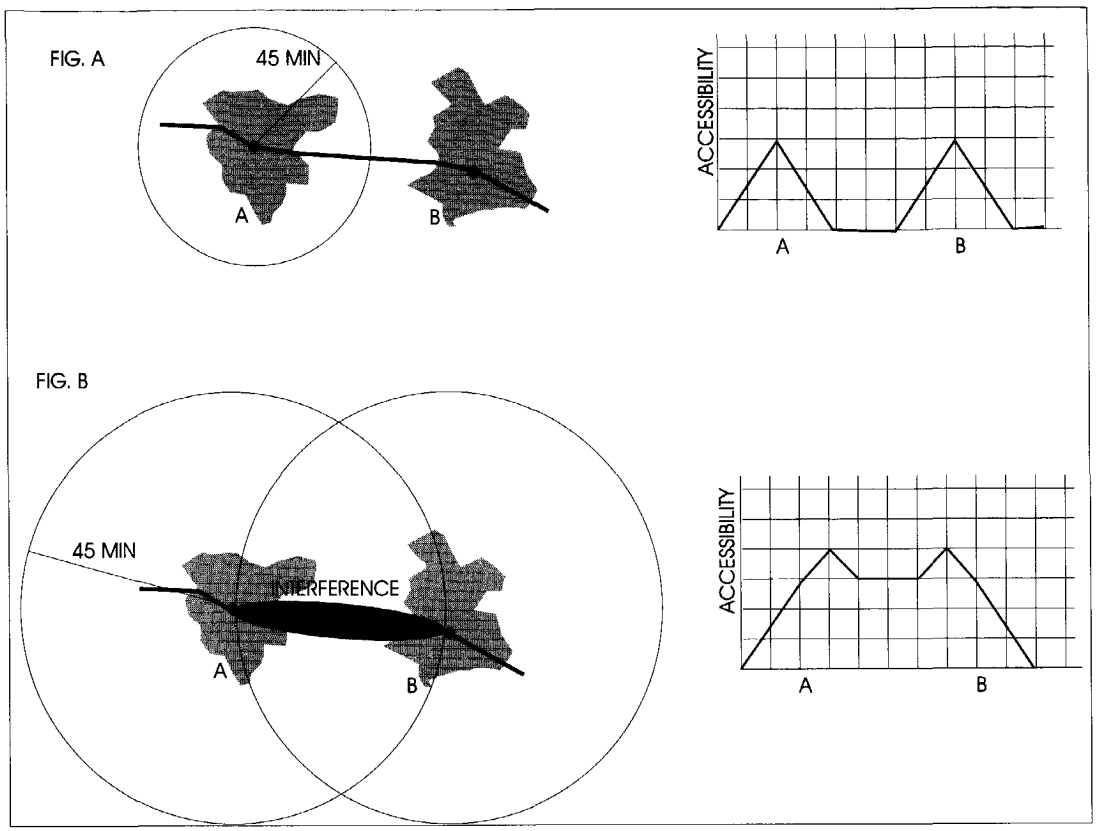


Figure 3.9
Decreasing travel time and interference

these cities to the other, any possible benefit that companies and organizations might gain by choosing a site along a road leading out of town, for instance, would be negligible. The time it takes to traverse one of the two cities is a fraction of the time it takes to get from city A to city B. In contrast, the amount of time that could possibly be gained becomes greater as the travel time between the two cities decreases. To the extent that the accessibility from the other city plays a role in the selection of a location, the position of that other city will exert an influence on the functional structure. That would be a case of interference. By interference we mean the mutual influence on the functional structure of two or more urban systems as a consequence of their relative proximity. That influence is determined by the significance of the accessibility of one or more nearby urban systems. One example would be the enlargement of the service area for businesses. Another would be an increase in an individual's choice of jobs as a result of the expansion of the labor market.

Intervening opportunities are created when those companies and organizations that normally could be expected to establish operations in a particular center, in view of the size of the city systems in question, select a site that can be reached within 45 minutes from several urban systems. One example is a shop that can only stay in business with a population base of at least 100,000, while there are two cities each with 100,000 inhabitants that are roughly one hour away from each other, measured from core to core (see Fig. 3.8). If the shop is sited in the center of one of these cities, it could not benefit from the economic basis of the other city. In that case, there is no interference. In another scenario, the shop might be sited along the road connecting the two cities. In that case, the clientele of this shop would be made up of a percentage of the residents of city A and a share of the residents of city B. Then we would speak of interference.

The economic base, the service area, and the labor market are all dependent on accessibility, as well as on the size of an urban system. Figure 3.9 clearly shows how the decline in the travel time between two urban systems of equal size generated locations where interference activities can take place. In the starting situation (shown in Fig. 3.9.A), it takes more than 45 minutes to travel from the edge of one city to the edge

of the other. The accessibility of any given location in either city A or city B expressed as the size of the area from which that location can be reached is in that case no larger than the size of A or B. As the travel time decreases (Fig. 3.9.B), the accessibility value increases in the area lying in between the two cities. The accessibility value of areas along the road and in the urban fringe bordering the area lying in between the cities will first rise. If that value is greater or equal to the maximum value of A or B individually, then conditions at the location in question are sufficient for the establishment of collective activities that would correspond to the level of city A or B. A further increase of that accessibility value would theoretically lead to a rise in the level of those collective activities. In this regard, we should note that accessibility is just one of many locational factors. In terms of accessibility and perhaps also in terms of the price of land locations along the road between A and B would be competitive with locations in existing centers. Aspects such as historic features, in contrast, could be considered advantageous to existing centers. The important issue is the conditional relation between accessibility and the location of collective activities. The greater accessibility, as sketched in Figure 3.9.B, therefore fosters the emergence of locations where interference could take place.

Figure 3.10 shows the effect of the increase of accessibility in two urban systems of differing size. It appears that the smaller system B, in particular, is affected much more strongly than A as a consequence of their mutual accessibility. A further increase in accessibility only leads to an increase in the accessibility value in B up to the point where the maximum is reached in both A and B. This phenomenon seems to offer a way to explain the strong development of suburbs surrounding a large city, which are no longer inferior to the central city as a result of the increased mobility i n the sense of accessibility.

3.8.4 System Development

Interference is associated with a development whereby the mutual accessibility of two (or more) urban systems increases from being inaccessible to being partially accessible. In the latter case, the accessibility is greater

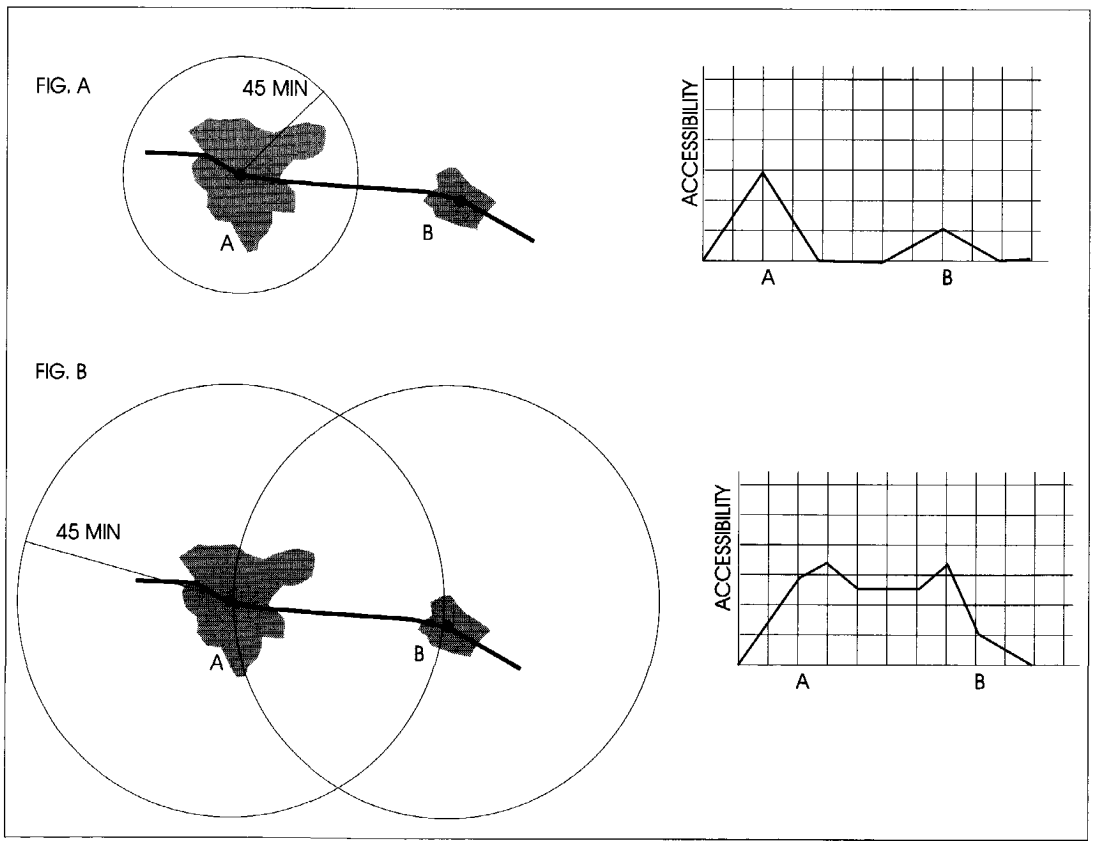


Figure 3.10
Decreasing travel time and interference, inequal size

than or equal to the maximum value in one of the individual urban systems. As the accessibility increases further, locations may sprout up that can be reached within 45 minutes from anywhere in the entire urban area covering all of the urban systems in question. When the urban systems are very different in size, a development of this kind will have a negligible effect. As a conurbation develops between an urban system with a million inhabitants and one with ten thousand, the latter will be influenced significantly by interference. One way in which interference could have an effect is by increasing the population base from ten thousand to one million and ten thousand inhabitants. The increase in the larger urban system is the same in size though it represents a much smaller percentage. A one-percent increase in the population base cannot be expected to provide the necessary support for collective activities that would greatly surpass the level already attained. This is, of course, different when the urban systems involved in the emergence of a conurbation are more or less the same size. The reason is that the base is doubled in that case.
The fact that one or more locations can be reached within 45 minutes from two or more previously independent urban systems does not necessarily mean that a new (and bigger) urban system has been created. That would only be the case if it proves that the majority of the physical trips traverse the territory of the previously independent urban systems. This can be determined by looking at the traffic flows in a given area.

Let us consider the situation sketched earlier where there are two urban systems that differ greatly in size. In that situation, the establishment of collective activities catering to the entire urban area would imply the creation of a new urban system with a multinodal structure. In view of the great difference in size, this development specifically, the effect on the level of the new collective activities is almost comparable with the transformation of a single urban system. Regarding the existing concentrations of collective activities in the largest urban system that is involved in this process of conurbation formation, it is reasonable to expect that these will also play a significant role in the new situation. When the emergence of a conurbation leads to the convergence of two equally large urban systems to form one new urban system thereby doubling the population base, the labor market, and the sales territory it is likely that the new concentrations of collective activities will surpass the level of prior concentrations. Thus, at the level of the new urban system, the old centers are actually subcenters, each having a function for part of the urban area. This means that only the new centers will then have a function for the overall urban system. Of course, new collective activities may be established in the area of one of the older centers, as long as the accessibility condition at that location is adequately provided for. We can observe the emergence of a conurbation by looking at the development of new collective activities that have a demonstrable function for the entire urban system. In particular, that function is manifest in the place of origin of both clientele and personnel.

At times, a conurbation may develop by fits and starts. It should be realized that the process could stagnate in the interference phase, due to the effect of the limiting factor of accessibility and thus of mobility, infrastructure, and modes of transport. Major changes such as the rapid increase in motorized traffic in a region or the construction of bridges and tunnels to surmount barriers can lead to the further development of a conurbation. It is also true that the emergence of a conurbation does not necessarily lead to the formation of a multinodal structure. If only a single location is accessible within 45 minutes from any place in the entire urban area whereby only that one location will offer sufficient conditions for the siting of collective activities with a function for the entire urban system then the development of a new nodal structure would be more likely. In highly urbanized areas, the picture seems to be dominated by the development of multinodal structures as a consequence of the emergence of a conurbation and sometimes the accompanying transformation.

3.9 Properties of Structures

3.9.1 Quality: a Normative Choice

Since Jane Jacobs (1961) critique of the orthodox city planning theory as propounded by Lewis Mumford and Catherine Bauer, among others, the quality of the city has been the subject of debate that flares up from time

to time. The normative top-down approach has been dominated by the innovators of city planning and master builders such as Ebenezer Howard and Le Corbusier. They laid the groundwork for the aims that a city would have to achieve, but they also set the spatial parameters for the task. This normative approach eroded further and further during the seventies and eighties. In order to formulate planning targets, efforts were made to measure quality objectively (see for instance Doxiades 1967 book on the Objectives of Ekistics), but most of these stranded in generalities. The process of translating these general quality targets into planning criteria seems to be determined by gut feeling and subjectivity.[4] It seems almost inconceivable that we could determine objective criteria by which to measure the quality of a city or its functional structure. The problem is altogether different from the task of measuring the quality of technical objects such as an airplane engine, whereby criteria can be related to the purpose that object serves. Those criteria would be thrust, fuel consumption, cost of production, cost of maintenance, and lifespan. In a non-technical situation like the one that concerns us here, however, one can hardly imagine what purpose a city might serve (De Jong, 1992). Even assuming that it would be possible for a city to cater to the desires of the present generation, it remains to be seen whether that effort would expand the options of future generations or restrict them. Flexibility or the capacity to change might be more important in that respect than any other aim. Is it then fair to say that a multinodal structure would have greater flexibility than a nodal structure? Then we must consider how to define flexibility. If flexibility is translated as the capacity to adopt new developments, to provide room for innovation, then Hall's research (1995) might offer some points of departure. He asks if cities can be innovative and, if so, which characteristics they would have to display. His studies reveal that many new developments such as the rise of the film industry in Hollywood and the massive expansion of computer technology in Silicon Valley take place on the edges of the urban system, precisely where the climate is favorable to entrepreneurs. According to Hall, traditional centers are too conservative for entrepreneurial activity. On that basis, one might posit that a nodal structure, in which there is usually one single historically developed center, would offer fewer possibilities for innovation and thus be less flexible. Hall's analysis of Tokyo, on the contrary, shows that a traditional center can also provide scope for innovation. Some questions remain, however. To what extent is innovation really related to the spatial structure? What is the role of administrative bodies? The role of numerous other factors has yet to be determined. The traditional centers or the nodal structures, as the case may be have the capacity to absorb new developments into themselves. This fact has been amply demonstrated by cities such as Paris, Milan, and Amsterdam. For centuries, their centers have hosted many different functions. Thus, nodal and multinodal structures do not differ from each other in this respect. In that light, the mere distinction between nodal and multinodal would not seem to provide sufficient grounds on which to make generalizations about flexibility.

The Fourth Policy Document on Spatial Planning (Ministry of Housing, Spatial Planning and the Environment, 1988) expands upon the concept of Randstad Holland as a polynucleated metropolis and implicitly attributes to it the characteristics of complementarity and specialization. In the same vein, Cortie (1994) takes the standpoint that specialization provided that it occurs expressly within a single daily urban system[5] forms the definitive feature of multinodality. It was argued earlier that multinodality can also be determined by the existence of centers that are more or less equal. Notwithstanding that earlier point, the idea of specialization forms an interesting challenge in the discussion of the characteristics of the functional structure. What is the driving force of specialized and monofunctional centers? Do they bring order into the complexity of urban activities? Are they a product of a short-term vision of the city as a volatile, changeable object that is continually being redesigned for new functions as a counterpoint to the static, conservative multifunctional bulwarks of venerable banks and department stores? Is a multinodal, specialized structure actually more flexible in the long run? Or is this true of multifunctionality instead?

Not so long ago, the Denver Post (February 9, 1997) reported that a 15-year-old regional shopping center was

to be closed as a result of the decision to move the stores to another location in the city. This is a telling instance of the fate of small-scale specialized centers or stand-alone superstores. The disappearance of such objects has a negative effect on the immediate surroundings. Furthermore, it is impossible to put in a high-quality public transport system to serve short-lived centers of this kind. These two effects show that a multinodal, specialized structure has drawbacks. On the other hand, it is remarkable how easily new centers can arise. Thus, it is important to note how an ample provision of spatial conditions makes it possible for the spatial structure to change continually. In this regard, it is hard to objectify flexibility. From the standpoint of companies and organizations that can function independently that is, without depending on the direct proximity of other activities an urban area with a favorable climate is one in which any place is as good as any other. Such a climate offers companies the freedom to establish premises throughout the area. Thereby, the firms may be able to get around the various problems of classic multifunctional centers that have been identified the lack of space, the high price of land, and expensive premises (Dewulf and De Jonge, 1994). On the other hand, some activities are indeed dependent on the proximity of other activities. For these so-called symbiotic activities, the flexibility of such an urban area would seem to be unfavorable. The place-hopping behavior typical of strong activities compels these symbiotic activities to continually pack up and move too. The risk is that the volume and the nature of the activities at the new location might be an inadequate basis on which to survive.

When analyzing functional structures, we may choose to study two characteristics that supposedly are directly related to the structure. One is the effect on high-quality public transport; the other is the effect on symbiosis. The selection of these characteristics can be firmly supported by policy efforts on both sides of the Atlantic to promote public transport in the cities. Nonetheless, the choice of this criterion is also based on personal preference. I personally believe that a properly functioning high-quality public transport system is the result of a well thought-out spatial design. This does not imply, however, that in our role as urban designers we should ignore the question of the optimal way to lay out a city to accommodate the automobile.
In the above discussion, it has been suggested that both public transport and symbiotic activities are only found in combination with a volatile structure. These characteristics confirm the normative nature of the choice of any criterion whatsoever. The reason is that a volatile structure would always have a negative score on these criteria. Any generalization about the quality or, as the case may be, about the features of a functional structure should therefore be interpreted in the context of the selected criteria.

3.9.2 Symbiosis

Symbiosis is the effect that activities derive benefit from the proximity of other activities (N.A. de Boer, 1983, 1989). One well-known example is the presence of specialty shops in the vicinity of large department stores; another is the location of specialized bookstores near major educational institutions. At a different level, street vendors, musicians, and theater groups are also examples of symbiosis. According to N.A. de Boer (1978), symbiosis is of vital importance to the quality of centers. Symbiosis leads to a reinforcement of a center by increasing both the volume and the diversity of the activities that take place there. Symbiotic activities thank their existence to the direct proximity of other activities. Due to this dependency on the size and functions of a center, symbiotic activities can give some indication of the characteristics of a particular structure.

Symbiosis can be subdivided into two categories: permanent and non-permanent. The latter form of symbiosis is found particularly along with major events. There, the symbiotic element benefits for one or more days from the sheer mass of people congregating there (Jacobs, 1990). One example is the practice of selling clothing and snacks at large concerts. Because of its non-permanent character, this form of symbiosis does not make any structural contribution to the quality of a location in the long run.[6] Thus, this form is less interesting in the context of our discussion of various structures. Permanent symbiosis is dependent upon the direct proximity of other activities. That dependency is based on the fact that those other activities draw enough visitors to the area in question for much of the year and

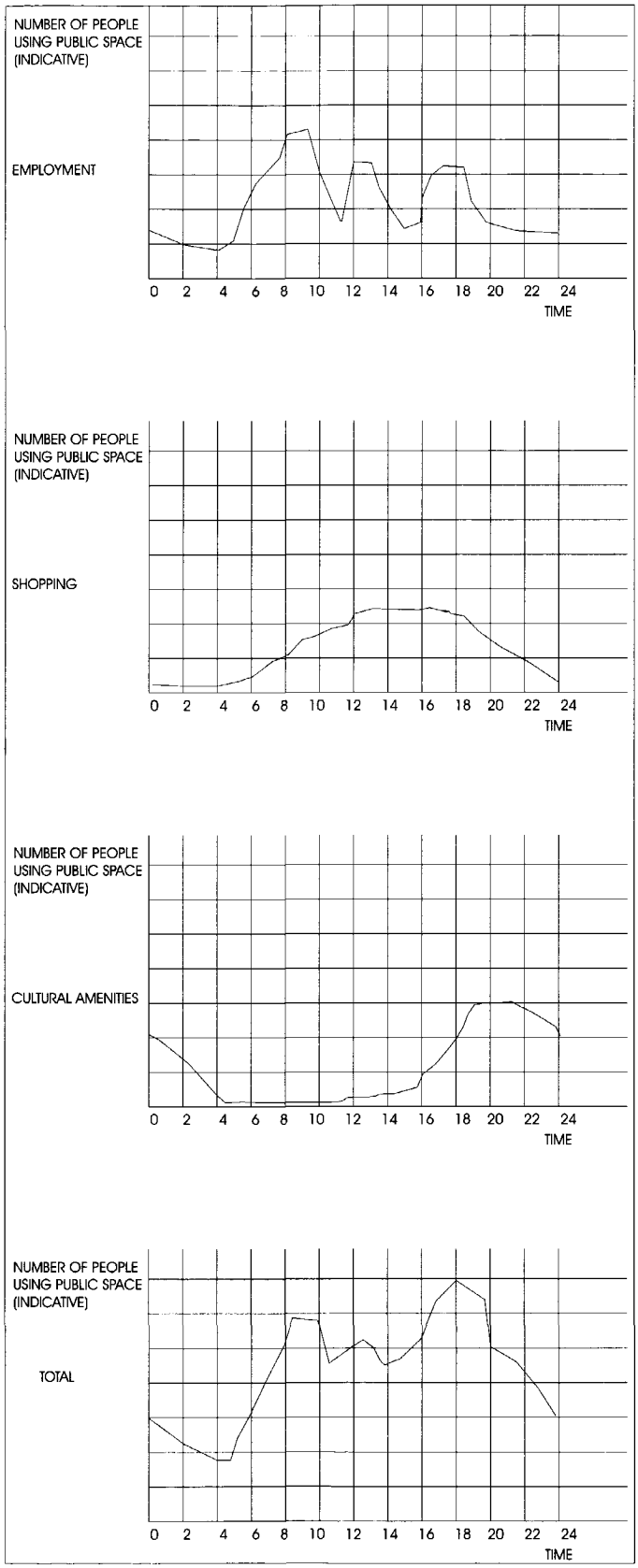


Figure 3.11 Activities and the use of public space (Jacobs, 1990)

for much of the day (Whyte, 1988). Large department stores, large educational institutions, and offices are the main daily destinations for many people. On the grounds of characteristics of various activities such as opening hours, working hours, and number of visitors, it can be determined to what extent an activity or a combination of activities would generate a sufficient basis for symbiosis. Figure 3.11 shows the effect of various activities on the number of people using public space in a given area. The rush hours are clearly recognizable and indicate places of employment. It is noteworthy that only shopping facilities generate an almost continuous presence of people in an area. In a structure consisting of monofunctional centers, it may be expected that permanent symbiosis will only occur in centers that have shopping facilities. Other centers, namely specialized ones, could only provide a sufficient base during brief periods of the day (the rush hours). By superimposing the various profiles in Figure 3.11, we can examine the opportunities that exist for symbiosis in centers where diverse activities are combined.

Symbiosis is not only dependent upon the functional structure of an urban region. Even though that structure determines the possibility of symbiosis, it is still true that the characteristics of public space specifically of the spatial design at the local level play a key role (Whyte, 1988). In this way, a carefully determined choice of locations for parking garages and public transport stops, made possible by the clustering of pedestrian flows, would enhance the symbiosis. Furthermore, the public character of an area plays a major role. For instance, in semi-public places such as shopping malls and similar centers, small-scale symbiosis such as street music will probably not occur. In contrast to the way things happen in public spaces like the street, what happens in centers such as these would depend on the guidelines set by a management organization (Garreau, 1991). In the latter case, symbiosis will take place chiefly in an institutionalized form.

3.9.3The Relation between Structure and Public Transport

A nodal structure provides an opportunity to cluster moves. In that light, it seems evident that nodal

structures would offer better perspectives for public transport than multinodal structures. Thus, the more centers there are, the smaller the number of moves per center, which would reduce the basis of support for public transport. It remains to be seen if these assumptions are valid. This question is certainly pertinent in light of the idea of developing the quintessential multinodal concept of the linear city in order to make optimal use of a railroad line, as found in the design by Arturo Soria y Mata (Lynch, 1981). One characteristic of a nodal structure is the multifunctionality of its center, which generates a demand for transportation throughout the day. Another characteristic is that because a large share of the transportation demand concerns the journey to work, the trips that take place in the morning rush hour go mainly toward the center, whereas they go the opposite direction in the evening rush hour. The problem is that one-sided flows make it hard to provide the appropriate infrastructure. This is a drawback with respect to both public transport and automobile traffic, since it means an inefficient utilization of the capacity of the infrastructure. In contrast, a multinodal structure opens up the opportunity to make better use of the infrastructure as a result of the multidirectional orientation of the demand for transportation. In a city with two centers, the infrastructure between these centers is better utilized than in the case where there is only one center. Of course, aspects of the infrastructure such as provision of service on a line and length of a route affect the feasibility of operation.

Public transport can function if the points of origin are sufficiently concentrated and the destinations are likewise concentrated. Ideally, all activities in a city including residential areas should thus be concentrated around places where the public transport system has stops or stations, as in Soria y Mata's linear city. The increasing use of the automobile has allowed activities to spread out, ushering in the decline of public transport. Suburbanization, but also the decreasing density in residential areas in the existing city, are processes that tend to deconcentrate the places of origin. This, in turn, tends to thin out the catchment area for public transport. Park & Ride facilities come to the rescue, taking advantage of moves that are already clustered in the automobile system. In this manner, P&R facilities can make a contribution by ensuring that a public transport system would not have to penetrate residential areas where the demand for transportation is too low. The functioning of a public transport system faces a more serious problem in the dispersal of destinations at the local level. At the beginning of a chain of moves in which the main mode is public transport, people have a choice of alternative means of getting to and from the stop, such as the bicycle or the automobile. The range of alternatives at the end of that chain of moves is limited, however.[7] When the emphasis is on the end of the chain of moves with public transport as the main mode, then dispersal at the local level, with the result that the distances become too great for pedestrians, is dysfunctional for public transport. Assuming that dispersal of points of origin can be resolved in the pre-transport trajectory, then it is reasonable to expect public transport to be feasible in both nodal and multinodal structures, as long as there is enough concentration of destinations in the centers. In summary, concentration of destinations forms the main condition for the functioning of a public transport system.

Multifunctionality contributes to the continuity of the demand for transport at any one stop or station. However, a mass transit connection between two or more specialized centers represents the same demand for transport but also a better utilization of capacity. In that sense, multinodal structures appear to be more favorable for public transport. In contrast, multifunctionality has a favorable effect on the overall travel time. More extensive chains of moves for instance, whereby a person goes shopping during the lunch hour and goes to the library after work can occur in multifunctional centers with little loss of time, at least if the destinations are concentrated. In a multinodal structure with specialized centers, the same chain of moves would be almost impossible even if those centers would be on the same rail or metro line because of the amount of time spent waiting for public transport. Only when the lines run at a very high frequency (more than eight trains an hour in each direction) would the waiting time becomes negligible. Such high frequencies are only achieved in metropolitan areas like Paris, London, and

Tokyo. With regard to urban areas of one to three million inhabitants, a multinodal structure of that type would not be conducive to travel. In such situations, travelers would certainly prefer the flexibility of the automobile to taking public transport. A nodal structure would then be more favorable from the point of view of the traveler. It is true that multinodal structures offer an interesting perspective with regard to the utilization of the capacity of the infrastructure. Nonetheless, it is also true that a shortage of passengers will ultimately determine the feasibility of operating high-quality public transport such as a metro system. The only context in which high-quality public transport could succeed is in multinodal structures, where the relative position of the various centers, the concentration of destinations in those centers, and an adequate frequency would permit chains of moves to take place without too much loss of time.

Notes

1.
The influence of public transport declined sharply as use of the automobile increased. In the United States, the turning point was around 1925. In many countries of Western Europe, that point was reached after the Second World War.

2.
One way to limit congestion (spatially) is by car pooling. In comparison with the mass transit system, however, we see that the auto-based system still needs more room, whereby its differentiating capacity is smaller than that of mass transit. Because car pooling is collective in nature, in contrast to individual use of the car, there must be a concentration in time, which is a characteristic of mass transit (both private and public).

3.
Klaasen and Van der Want (1988) discuss the choice of a location for the World Trade Center in Amsterdam in comparison with the site for a WTC in Rotterdam. They discuss the spatial dispersal that occurred as a consequence of the use of the automobile.

4.
See, for instance, the objectives set forth in the Fourth Policy Document on Spatial Planning (Ministry of Housing, Spatial Planning and the Environment, 1988). That document makes hardly any attempt to specify the general aims such as 'to strive toward a healthy and safe living environment' or 'to promote an internationally attractive climate in which companies would want to establish a presence' in concrete terms.

5.
A daily urban system is based upon the majority of daily reciprocal relatitions between different activities.

6.
The provision of a facility such as festival grounds, where throughout the year large-scale events are organized, is one possibility to ensure that non-permanent symbiosis will ultimately become permanent.

7.
The use of a people mover at an office location is one way to solve the problem of distances that are too far to walk in the destination area.

4. Hypotheses and Case Protocol

4.1 Accessibility

The most important tenet in the theory of multinodal structures is that accessibility is the most determining factor for the functional structure of an urban system. The theory also argues that the relationship between accessibility and the functional structure must be expressed in the form of a precondition rather than in terms of causality. In that relation, it is argued, the relevant measure is not absolute but relative accessibility. This chapter is concerned with the operationalization of the hypotheses mentioned in the theory and with the design of the research.

One of the key concepts used in the theory is the concept of accessibility. Hilbers and Verroen (1993) define accessibility as the amount of money, time, and effort spent by an individual or group in order to cover the distance from point of origin to place of destination. Accessibility is a characteristic of a location, whereas reach is a characteristic of a person (Dijst, 1995). Dijst describes reach as the space containing (a set of) loci of activities that a person originating in a particular place can select as the destination and incur acceptable costs (in terms of time) in getting there. According to the conceptual framework presented by Dijst, accessibility is thus a set of points of origin from which a location can be reached.

Accessibility can be measured in various ways. Infrastructure characteristics are frequently used as a measure of accessibility (Borgman, 1996; Hilbers and Verroen, 1993). Specifically, accessibility may be measured in terms of how far a place is from an highway or how closely meshed the road system is. This method is not related to the spatial pattern and therefore cannot take into account the location of places of origin and destination.

Therefore, it does not serve our purposes here. In fact, this method measures the degree to which infrastructure has been developed; it does not measure accessibility, as defined above. Likewise, the method that takes the position of a location in a network as the basis for measurement has the same drawback. That method is mainly concerned with nodes and usually measures accessibility in terms of rank order, as determined by topological analysis (Jacobs, 1990).

Another way to gain insight in accessibility is by applying the method of activity patterns. This means examining the extent to which an individual is able to carry out a desired pattern of activities in a real-life situation (Hilbers and Verroen, 1993). That method chiefly gives insight in the degree to which individual reach and the physical space are attuned to each other. However, it does not say much about accessibility as a characteristic of discrete locations. Another drawback of this method is the way an individual's desired pattern of activities is ascertained. The problem is that the pattern is strongly affected not only by a person's characteristics but also by the actual spatial situation (Dijst, 1995). There are more practical ways to determine the accessibility of locations, though. One is to measure actual accessibility; another is to measure potential accessibility. The former can be ascertained by gaining extensive knowledge about the places of origin and destination and the movements between them. The method requires detailed data on traveling time and traveling costs, in combination with information on the mode of transport that people choose. On that basis, conclusions can be drawn about the accessibility of a location. Therefore, this method is highly suited to the task of finding out which location will have a more favorable effect on moves. The reason is that destination locations can be compared with respect to their effect on the duration and the cost of travel as well as on the choice of a mode of transport. However, this method only sheds light on the accessibility of locations where the destinations are situated. It does not lend itself to complete measurement of accessibility and the differences therein within an urban region. This method can, nonetheless, measure potential accessibility.

For each location in a survey area, it is determined how many individuals can reach that location without exceeding a given budget (specifying maximum expenditures of time, cost, and effort). The strong point of this approach is that conclusions can be drawn for each location. The choice of the time budget is an important element of this method. A maximum travel time of 45 minutes can be taken as the standard acceptable duration. That figure is based on research by Vance (1977), Marchetti (1988), Levinson and Kumar (1994) and Schafer and Victor (1997). Studies by these authors reveal that the number of moves with a duration

longer than 45 minutes decreases sharply. Moreover, they point out that this figure has not changed in over a century. Apparently, travel time is more indicative than travel costs within the daily mobility pattern. Fortuin (1987) points out that the cost of travel is less significant than travel time, though the income position of the individual determines the choice of mode of transport. Without a doubt, car ownership in particular is dependent on income level (Goudappel, 1965). The rising rates of car ownership and car use in Western countries suggest that the role of cost is declining, while time is becoming more significant (Gordon, Richardson, and Jun, 1991).
In this study, accessibility is defined as potential accessibility. The latter concept refers to the size of the area from which a given location can be reached within a given time budget, set at 45 minutes of total travel time. The definition partially ignores the heterogeneity of the urban area, in that the indicators are not the number of residents but the size of the urban area, which includes non-residential areas as well. This does justice to the importance of accessibility for trips that originate at an industrial estate, for instance.

The potential accessibility of a location can be expressed as the number of hectares of urban area from which that location can be reached within a given time budget. The relative accessibility of given locations is thereby the difference between the measured (absolute) value of potential accessibility between those locations. Assuming that relative accessibility is critical to the functional structure, there are no grounds on which to conclude that a relation exists between the measured (absolute) potential accessibility of a location and the scope of collective activities. The relevant point is the correlation of accessibility differentials and the distribution of collective activities. In order to be able to compare different urban areas and thereby to investigate the relation between accessibility and functional structure, the obvious choice would be a relative measure of accessibility. Such a measure is devised by taking the absolute values measured for each urban area and dividing those figures by the maximum (measured) value. The outcome would be a distribution ranging from 0 to 100 percent. Another advantage of using a relative value is that it makes it easier to depict the difference in accessibility. The method of calculating that value is explained later in this chapter.

4.2 Functional Structure and Accessibility

The concept of structure implies the existence of a whole that is built up in a particular manner. This means that a functional structure reflects the way in which a spatial system and in this case, an urban system forms a whole. An urban system is defined as a set of localized urban activities and the relations between those activities (Bourne, 1975; Hansen, 1978). The functional structure of an urban system then becomes the way in which that set of activities forms a coherent whole on the grounds of the mutual relations among those activities.
A functional structure is thus more than a manifestation of the number of centers, including their nature and profile. That set of centers or better, the state of dispersal of collective activities must be brought into connection with the patterns of relation at the scale of the urban system. These patterns of relation are the result of the exchange of information, money, goods, energy, water, and people. It should be noted that in most western societies, the exchange or rather, the movement of people is more sensitive to time and space than the exchange of information or energy, for instance. In this connection, it should also be noted that the accessibility of a location by individuals proves to be indicative of the siting of collective (urban) activities (Hessels, 1992). For these reasons, a functional structure is chiefly determined by the pattern of relations among people. In that light, a functional structure may be described as the pattern of mobility of people at the scale of the urban system, conditioned by the pattern of distribution of points of origin and destination.
The pattern of distribution of collective (urban and regional) activities is thereby indicative of the functional structure.
Mobility patterns can be classified as radial (directed toward a single point), tangential, or a combination of both. The mobility pattern of nodal structures is primarily radial in orientation (Fig. 4.1). Multinodal structures have both tangential and radial patterns (Fig. 4.2). When there are multiple centers at central locations in an urban region, then there may be multiple radial patterns of mobility (Fig. 4.3). The crisscross

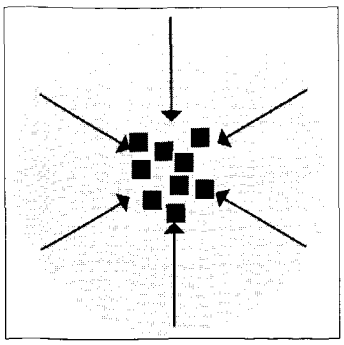


Figure 4.1
Nodal structure and radial pattern

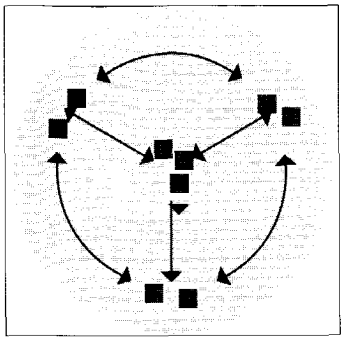


Figure 4.2
Multinodal structure and radial and tangential pattern

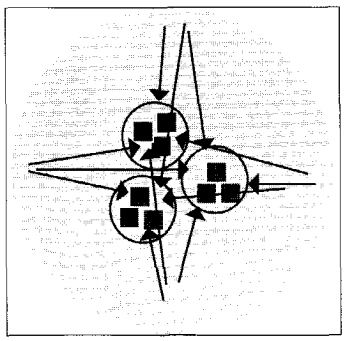


Figure 4.3
Multiple centers and multiple radial patterns

model developed by Alpass (1966) (Fig. 4.4) should be interpreted as a multinodal structure with multiple radial and tangential mobility patterns.
In the analysis of the effect of the functional structure on the possibilities for high-quality mass transit, the diverse patterns of mobility play a key role, as they are related to the distribution pattern of collective activities. With respect to the relation between accessibility and the functional structure, the emphasis should be placed on the pattern of distribution of collective activities.

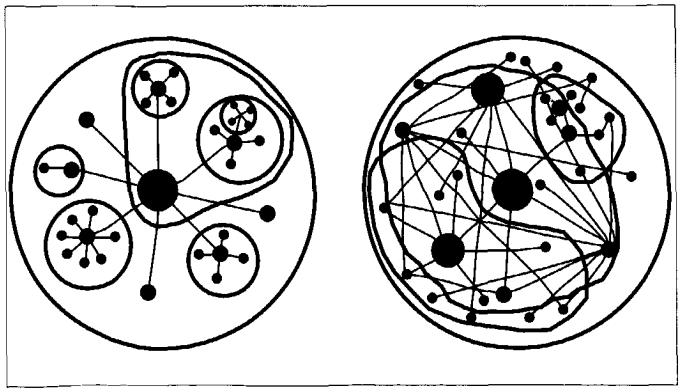


Figure 4.4 Traditional and criss-cross model (Alpass, 1966)

The presumed relation between accessibility and functional structure can now be investigated, at least in principle, by looking at how the location of those activities is linked to ease of access to that location.
In doing so, it is necessary to distinguish further among collective activities. On the one hand, accessibility, as defined in the previous section, cannot be related to all collective activities. This is particularly true of activities that are dependent upon their setting. For instance, certain kinds of outdoor recreation may be much more sensitive to the specific features of a location than to ease of access. Of course, accessibility remains a condition, but it is not the most important one. For activities that produce nuisance or hazard, such as heavy industry, it is also true that accessibility does not necessarily have to be taken as the primary condition.
The analyses described here are based on two categories, of which it is assumed that accessibility forms the primary condition and that the companies and institutions in question are more or less free in their choice of a location. One of these categories is employment, and specifically jobs provided by companies and institutions in the tertiary and quaternary sector. The other one is services, particularly urban and regional shopping facilities (mainly non-food), cultural amenities (museums and theaters), educational institutions (universities), and large sports facilities that have an important public function. In sum, this means that the study is focused on the question whether or not a relationship exists between accessibility and the distribution of the above-mentioned companies and institutions.

4.3 A Prerequisitory Relation

In the theory, it is assumed that accessibility is a prerequisite for the siting of collective activities and thus also for the functional structure. The characteristic of conditionality has implications for the way the study design is worked out. This is not a case of cause and

effect, whereby it might be suggested that a given score on accessibility would cause collective activities. Rather, the assumption here is that collective activities are possible when accessibility has a certain score. In other words, when the ease of access is inadequate, collective activities are impossible.
Conditions can be differentiated as necessary or sufficient. In the case if A then B, B is a necessary condition for A, though may be not a sufficient one: A occurs only if B is present. To illustrate this point: *the presence of oxygen (B) is a necessary condition* for a fire (A). The presence of oxygen is not a sufficient condition for a fire, as for instance fuel has to be present as well (oxygen in itself is not sufficient to cause a fire): the proposition if B (oxygen) then A (fire) is a false one. If A is a fact and B is not present both the propositions are falsified. In the case of the study presented here this means that if we find regional activities where the condition of accessibility isnít met, then the proposition that accessibility is a necessary condition, is falsified.

Besides determining whether or not a relation is a necessary condition, it is also assumed that the relation is not linear, whereby a higher accessibility score would correspond to more collective activities. Instead, there is a cut-off point at which access may be considered adequate or inadequate. When the accessibility scores are greater or equal to a threshold value, collective activities are said to be possible. The absence of collective activities at locations where ease of access is at or above the threshold value does not refute the hypothesis. The presence of collective activities at locations where accessibility is too low does lead to rejection of the hypothesis. In this regard, the time lag described by Bruinsma and Rietveld (1992) should be taken into account. The time lag implies that the effect of changes in infrastructure, and thereby also in accessibility, often only shows up in the functional structure after a decade or so. Thus, reduced accessibility also through improvements in ease of access elsewhere does not directly lead to a move or even the cessation of a collective activity at the location in question. It may also be true that the collective activity has been functioning below standards or poorly. Thus, it is important to take a critical look at collective activities where accessibility seems inadequate.

It is essential to determine the threshold value to be able to test the presumed relation between accessibility and the functional structure. The lack of empirical research focusing on conditionality in this regard has influenced the way the present study design has been elaborated. Besides the question of whether or not accessibility is critical to the functional structure, and not the other way round, it is also important to ask whether a threshold value can be determined. Moreover, it should be asked whether one value would apply to virtually all *metropolitan areas or if each area should be assigned* its own value. Rough estimates put the threshold value somewhere between 70 and 100 percent. This means that the accessibility score of a given location lies between 70 and 100 percent of the maximum score measured for the entire area. The assumption is based on the idea that the collective activities among which a relation supposedly exists form part of patterns of relations at the urban and the regional level. Thereby, those activities are dependent on easy access from almost anywhere in the urban area.
Using this as a basis, the threshold value can be set at 80 percent. It should be kept in mind that this value is relative and that, in principle, it applies to all cases. The absolute accessibility value to be measured might differ from one case to the next.

There is some risk especially in research looking for necessary conditions of confusing the condition with the possible effect. Here too, it is important to ask whether accessibility is a condition for a certain state of distribution of regional activities, or that the pattern of distribution is actually a determining factor.
For instance, the distribution might influence the development of infrastructure and thereby indirectly determine the change in accessibility. A method to ascertain which is the condition and which the effect is to study changes that have taken place during the previous period. In this period significant changes in the pattern of distribution of regional activities have taken place. It was also a time of significant changes with respect to accessibility. Regarding the latter point, from the introduction of the horse-drawn tram to the introduction of the high-speed train and the experimental train running above the rails on magnetic levitation (maglev) all in the course of 150 years our

mobility has undergone enormous change. An analysis of the process by which urban areas have changed in the same period offers a good opportunity to study the relation between changes in accessibility and the siting of regional activities. Incidentally, any attempt to extrapolate from the results of an analysis of that kind to predict future trends should be carefully considered. The point is that we must not simply accept that ease of access will remain the most decisive location factor in the future.

On the grounds of the operationalization of the concepts and the positioning of the relations to be studied as conditional, the following hypothesis may be posed on this topic:

Hypothesis 1 Change in relative accessibility within an urban system is a necessary condition for a change in the distribution of collective activities.

In other words, the pattern of distribution of collective activities does not change if the differences in accessibility remain the same. This proposition can be investigated by analyzing the change in accessibility in an urban area. On the basis of the introduction of the motorized tram and the train in the second half of the 19th century and the further application of those modes in the early 20th century, along with the arrival of automobile traffic and later the construction of highways, it seems self-evident that a study should focus on the developments that have taken place over the past 150 years. Of course, an improvement in infrastructure or an increase in mobility will not by definition affect the differences in accessibility.

The processes described in the theory transformation, interference, and system formation can be studied in terms of the following hypotheses:

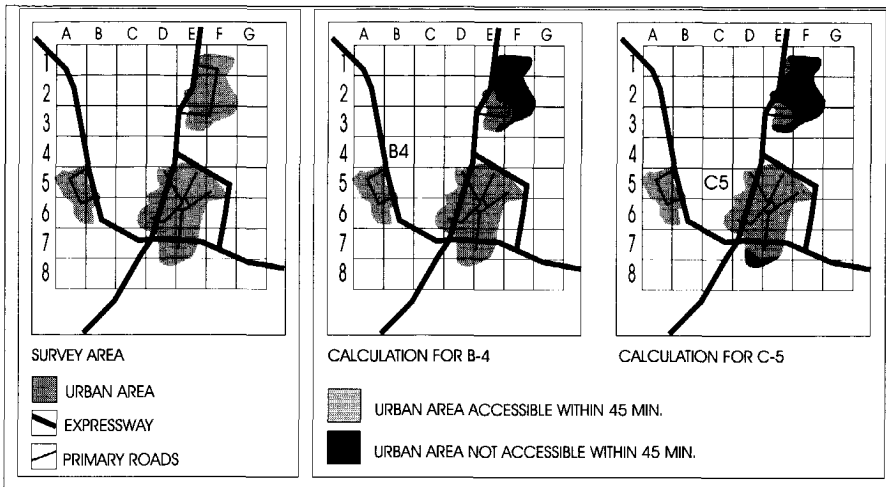
Hypothesis 2 Change in the relative accessibility in an urban area whereby at least two locations get an accessibility score that is greater than the threshold value is a necessary condition for transformation.

Hypothesis 3 Change in the relative accessibility in an area where multiple urban systems are found with the result that one or more locations get an accessibility score that is greater than the maximum score applicable to each of the systems separately yet lower than the threshold value for two systems jointly, is a necessary condition for interference.

Hypothesis 4 Change in the relative accessibility in an area where multiple urban systems are found with the result that one or more locations get an accessibility score that is greater than the threshold value applicable to each of the systems separately, is a necessary condition for system formation.

One thing these hypotheses have in common is that they do not refer to a sufficient condition. As formulated in Hypothesis 4, the incidence of differences in accessibility with a specific score does not lead to the formation of systems, though it does constitute a condition for such. In other words, without those specific differences in accessibility, no system formation will occur. Of course, this has implications for the way the hypotheses can be tested.

In the event that Hypothesis 1 is not rejected, it becomes possible to investigate the relation between accessibility differentials with respect to the functional structure. It should be noted that in order to apply the results of the study, it is important to have insight in that relation. The point is that the outcome offers the possibility to evaluate spatial interventions in an urban area before they are carried out to predict how they will affect the functional structure. It also opens up the possibility to determine the extent to which existing differences in accessibility have to be changed through spatial interventions in order to bring a desirable functional structure to bear. The relation between differences in accessibility and the functional structure at the scale of urban systems can be studied on the basis of the following hypothesis:



CELL	VALUE	%	CELL	VALUE	%	CELL	VALUE	%
A-1	12,000	33	C-5	20,000	56	F-1	14,000	39
A-2	16,000	44	C-6	26,000	72	F-2	12,000	33
A-3	20,000	56	C-7	32,000	89	F-3	16,000	44
A-4	22,000	61	C-8	26,000	72	F-4	26,000	72
A-5	24,000	67	D-1	10,000	28	F-5	20.000	56
A-6	26,000	72	D-2	16,000	44	F-6	20,000	56
A-7	0	0	D-3	18,000	50	F-7	24,000	67
A-8	0	0	D-4	30,000	83	F-8	16,000	44
B-1	0	0	D-5	36,000	100	G-1	2,000	6
B-2	8,000	22	D-6	36,000	100	G-2	4,000	11
B-3	12,000	33	D-7	34,000	94	G-3	8,000	22
B-4	24,000	67	D-8	20,000	56	G-4	14,000	39
B-5	28,000	78	E-1	16,000	44	G-5	10,000	28
B-6	30,000	83	E-2	18,000	50	G-6	10,000	28
B-7	26,000	72	E-3	24,000	67	G-7	14,000	39
B-8	10,000	28	E-4	30,000	83	G-8	14,000	39
C-1	0	0	E-5	36,000	100			
C-2	0	0	E-6	36,000	100			
C-3	0	0	E-7	30,000	83			
C-4	0	0	E-8	16,000	44			

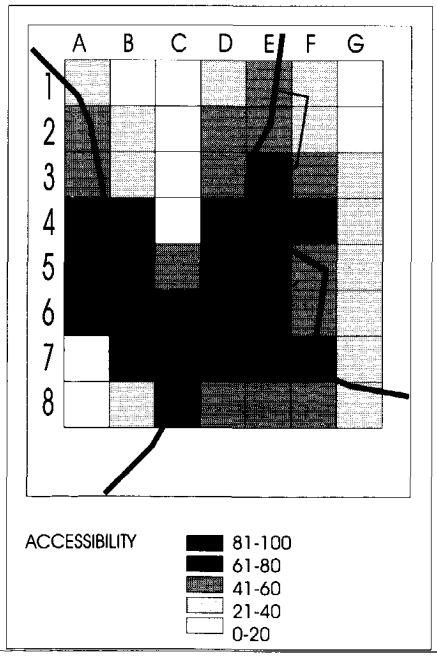


Figure 4.5
Measuring accessibility

Hypothesis 5 A location's accessibility score that is greater or equal to the threshold value is a necessary condition for the presence of urban and/or regional collective activities at that location. The threshold value is 80 percent of the maximum accessibility score for the area of the urban system.

The presence of collective activities at a location of which the accessibility score is too low leads to the rejection of the hypothesis. In this regard, any exceptions would call for further analysis of how and why the activity has been established on that particular site. Furthermore, any such exceptions would call for a reconsideration of the appropriateness of setting the threshold value at 80 percent.

4.4 Measuring Accessibility

When calculating the potential accessibility of diverse locations, it is imperative to determine which mode of transport is the most important at the regional scale. Once an analysis of the modal split has revealed which mode predominates in the patterns of relations at that scale, it is then possible to calculate the accessibility for individual locations in terms of characteristics of the dominant mode of transport. For that purpose, it is first necessary to circumscribe an area within which measurements can be made. That survey area has to be larger than the territory of the urban system. It should be kept in mind that information on the underlying patterns of relations in the urban system is not always accurate. Therefore, once the measurements have been completed, the results will have to be checked to see if the values measured on the periphery of the survey area are too small to take into account. Setting the boundaries of a survey area in a situation where the urban area is clearly circumscribed, surrounded, for instance, by an agrarian hinterland will obviously be simpler than in a situation with a more or less contiguous built-up urban area. In the latter case, a distinction is made between the survey area and its surroundings. Accessibility values are not calculated for the surrounding area. The influence of that area is, however, included in the calculations for the survey area.

The survey areas span metropolitan areas and can thus cover roughly 50 by 50 kilometers for single cities, while conurbations may cover an even larger area. Because of the size, the survey area is divided into sections of 2.5 by 2.5 kilometers. Thus sectored, the surface of the urban area can be calculated for each measurement cell with the help of topographical maps (see Fig. 4.5). Then, taking the main modes of transport and the average travel speeds into account, the sum of the surfaces of those measurement cells is calculated, as well as the sum of the surfaces of the surrounding area from which a measurement cell x can be reached within a total travel time of 45 minutes. The result of this calculation is a table showing the absolute accessibility scores calculated for each measurement cell. Incidentally, in this exercise, the maximum score has to be smaller than the total surface of the urban area in the analysis. Taking the average travel speeds for various types of infrastructure a typical way to calculate potential accessibility might introduce some bias into the picture. This danger is greatest when studying situations where serious delays have occurred over a long period of time, due, for instance, to traffic congestion. The bias can be compensated by including the average loss of time in the calculations, using information that can be derived from traffic data. Because the issue here is the relation between accessibility and the functional structure a relation whereby the effects only show up after a period of five years or more it is clear that incidental delays due to sporadic traffic tie-ups or malfunctions in the rail network are irrelevant.

As the last step in the calculation, all measured scores are divided by the maximum measured score. The result is a score for the weighted accessibility of each measurement cell expressed in percentages. On the grounds of the threshold value that was set at 80 percent, it then becomes visible where at which locations (i.e., in which measurement cells) the necessary condition for the siting of collective activities has been met. The figures from this last table are also presented in graphic form. Finally, the relation between the weighted accessibility and the distribution of collective activities can be investigated.

4.5 Case Protocol

In Chapter 2, it was demonstrated that the case study is the most appropriate method for investigating functional structures. Because the case study is based on extensive use of diverse sources, and because the border between the phenomenon to be studied and the context in which it occurs is not always easily discernible which is certainly true in a study such as this one it is important to set up a protocol for the cases. To serve this purpose, and precisely in the event of a relevatory case, a protocol must prevent continual ad hoc revision of the hypotheses in response to new evidence that comes to light in the case. With respect to the multiple case, it is important that the individual cases remain comparable, even though they are derived from different sources; this is a definite advantage of the protocol.

4.5.1 Single Case

Hypotheses 1 through 4 are examined in the single case. The focus of the case study is the process whereby the pattern of dispersal of collective activities changes. Change is traced here in terms of the developments that have taken place during a particular period of time. The presumed relation to the differences in accessibility is crucial to the design of the protocol for the case. One reason lies in the time lag (Bruinsma and Rietveld, 1992), which implies that the effect of changes with respect to accessibility usually show up only after five or ten years in the functional structure. Another reason lies in the assumption that the differences in accessibility implicitly determine a number of periods that are probably of interest to the research for instance, the emergence of automobile traffic, the construction of the first highways, and so forth. Therefore, the protocol stipulates that the starting point for the cases should be just prior to the ascendancy of the train, while the endpoint should be the present. At the same time, in order to compensate for the problem of the time lag, the protocol prescribes a series of snapshots of the area taken at 20-year intervals.

No written description can do justice to the phenomenon of the city. Still, the first logical step in the two single cases presented here is to describe the area to be investigated. The aim is to be able to depict the area as well as to shed light on its specific situation-bound idiosyncrasies.

The basic material for a single case consists of topographical data. Using data on number of people traveling as well as on vehicle ownership and utilization, the study first determines which mode of transport predominates at that point in time. In combination with data on travel time (if available), data on characteristics of the infrastructure, and the basic topographical data, it can be determined which changes in the accessibility of the diverse locations have taken place in the course of 20 years. This first step in the analysis shows which locations have become more or less accessible. With such diversity in data that can provide insight into the location decisions for collective activities banks, high-skilled employment, amenities such as museums, theaters, and large sports stadiums it is determined whether or not a relation exists between the changed accessibility and the establishment of institutions like these at a particular location. Most importantly, it should be determined whether or not there are collective activities with a function for the entire urban system. Insight into the place of origin of the clientele (gained, for instance, by charting their orientation to a specific service area) and the degree to which an institution is present (and is unique or not) is particularly relevant to the study.

The socioeconomic development of the metropolitan area cannot be understood without looking into the establishment of diverse companies and organizations. Therefore, for each period, an inventory is made of the developments taking place in the region with regard to the economy. Furthermore, the contours of the planned developments are sketched. The aim is to examine more closely the extent to which such interventions reinforce the process of change in the functional structure or actually obstruct such change.

4.5.2 Multiple Case

The essence of the multiple case study is the supposed relation which might be adjusted in light of the findings reported in Chapters 5 and 6 between accessibility differentials and the functional structure, as formulated in Hypothesis 5. The main difference between the

multiple and the single case lies in the fact that each of the multiple cases is studied at just one point in time. This part of the study is not concerned with change or finding a baseline on which processes such as transformation, interference, and system formation can be charted but rather with the correlation between accessibility and the functional structure. A key element of the multiple case is mutual comparability of the urban areas that are under study. To ensure comparability, it is essential to follow the protocol precisely. Any interim processing of the findings would make the outcomes less comparable and must therefore be avoided.
For each urban area, the case starts with a description. This description covers the geographical location, the climate, economic characteristics, and any particularities that may seem pertinent, before reviewing the role of spatial planning in the area being considered. After giving a description, the accessibility score is determined. This is done on the basis of topographical data and traffic data, which can be used to gain insight in average driving speeds and the modal split.
The calculation of accessibility is then used to create a map.
On the basis of background material and fieldwork to check that data, the spatial distribution is determined for office employment as well as for urban and regional facilities. The latter category includes large retail concentrations, museums and theaters, and sports stadiums. The dispersal patterns are then compared to the accessibility scores. That means that for every category of accessibility (for instance, 0 to 10 percent, 11 to 20 percent, etc.), it must be determined how many concentrations of collective activities correspond to each class. Finally, it can be determined for each urban area whether or a concentration of collective activities corresponds with an accessibility class of 80 percent (the threshold value) or higher.

If only one (new) urban system has developed, a location with a value of 100 percent will not necessarily be accessible from the entire urban area. Taking this into account, the scale of the developing urban system forms the point of departure for the analysis in those instances where the findings are checked by comparing the maximum score with the total score for the research area. In fact, it may be suggested that if the measured maximum score corresponds somewhat with the total score for the survey area, the system may be said to be developed. In contrast, a large gap between the two scores indicates that there can only be interference.

4.6 A Selection of Cases

Four metropolitan areas were selected for analysis. Two in North America, respectively Minneapolis - Saint Paul and Dallas - Fort Worth, and two in Western Europe, respectively Randstad Holland in the Netherlands, and Frankfurt am Main - Wiesbaden - Mainz in Germany. The selection was based on several criteria:
— how the areas are spread out in the territory circumscribed as the liberal-capitalist domain, namely North America and Western Europe;
— size;
— economic situation;
— role of mass transit;
— multinodality;
— the degree to which these areas are familiar to researchers in the fields of urban design or geography.

The decision to select areas that are spread out across the globe reflects the intention to determine the degree to which the supposed relation between accessibility and the functional structure is region-specific or more generally applicable. Moreover, the choice of these areas makes it possible to gain insight into the relative importance of spatial planning. In Western Europe, far-reaching planning authority is common. The authorities can have extensive influence on the siting of public institutions in particular. In addition, planning principles have formed the foundation for the development of European cities. In contrast, planning authority is often limited in the United States, as is the array of planning instruments that can be implemented. The impact of external moves or moves that go beyond the bounds of the system also plays a role in the geographical distribution of the research areas. In the European setting, the automobile and the train play an important role, especially for trips to other metropolitan areas covering distances anywhere between roughly 40 and 400 kilometers. In the American situation, however, air traffic plays a key role, partly because the distances there

are longer (Hall, 1991). In this regard, it is conceivable that because of these differences, roads leading out of the city, railway stations, and airports will have different effects on the spatial structure.
The criteria of size and economic situation are critical. They ensure the comparability of the distribution pattern of regional activities as well as the comparability of the pace at which developments have taken place, particularly over the past decade. In order to bring some variation into the picture of the relation between multinodality and mass transit, the selection was intended to run the whole gamut, from a place with hardly any mass transit to one with an extensive system. Frankfurt seems to be the leader of the four, having an extensive supply of urban and regional transport systems, while Dallas seems to bring up the rear.
In the course of the analysis, it will become clear whether or not the mass transit in Frankfurt also has a structuring effect.
The next-to-last criterion on the list is in itself not relevant to a study of the relation between accessibility and the functional structure, as set forth in the multiple case. In order to be able to highlight a relationship between mass transit or symbiosis, on the one hand, and multinodality on the other, however, this criterion is indispensable. Of course, in a study looking for signs of interference and system formation, it is clear that the research areas must be multinodal - or must have been so in the past, albeit that the practical use of possible annotations on the quality of the urban structures is more relevant for further research. The last criterion has a more practical significance. The fact that some attention has been devoted to a particular research area suggests that some knowledge and information is available about the area in question. In the individual cases, the various urban areas are given a more extensive introduction.

'Minneapolis and Saint Paul are nicknamed the Twin Cities. They are divided by the Mississippi River, and united by the belief that the inhabitants of the other side of the river are inferior'
(Fishlock, Americans and Nothing Else, 1980).

5.1 Why Minneapolis – Saint Paul?

The urban region of Minneapolis – Saint Paul goes by the name of the "Twin Cities" in recognition of the two clearly distinguishable downtowns. On the basis of those two centers, Minneapolis – Saint Paul would appear at first sight to be a region with a multinodal structure in the most elementary sense of the concept. Minneapolis and Saint Paul were founded in the second half of the 19th Century. Up till 1890, they developed separately at a distance from core to core of about 15 kilometers into cities of roughly equal size (Fleetham, 1993). In the period 1880-1940, both cities expanded by putting in a tramway. That system also provided a connection between the two centers, allowing the region to develop into twin cities (Adams and VanDrasek, 1993 p. 80).

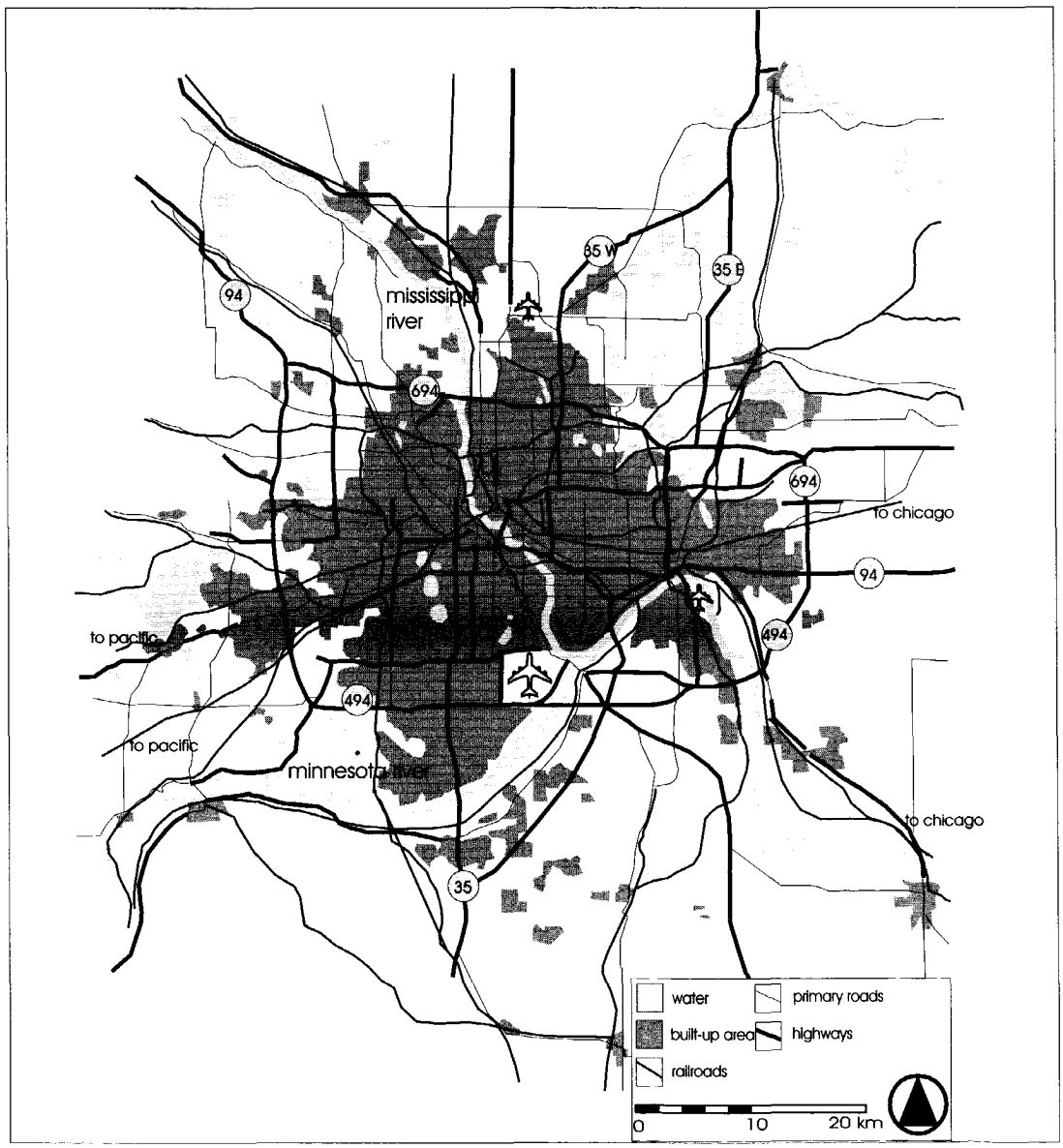


Figure 5.1
Minneapolis – Saint Paul (1990)

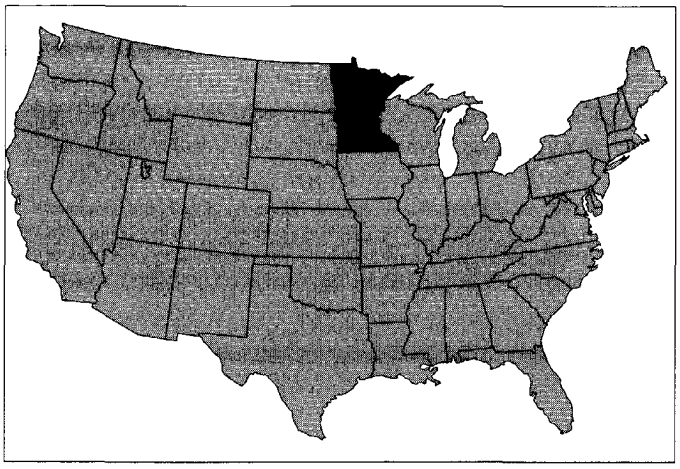


Figure 5.2 Minnesota (position in the USA)

The concept of twin cities –an urban system with two main centers – is still easily recognizable in the urban structure of Minneapolis – Saint Paul. Nonetheless, additional centers have arisen over the past 30 years. The Twin Cities have developed into a multinodal urban region with a population of about 2.5 million (11-county metropolitan area, U.S. Bureau of the Census; Census of Population and Housing, 1990). Minneapolis – Saint Paul thereby constitutes an interesting case for testing hypotheses on the emergence of conurbationand on the development of a multinodal structure. It is a suitable case because it has developed from two separate urban systems into twin cities, but also in light of the development of a multinodal structure. Especially the extensions that were made possible by the tramway network during the period 1880-1940 and afterwards by the presence of highways also provide insight into the reciprocal effects of different kinds of infrastructure and the development of the urban structure.

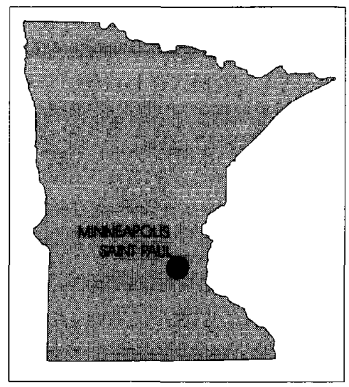
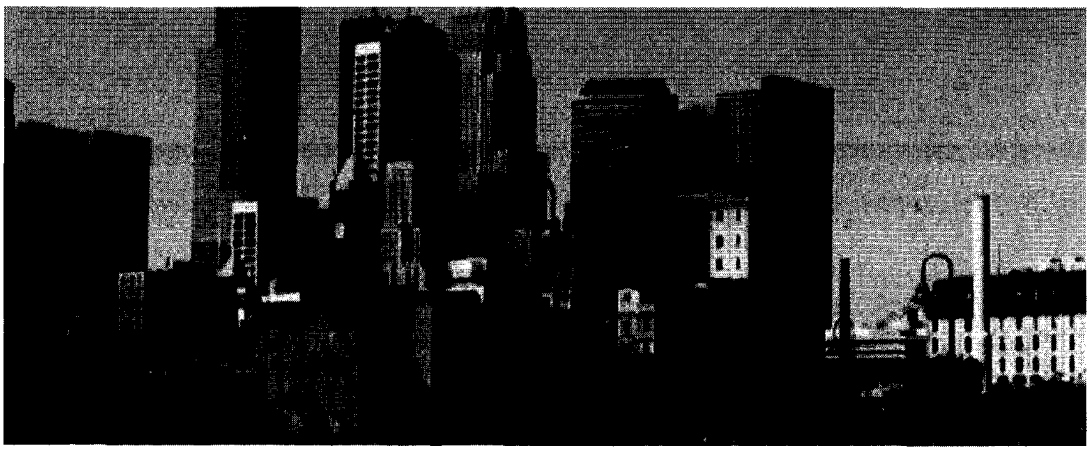


Figure 5.3 State of Minnesota and location of Minneapolis – Saint Paul

5.2 The Twin Cities: Cities Along the Frontier

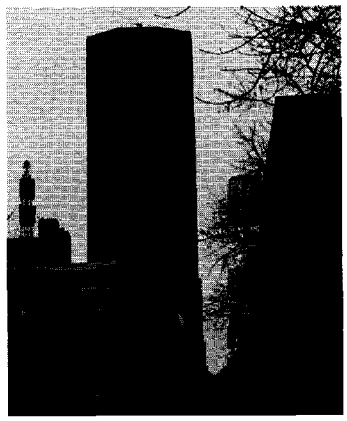
The urban region of Minneapolis – Saint Paul is situated in the southeastern part of the state of Minnesota in the USA, where the Minnesota River flows into the Mississippi River. The urban area lies on a plain of sand and gravel. This outwash plain is surrounded by a hilly terrain and countless lakes, which have come into being as a result of the last Ice Age (Adams and VanDrasek, 1993, pp. 2-4). Both the Mississippi itself as the landscape have played an important role in the initial development of both cities. Besides the significance of the river transport in the middle of the last century, the available water power, resulting from the differences in relief in the upper reaches of the Mississippi, was also an important condition for the development of both cities. This research follows that development starting from the point in time when Fort Saint Anthony was built.

In 1803, Thomas Jefferson, who was the President of the United States at that time, sent military troops to the



Downtown Minneapolis

IDS Tower



location where the Minnesota and the Mississippi Rivers met with the assignment to build a center of civilization there. This led to the construction of Fort Saint Anthony (later renamed Fort Snelling) in 1819. Until 1837, this fort sheltered traders, pioneers, missionaries, and farmers. The treaty signed in 1837 with the Sioux (originally the Ojibwa) opened the opportunity to build new settlements outside the fort. The location where Saint Paul was established had some big advantages for river transport on the Mississippi. In a short time, Saint Paul developed, partly on the basis of the emerging timber industry and the trade in pelts, into the main commercial center in the region (Adams and VanDrasek, 1993, pp. 29-30). Sawmills and eventually flour mills were established at the Saint Anthony waterfalls, where the sawmill of Fort Snelling was originally located too, as they could take advantage of the water power available there. Although civil settlements were not allowed west of the Mississippi until 1851, squatters settled near Saint Anthony on both sides of the Mississippi. The opening up of this territory, and the construction of a bridge over the Mississippi in 1855, lead to a rapid development of Minneapolis. In a short time, Minneapolis overshadowed the settlement of Saint Anthony; in 1872, the growing city annexed the settlement.

The economy of Saint Paul consisted mainly of trade and transport, in addition to a diversity of other industries connected with the trade in pelts and the production of lumber, such as saddle- and shoe-makers and carpentry, especially furniture-making. As a result of a stronger financial relationship with the cities on the East Coast, Saint Paul initially became the financial center of the region. Moreover, Saint Paul was designated as the capital of Minnesota in 1858. Minneapolis, in contrast, benefitted greatly from the development of agriculture, both in Minnesota and in the adjoining states to the west, North and South Dakota. As a result of these developments, the grain-processing industry in Minneapolis expanded in the period between 1870 and 1880 to become the biggest in the world (Adams and VanDrasek, 1993, p. 36).

The close cooperation between the railway magnates in Saint Paul and the industrialists in Minneapolis resulted in an extensive network of railroads. Consequently, the Twin Cities became a hub between the East and the West Coast while also offering good connections with the Great Lakes. This favorable position contributed to the region's further economic development. However, depletion of the forestry resources led to the decline of the timber industry in the 1920s. In addition, the opening up of the Panama Canal in 1914 and the increase in the cost of shipping by railroad made it cheaper to transport grain by sea from the West Coast to the East Coast than to transport flour, after the grain had been processed, overland and then across the Great Lakes. In combination with the disappointing grain harvests in Minnesota, this led to the demise of the grain-processing industry. When the lumber- and grain-processing industries collapsed, the attention shifted to other and more diverse economic activities. Adams and VanDrasek (1993, p. 41) state that 1940 is the turning point for the Twin Cities, when they exchanged their agriculture-based industry for an economy with greater emphasis on manufacturing and services. The biggest employers in Minneapolis – Saint Paul at present are Dayton Hudson Corp. (retail, department stores, with 161,215 employees), 3M (industrial and consumer goods, with 89,201 employees), and Cargill Inc. (agricultural commodities, with 54,000 employees) (Smith, 1991).

In the postwar period, the urban area of Minneapolis – Saint Paul has been undergoing a development that is comparable with that of numerous other cities in the United States. Along with the ascendancy of the automobile, the urban area has increased greatly in size, and several outlying districts and suburbs have

emerged. This development was quickly followed by the construction of huge shopping malls in those new residential areas. For instance, in the period between 1955 and 1965, a total of 65 small and large shopping centers were built (Gilhousen, 1990). As the suburbanization continues, the inner city goes into deeper decline. With the further extension of the highways and the development of new business parks and office locations, the attraction of the inner city has been losing much of its force (Adams and VanDrasek, 1993, p. 109). In the 1980s, both Minneapolis and Saint Paul invested large sums in an attempt to made the old city centers attractive again. The efforts include impressive projects such as the IDS tower (Investors Diversified Services) in Minneapolis and Galtier Plaza in Saint Paul. Besides devoting a great deal of attention to pedestrian precincts and parking space, both cities are known for the skyways that connect the buildings in the center of each city. These skyways allow the inner city to offer the same climate control as a shopping mall. And in view of the climate in Minnesota, that is certainly welcome. Minneapolis – Saint Paul has a continental climate. The average temperature in July (22 degrees centigrade) is only a few degrees cooler than the average temperature in the South, whereas the average in January is minus 12 degrees centigrade.

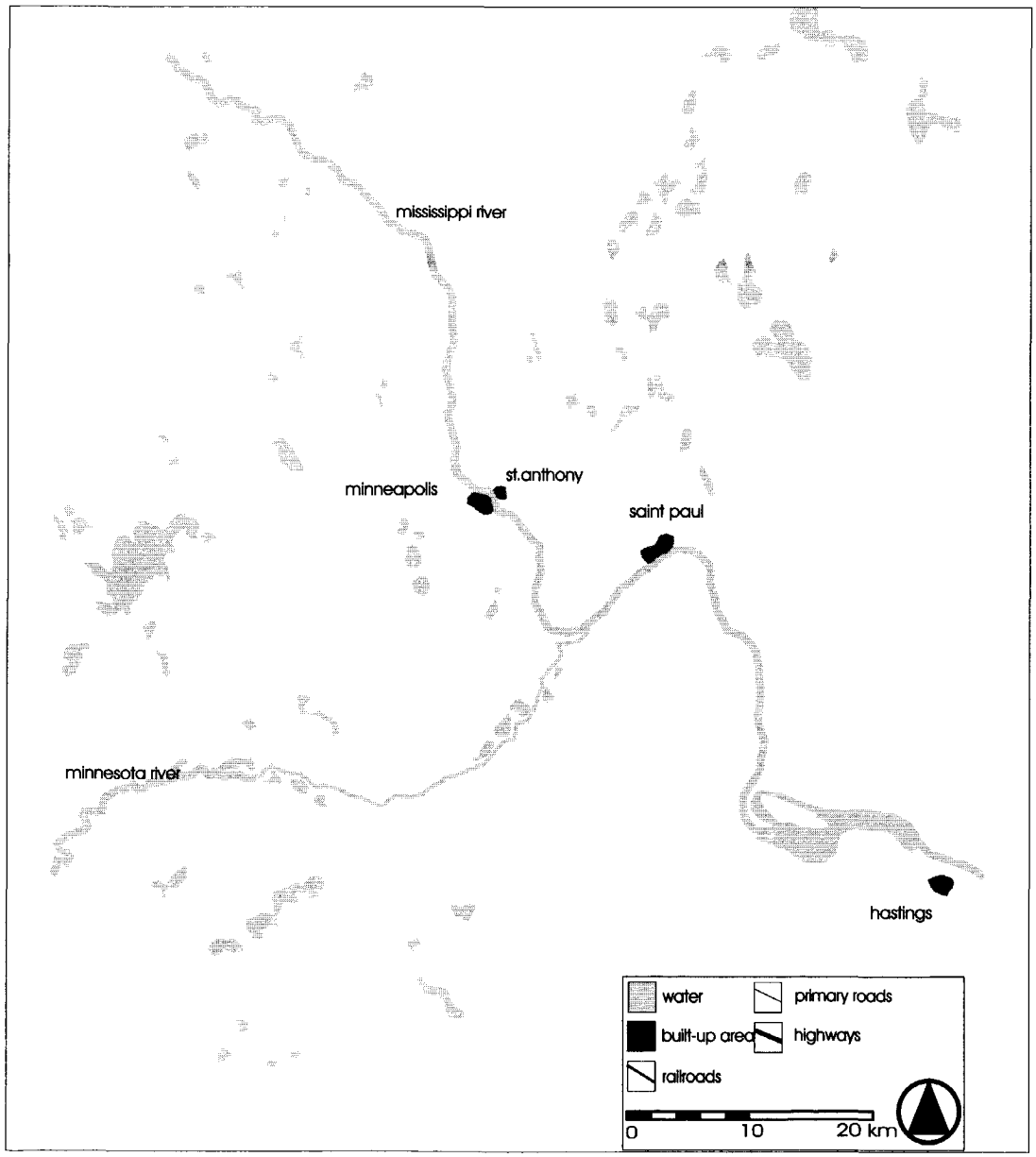


Figure 5.4
Minneapolis – Saint Paul, 1860

Even though both centers are in the process of revitalization, the deconcentration and decentralization of the retail sector and the employment base continue. There is a vigorous development of businesses and offices along the southern beltway (Bloomington-Edina I-494 and Minnetonka I-494), a development that fits Garreau's classification of an edge city (Garreau, 1991, p. 432). There too, the Mall of America was opened in 1992. According to Frommer's guide, it is the biggest and most diverse shopping center in the United States. Besides four major department stores and 400 specialty shops, the mall also has the world's biggest indoor amusement part (33 hectares), a movie complex containing 14 theaters, and numerous restaurants, cafes, and nightclubs (Frommer, 1993, p. 123). With that range of amenities, the mall doubtless offers stiff competition to the inner city and other centers.

5.3 Development of the Conurbation Minneapolis – Saint Paul

5.3.1 From Fort Snelling to a Multinodal Network

In 1860, the starting point for this analysis, there were three settlements. Saint Paul, with 10,401 inhabitants (Kieffer, 1958), was founded in 1837 after the treaty with the Sioux was signed. Saint Anthony grew out of a squatter settlement near the sawmill alongside the Saint Anthony waterfalls. And Minneapolis, with 2,564 inhabitants (Kieffer, 1958), was established in 1855, partly as a result of the opening up of the territory to the west of the Mississippi. The main mode of transport in the region was by river boat on the Mississippi. The distance between Saint Paul, on the one side, and Minneapolis and Saint Anthony, on the other, was small. Nonetheless, it took about half a day to get from one side to the other by boat (Adams and VanDrasek, 1993, p. 30).

Employment in Saint Anthony and Minneapolis was concentrated around the waterfalls at Saint Anthony. The falls provided the water power for the sawmills and the flour mills. In Saint Paul, where trade and transport were the predominant sectors in that period, there was a concentration of activity along the wharves where the Mississippi river boats docked. The agencies of the Minnesota State Government were established in 1849 in Saint Paul, which was designated as the state capital in that year. As a result of the political rivalry between the cities in Minnesota, the State Government decided to distribute a number of services among the competing cities. Stillwater (in eastern Minnesota), which was a bigger and more influential town than Saint Anthony, was chosen as the site for the prison, an important institution at the time. Saint Anthony got the university (University of Minnesota); the full impact of that decision on Minneapolis and the Twin Cities only became clear in later years (Adams and VanDrasek, 1993, pp. 31-32).

In view of the amount of time it takes to get from Saint Paul to Minneapolis and Saint Anthony, it is fair to say that the interaction between the two cities was limited to shipping goods on the river and a relatively small number of journeys to and from work, probably by a select group of persons in business, politics, banking, and commerce. There were no collective activities that could benefit from the mutual proximity of these places. Thus, the hypotheses formulated in Chapter 4 were not rejected.

5.3.2 Pacific Railroad and Streetcar: Twin Cities in 1900[1]

The first railway line through the region was laid in 1862 and connected Saint Paul with Saint Anthony. Then, in a spurt of activity up to 1900, many major regional and trunk lines were laid. In 1883, the Northern Pacific Railroad in the direction of Portland, Oregon was opened. Then, in 1893, the Great Northern Railroad, running through Montana to Seattle, Washington was opened, turning Minneapolis – Saint Paul into a hub in the system of railroads crossing the continent. The territory that had recenly been opened up to farming, not only in Minnesota by also in several states further west, was made accessible by the railroads. The farmers there had to rely on the commercial sector in Minneapolis and Saint Paul to deliver equipment as well as to buy their produce. This dependency led to a strong development of trade and agriculture-related industry in the Twin Cities.

Adams and VanDrasek ascribe the growth of the surface

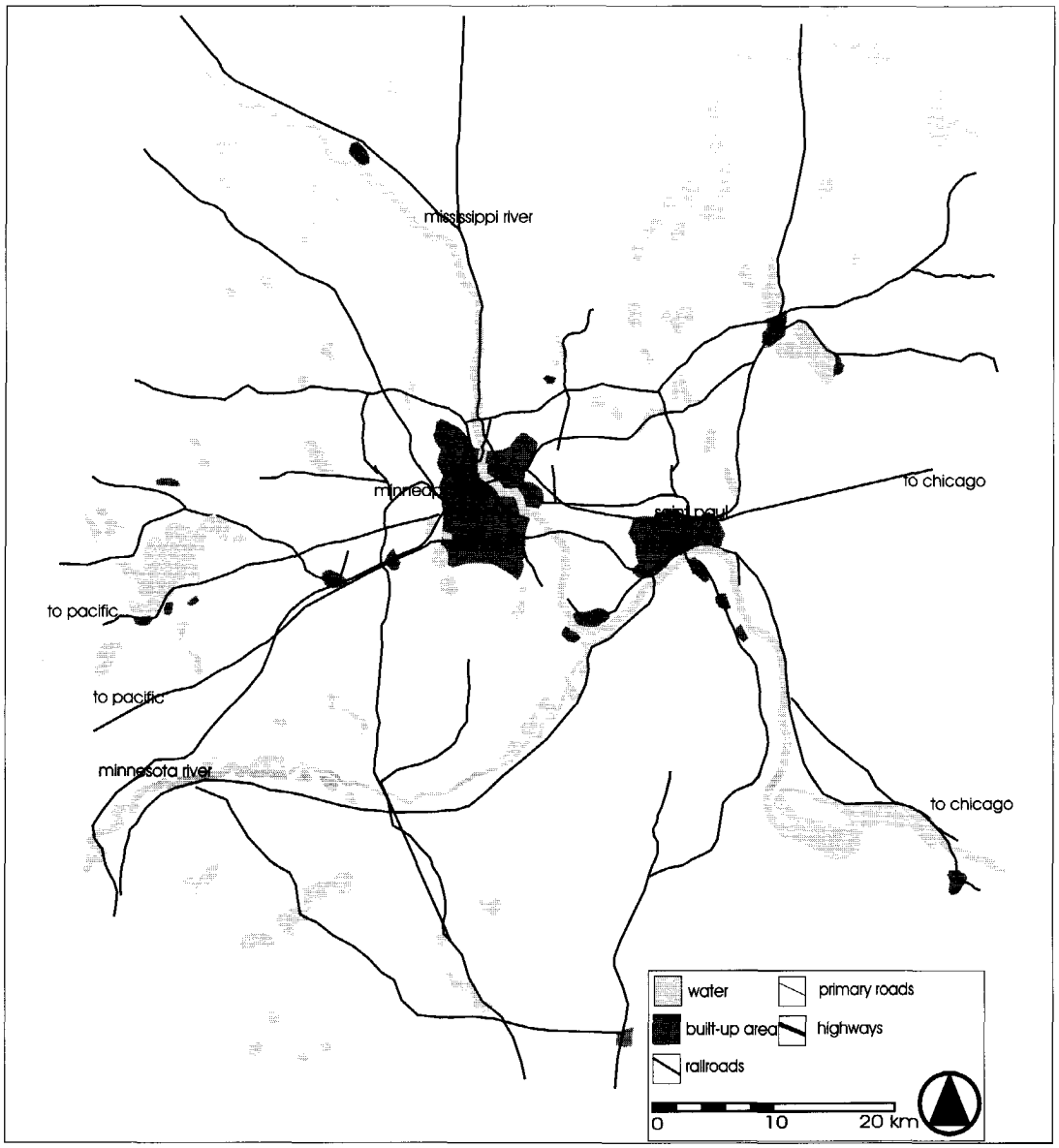


Figure 5.5
Minneapolis – Saint Paul, 1900

area covered by the Twin Cities during this period to the expansion of the tramway system. In 1890, the Twin City Rapid Transit Company, which was founded by Thomas Lowry, operated a network of tram lines running a length of 621 kilometers[2] and spreading out across the entire urban area. Like the strategy taken by the railroad companies, the strategy taken by the rapid transit company was to first put in the line and then to earn back their investment by selling off parcels of land along the route. In that period, the result of this strategy was a series of finger-shaped extensions of the territory of both Minneapolis (primarily to the south) and Saint Paul (to the west). However, the pace of urban development was not as rapid as the tram company had expected. Therefore, the size of the parcels of land they put up for sale kept increasing. As a result, the housing density in the area is one of the lowest found in any of the large cities in the Midwest (Adams and VanDrasek, 1993, pp. 80-83).

In this period, the tram was the main mode of transport in the region. In 1900, it carried 53,600,000 paying passengers (Kieffer, 1958), while the population of the Twin Cities at that time was 459,748 (Fleetham, 1993, p. 20). On the basis of the length of time it takes to travel by train from Saint Paul to Minneapolis, roughly 45 minutes to an hour (Adams and VanDrasek, 1993, p. 30), as well as on the grounds of the lower average

speed of the tram, it may be assumed that it took longer than 45 minutes to travel between the two cities by tram. New plants of the grain-processing industry were built in this period along the train tracks between Minneapolis and Saint Paul. It was logical to choose a site between the two cities, in view of the infrastructure present there, the proximity to other companies, and the availability of a work force. The establishment of these businesses might seem to be indicative of interference between Minneapolis and Saint Paul. Yet it should be kept in mind that this industry depended primarily on the railroad. Thus, on the grounds of that dependency on heavy infrastructure for freight transport, and not primarily on the grounds of accessibility as defined in Chapters 3 and 4, the hypotheses are not supported by these location preferences. More important than the development of this industry is the establishment of retail facilities. In addition to the centers that were already in existence, which got started in the pedestrian era, the retail sector expanded in this period near the intersections of the main tram lines, where department stores and concentrations of specialty shops were opened.

Each of these intersections constitutes of its own accord the most accessible location in Minneapolis and Saint Paul, respectively. That fact suggests that there is a relation between the functional structure and the degree of accessibility in each of the 'separate' urban systems.

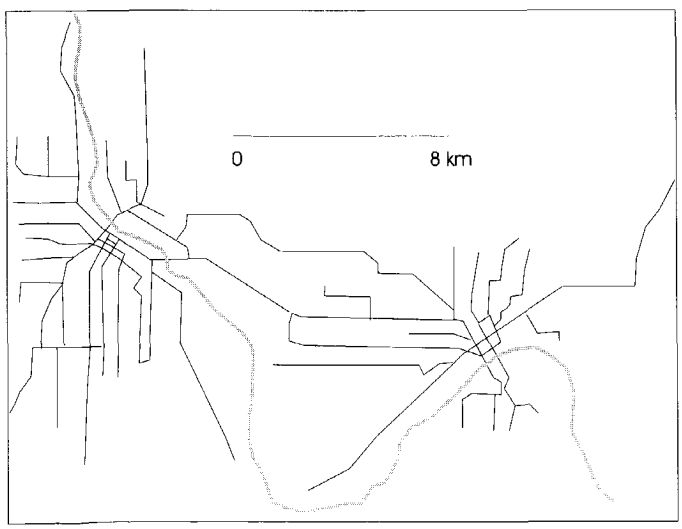


Figure 5.6 Tram Network, 1905

The businesses located at the intersections in both Minneapolis and Saint Paul are not demonstrably oriented toward any advantages they might derive from being accessible to customers coming from the other urban system. As formulated in Chapter 4, hypotheses 2, 3, and 4 do not have to be rejected because of this development. Although there are signs of improvement in the accessibility at the locations mentioned here, the differences in accessibility remain unchanged. Thus, there are no grounds for rejecting hypothesis 1 either.

5.3.3 The Heyday of the Tram

The lumber production in Minneapolis – Saint Paul was at its peak around 1895 (approx. 1625 cu.m. per year). After years of steady decline, the industry disappeared completely in 1920, partly as a result of the sharp decline in forested acreage in the region. The flour production was at its peak around 1920 and then gradually declined. In 1930, it still accounted for a quarter of the region's income. Then large meat packing complexes arose to the south of Saint Paul, along with the stockyards. At the same time, printers and publishers developed into a key industry in Saint Paul in particular (Adams and VanDrasek, 1993, pp. 37-42).

Around 1920, the tram was the chief mode of transport in the region. While the population of the Twin Cities had grown to 759,518 inhabitants (Fleetham, 1993, p. 20), the rapid transit company transported 226,543,924 paying

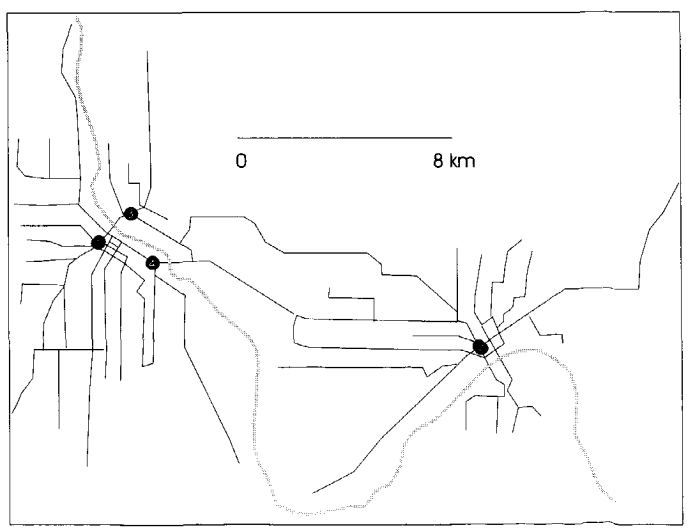


Figure 5.7 The intersections of 7th and Nicollet (1); 7th and Robert (2); Lake and Nicolet (3); Snelling and University (4).

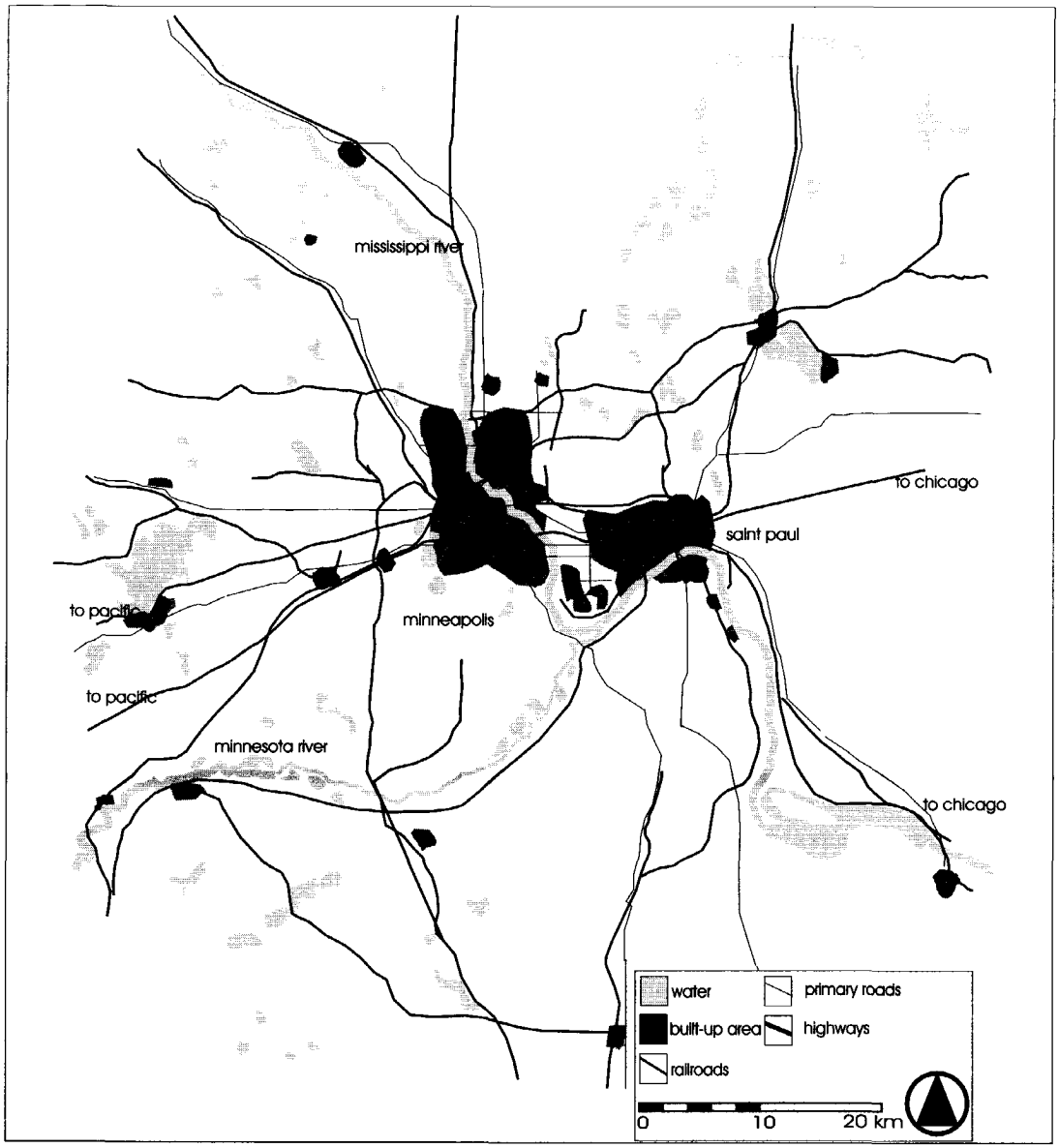


Figure 5.8
Minneapolis – Saint Paul, 1920

passengers (Kieffer, 1958; these figures are for 1922). The year 1922 was the top year for the rapid transit company. Afterwards, the number of passengers declined steadily. In the meantime, the automobile arrived on the scene, although the use of the car was still quite limited. Driving was the prerogative of a select part of the population. Whereas it still took more than 45 minutes to get from Minneapolis to Saint Paul by tram, it may be assumed on the basis of the possible speeds that cars could have driven during that period that the driver of a car could indeed have covered that distance within 45 minutes.

The spatial structure of the employment base remained essentially the same throughout the period from 1900 to 1920. Banks and services were located in the central parts of Minneapolis and Saint Paul. Manufacturing, including the meat packing industry, remained oriented toward the railroad corridors. A number of interesting developments took place in the spatial structure of the Twin Cities. First, the urban area was extended. Near Saint Paul, the expansion to the west is particularly clear. Minneapolis went through a similar development to the southwest and to the east of the city. Adams and VanDrasek (1993) explain the directions in which Saint Paul and Minneapolis developed – a pattern that was dictated in both instances by the expansion of the rapid transit system but also by the development of residential areas geared to the automobile in places lying between

the 'fingers' of the tram lines – chiefly in terms of the previously created industrial corridors along the railroads, which made it more difficult for the city to expand in all other directions.

The wealthy upper class settled in various places, including White Bear Lake, to the northwest of Saint Paul, and near Lake Minnetonka to the west of Minneapolis. Access to both areas was made possible by the tram.
Another interesting development is the change that took place in the main shopping areas. To be ready for the arrival of the automobile, parking garages were built in the center of Minneapolis and Saint Paul. Meanwhile, shopping precincts were created on the south side of the center of Minneapolis and on the southwest side of the center of Saint Paul. These new shopping precincts, which were oriented toward the new residential areas for the middle class, were accessible by tram as well as by car (Adams and VanDrasek, 1993, pp. 108-109).

On the basis of the fact that the tram was still the most important mode of transport and in view of the length of time it took for a journey, the differences in travel time did not change. There were thus insufficient conditions for interference. In light of the observed changes, there are no grounds to believe that the two urban systems have had a strong reciprocal influence on each other. Nor is there any reason to believe that any collective activities are oriented toward both cities. Thus, the hypothesis is not rejected for this period either.

5.3.4 The Automobile Era Arrives

The year 1940 was a turning point in the spatial development of the Twin Cities. In the meantime, the cities had grown tightly together. The area could be called a conurbation as defined by Geddes. Car ownership in the region was roughly one vehicle per household, while the number of rides per person per day was approximately 1.2 (Metropolitan Council, 1992, p. 10). The rapid transit company saw the number of paying passengers decline to just over 100 million per year (Kieffer, 1958). At a population of 1,000,585 (Fleetham, 1993, p. 20), this amounts to 280,000 tram passengers per day, compared to approximately 1.2 million automobile trips made by drivers and passengers. Thus, in 1940, the automobile had become the most important mode of transport in the region.
In this connection, it is interesting to note that at an average speed of 30 kilometers per hour in the built-up area (Metropolitan Council, 1992), the journey between the center of Minneapolis and the center of Saint Paul takes less than 45 minutes. For a number of places, the accessibility value is greater than or equal to that of the centers of Minneapolis and Saint Paul. Thus, interference is possible. At the same time, there are places that can be reached within 45 minutes from anywhere in the entire urban area which have an accessibility value that is equal to that of the maximum value for the area of both cities. For instance, this is true of the zone between Minneapolis and Saint Paul along University Avenue. Thus, the condition for the formation of a system is present here.

The regional economy is becoming more diversified as time goes by. As the number of jobs in trade, manufacturing, finance, and business services increases, these sectors are becoming predominant, while the significance of the milling industry is declining. Banks and other services as well as various office functions are opening up in the existing centers of Minneapolis and Saint Paul. Most new industries are located along the old railroad corridors, particularly to the north and south of Saint Paul and to the north and west of Minneapolis as well as in the area lying in between the two cities, namely Midway. This close association with the rail corridors points to a strong dependency on rail transport during that period.
Although the automobile was the most important mode of transport at the regional level, it proves that trade and industry give priority to rail transport – especially to Duluth (the gateway to the Great Lakes), Chicago, Seattle, and Portland – for the long haul (at least 200 kilometers). Because the new industrial establishments are dependent upon heavy infrastructure, they cannot be an indicator for interference and the formation of systems. Nonetheless, this does represent an interesting development of the functional structure.
The reason is that all new industrial sites in Minneapolis can be reached from each and every location in the urban area of Minneapolis and partly from Saint Paul within 45 minutes travel time by car. The same is true for

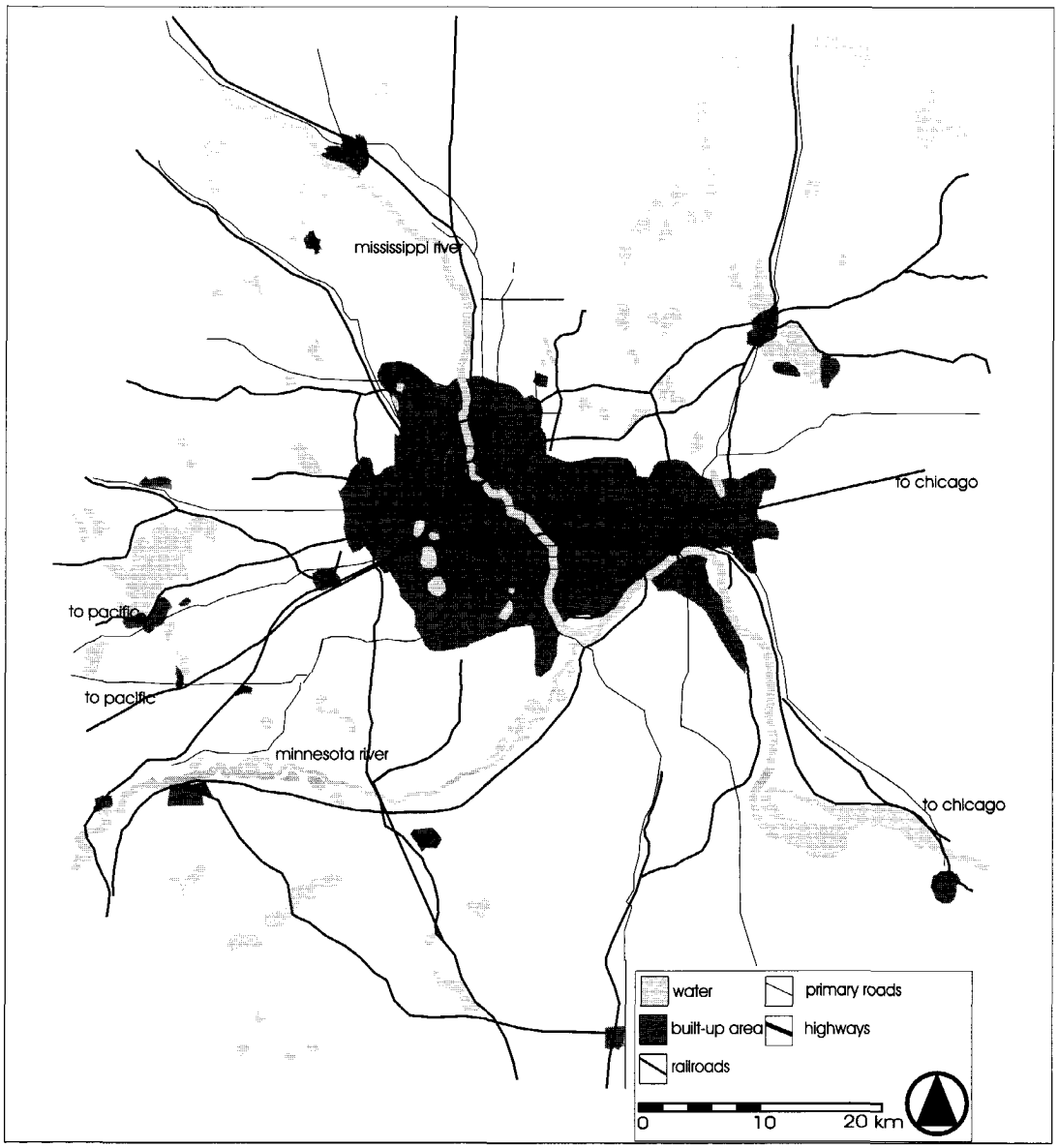


Figure 5.9
Minneapolis – Saint Paul, 1940

the new industrial sites in Saint Paul. The question regarding the extent to which the new industrial activities are directly dependent on the railroads must remain unanswered due to the lack of detailed information. Therefore, they cannot be classified as interference.

Between 1930 and 1945, new shopping areas arose on Excelsior Boulevard and on Wayzata Boulevard to the west of the center of Minneapolis. Furthermore, new shopping facilities appeared on the western end of University Avenue and on Cleveland Avenue – Ford Parkway, between the centers of Minneapolis and Saint Paul. These centers were developed to cater to customers who would be coming by car (Adams and VanDrasek, 1993, p.109). In that period, the centers on Excelsior Boulevard and Wayzata Boulevard could be reached within 45 minutes from anywhere in the entire city of Minneapolis and from parts of Saint Paul. In that way, those centers are indicative of interference between Minneapolis and Saint Paul. However, given their specific location as well as the fact that Saint Paul has a center of the same content and size, it is clear that the economic base consisted predominantly of the inhabitants of Minneapolis.

The centers on the west end of University Avenue (the main artery between Minneapolis and Saint Paul) and on Cleveland Avenue – Ford Parkway could be reached

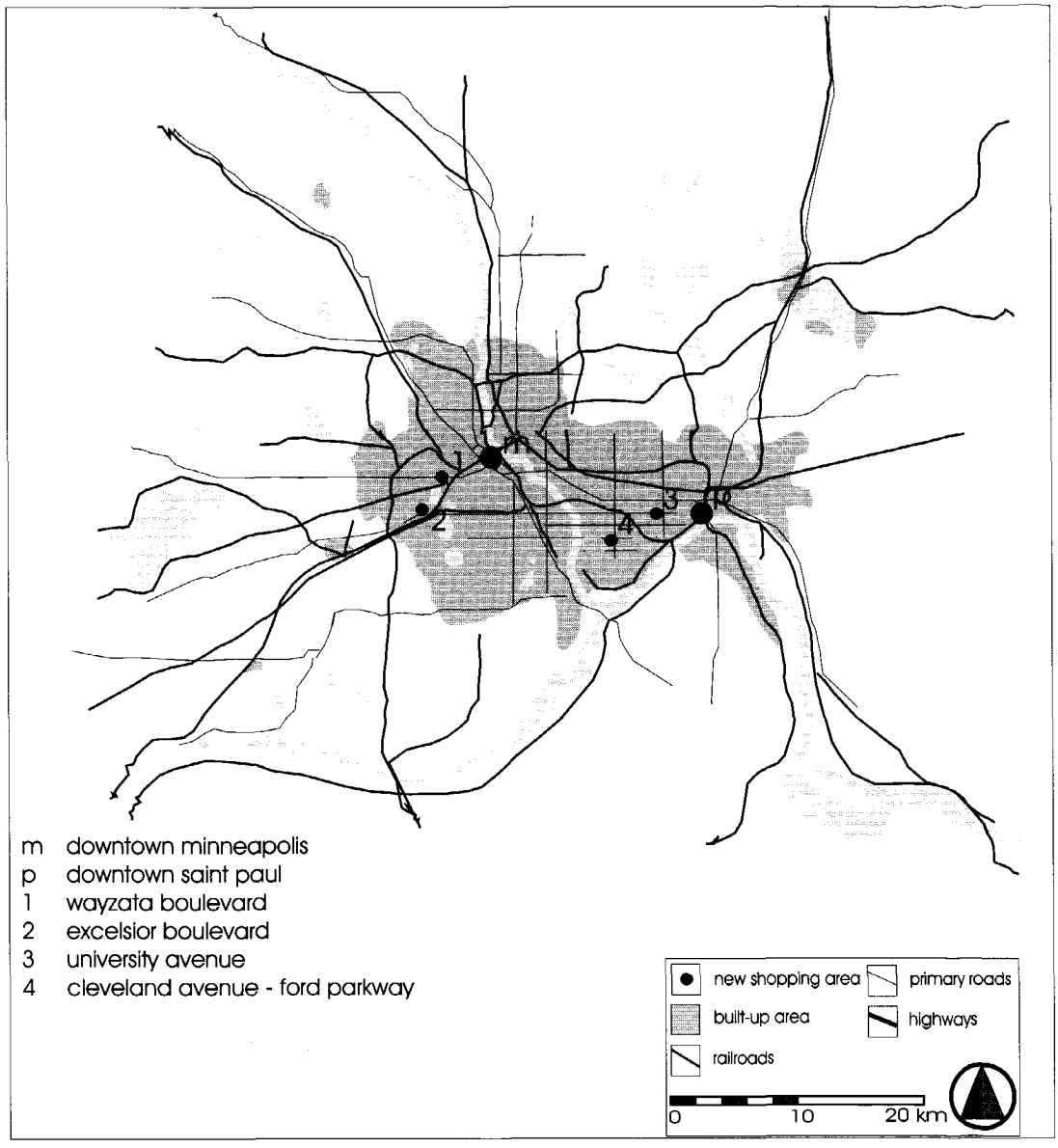


Figure 5.10
New shopping areas between 1930 and 1945

within 45 minutes from anywhere in the entire urban area. This means that there could have been evidence of interference, but also of system formation. Taking the population figures for 1940 (1,000,558; Fleetham, 1993, p. 20) and the level of these shopping areas, it proves that these were subregional facilities, which were able to benefit from the accessibility from both urban systems because of their specific location (Gilhousen, 1990). This leads to the conclusion that there was interference between Minneapolis and Saint Paul.

There are other locations where interference was possible on the grounds of accessibility. The change in differences in accessibility, which is a direct consequence of the shift from the tram to the private car, was a decisive factor in the increase of accessibility of a number of locations. The new concentrations of collective activities (University Avenue West and Cleveland Avenue – Ford Parkway) – activities that clearly benefited from an economic base that is provided by both cities and exemplify interference – offer support for hypotheses 1 and 3. The fact that as yet no activities can be observed that indicate system formation, or that a number of new concentrations cannot be classified as interference, does not refute the hypotheses.

5.3.5 The Expansion of the Twin Cities

The period around 1960 was an important turning point, partly because of the cooperation between the two cities

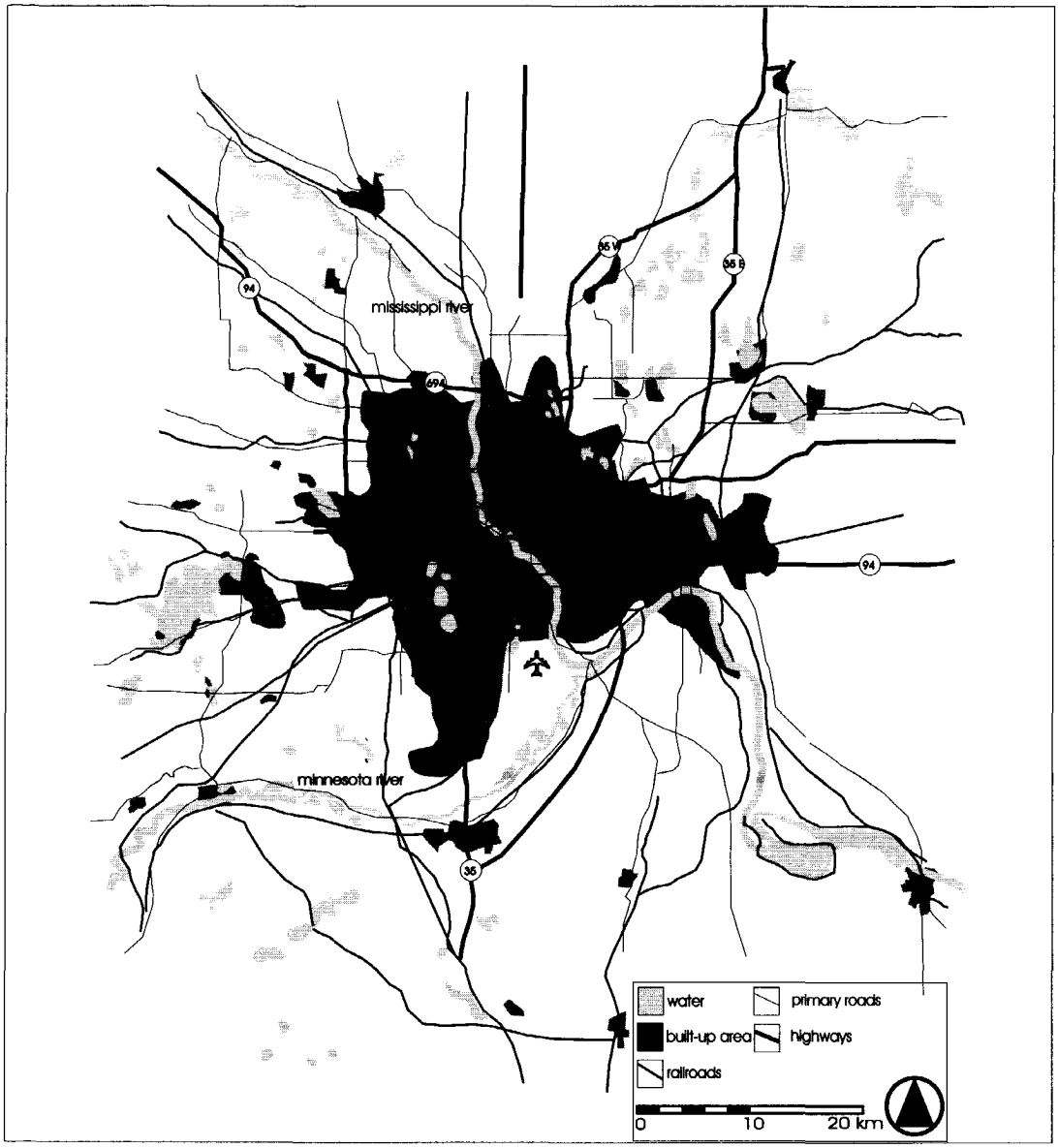


Figure 5.11
Minneapolis - Saint Paul, 1960

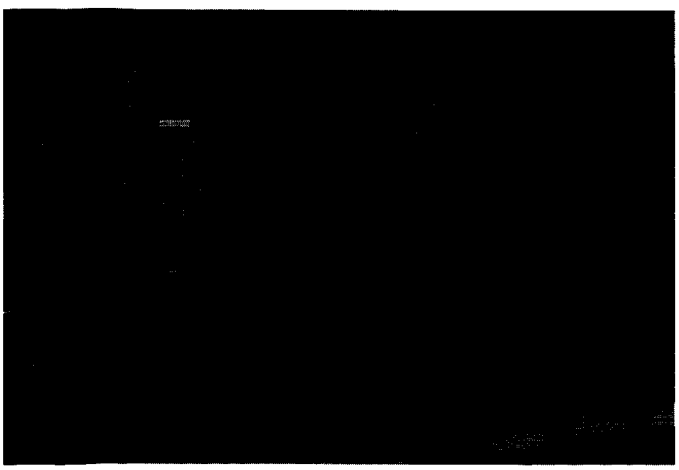
at that time. As Adams and VanDrasek write, "After an adolescent sibling rivalry that lasted some eighty years, Minneapolis and Saint Paul finally matured in the 1950s to the point that cooperation became an obvious need. Separately, the two cities occupied lower ranks among members of the American urban system, but working together as one metro area they gained the critical mass needed to become a major player" (Adams and VanDrasek, 1993, p. 170). Almost emblematic of this new period was the founding of the major league baseball team, which was aptly named the Minnesota Twins. Other important developments were the founding of other major league teams (in ice hockey, football, and basketball), the Walker Arts Center, the Guthrie Theater, and the construction of the international airport.

In the course of time, the automobile overtook public transport in Minneapolis – Saint Paul. From 1954 on, trams were replaced by buses, and the tram service was terminated in 1957 (the number of passengers in 1957 was 74,479,993; Kieffer, 1958). Given the number of bus passengers in 1971, namely 57 million (Metropolitan Council, 1992), it is fair to say that this mode of transport was not able to reach the level of service that had been attained by the tram. The number of trips by private car was roughly 3.5 million per day in 1960. Car ownership rose to 1.3 vehicles per household (Metropolitan Council, 1992), and the system of highways was extended significantly. Whereas the total

length of roads in that system was just 8 kilometers in 1950, there were 161 kilometers of highway by 1960. In developing the highway network, the emphasis has been on radial roads leading to and from the centers of Minneapolis and Saint Paul. Not only did that network provide better accessibility for the city centers, it eventually led to more traffic congestion and parking problems as well. The highways allow the average speed to increase, which in turn leads to more locations that can be reached within 45 minutes from any place in the entire urban system, thereby providing the necessary condition for system formation.

Apart from the increasing number of jobs in retail trade, the employment trend that had already started did not change course. Thus, new sites continued to be developed along the old railroad corridors. There was a strong development of new food warehouses as well as processors and machine industry along the Saint Louis Park – Hopkins strip to the west of Minneapolis following the Northern Pacific railroad tracks. Other agricultural processors and machinery and metalworking plants were established in the railroad corridor along the Mississippi River to the north of the center of Minneapolis. Oil refineries and other petrochemical installations, which were made possible when new oil fields were opened up in Alberta, were established in the railroad corridor to the south of Saint Paul downstream along the Mississippi.

The job growth in the service sector in particular has been most visible in the centers of Minneapolis and



Metrodome

Downtown Minneapolis

Saint Paul (Adams and VanDrasek, 1993, p. 184). In order to cope with the parking problems and traffic congestion in the inner cities, as well as to protect pedestrians from inclement weather, skyways have been built alongside the parking garages, connecting a large number of buildings in those centers. The skyways allow drivers to walk indoors from the car to their place of work. For instance, in Minneapolis, a total of 30 blocks are linked by the skyways. One of the consequences was that various shops have been established at the level of those skyways, in response to the relocation of the pedestrian traffic. The center of Saint Paul also underwent similar changes. Numerous old warehouses made way for new offices and residential structures; there too, a system of skyways was put in place. Measured in terms of the number of blocks that were connected by the skyways, it would appear that the center of Minneapolis had developed more vigorously than the center of Saint Paul. On the other hand, Saint Paul had a number of important institutions such as the State Government and the World Trade Center.

The choice of a location for the shopping areas, which were opened between 1930 and 1950, seemed to bear a strong resemblance to that for shopping areas in the period of the tram. There was a strong accent on finding a site at the intersection of major roads. At an early stage, this location preference led to traffic congestion and parking problems, which in turn ushered in a new era for retail facilities. A case in point is the opening of Southdale shopping mall in 1956. This mall was located at some distance from the highway and offered unlimited free parking. The choice of a location, between 66th and York Avenue South, was based on the

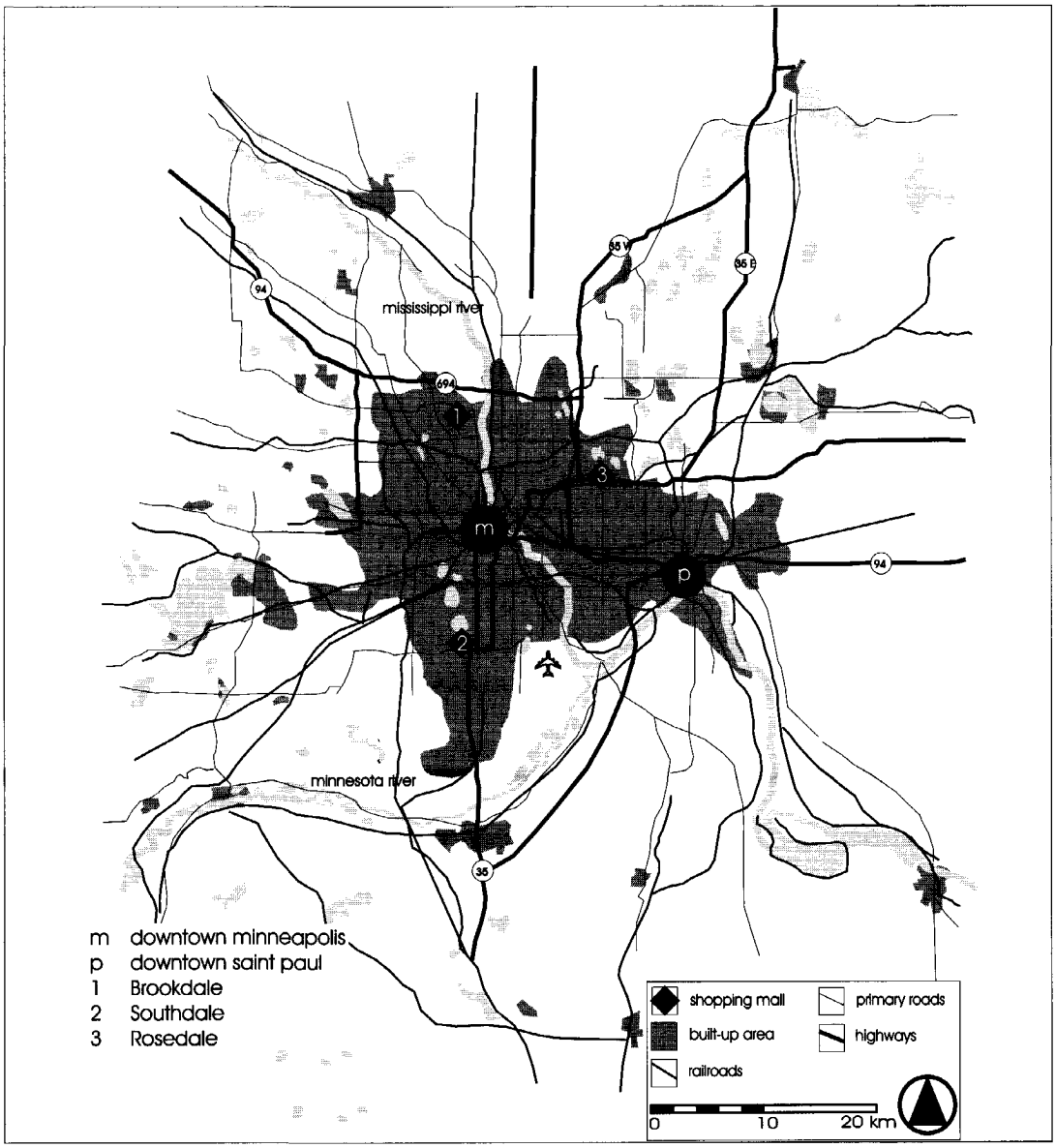


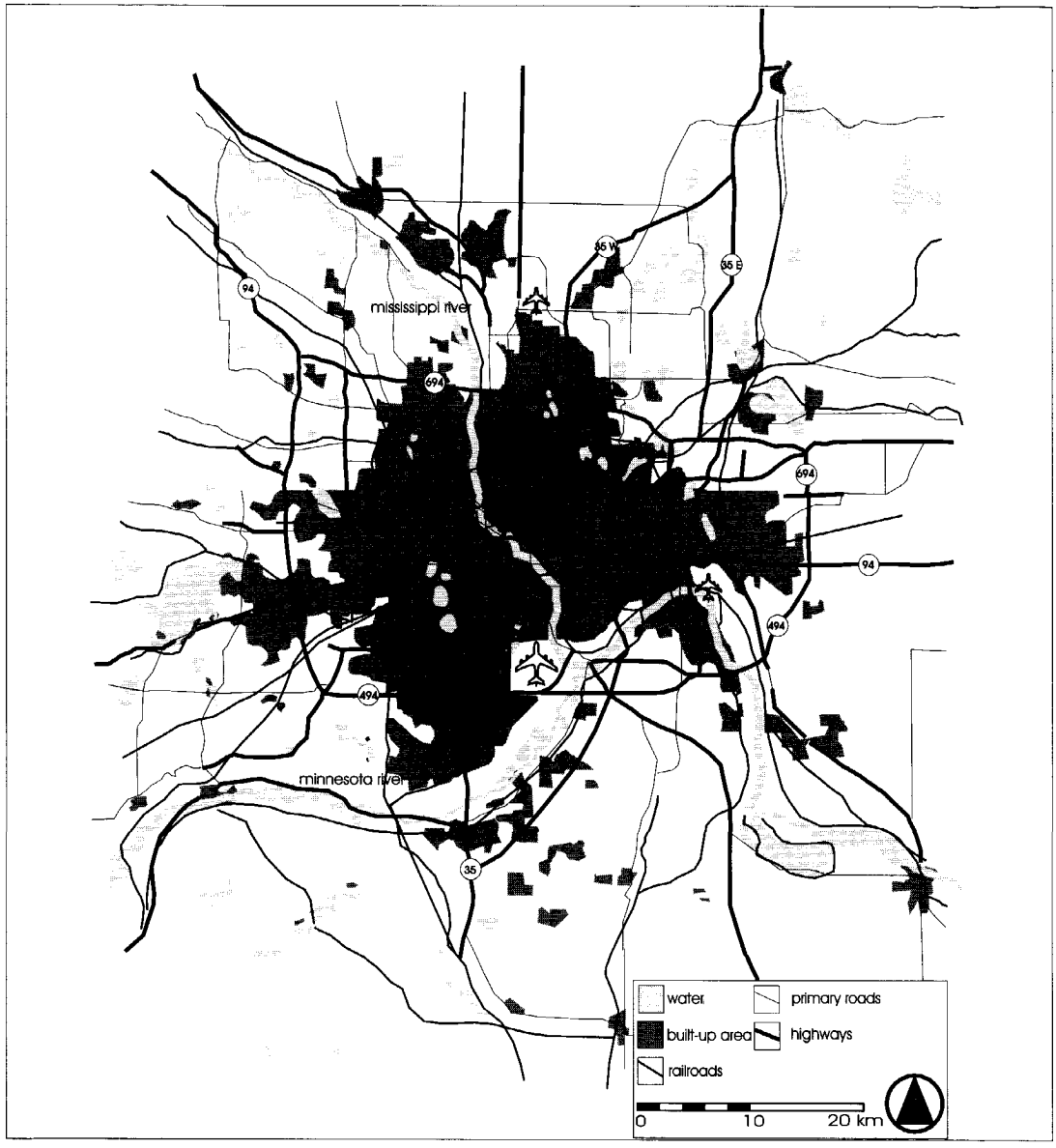
Figure 5.12
New shopping malls, 1960

anticipated growth of the residential areas for the middle class to the south of the center of Minneapolis and areas for higher-income households in the southwest (Adams and VanDrasek, 1993, pp. 109-110). When the mall opened, it had 72 stores; even now, it is still classified as a regional center (Metropolitan Council, 1990). This concept was copied in various places; it was the model for the Brookdale shopping mall (1962) to the north of Minneapolis and for the Rosedale shopping mall (1969), which lies in between the centers of Minneapolis and Saint Paul (Gilhousen, 1990).

The favorable development in the 1960s also took shape in other ways. For instance, the University of Minnesota saw its enrolment rise to more than 40,000, while several museums, theaters, and sports stadiums were built. In that respect, Minneapolis turned out to be the favorite place to open a facility. The stadiums for the Minnesota Twins (baseball), the Minnesota North Stars (ice hockey), and the Minnesota Timberwolves (basketball) are there, as is Orchestra Hall, the Walker Arts Center, and the Guthrie Theater. All of these amenities were located in the center of Minneapolis.

The enormous changes in the network of roads had a definitive influence on the change in the differences in accessibility in the region. Especially because of the radial orientation of the highways, a large area, forming

Figure 5.13
Minneapolis – Saint Paul, 1980



a kind of central ellipse in the region, provides the necessary conditions for system formation. All new and unique activities – such as the Walker Arts Center, the Guthrie Theater, the World Trade Center, and the sports stadiums – as well as the new office buildings are found in this central area and thus support hypothesis 4. There are no new collective activities that have been established at locations where accessibility is inadequate. The hypothesis is thus not refuted.

The shopping malls that were built during this period are classified as regional or supra-regional centers. Independent of the question whether or not the location of these malls satisfies the criterion of accessibility, this classification warrants a critical review. Gilhousen (1990) observes that in Minneapolis – Saint Paul, one may speak of a supra-regional center if the location has more than 74,420 sq. meters (or 800,000 sq. feet) of gross floor space and at least three department stores. In view of the size of the population in 1960 (1,525,279; Fleetham, 1993, p. 20), there is no doubt that by Dutch standards, a shopping area of that size would be classified as a sub-regional center.[3] The shopping malls that were developed in this period also show a great degree of similarity with respect to the range of shops (Gilhousen, 1990). At the same time, there are strong indications that each of these malls is oriented toward the new suburban areas. In light of these two observations, it may be concluded that in

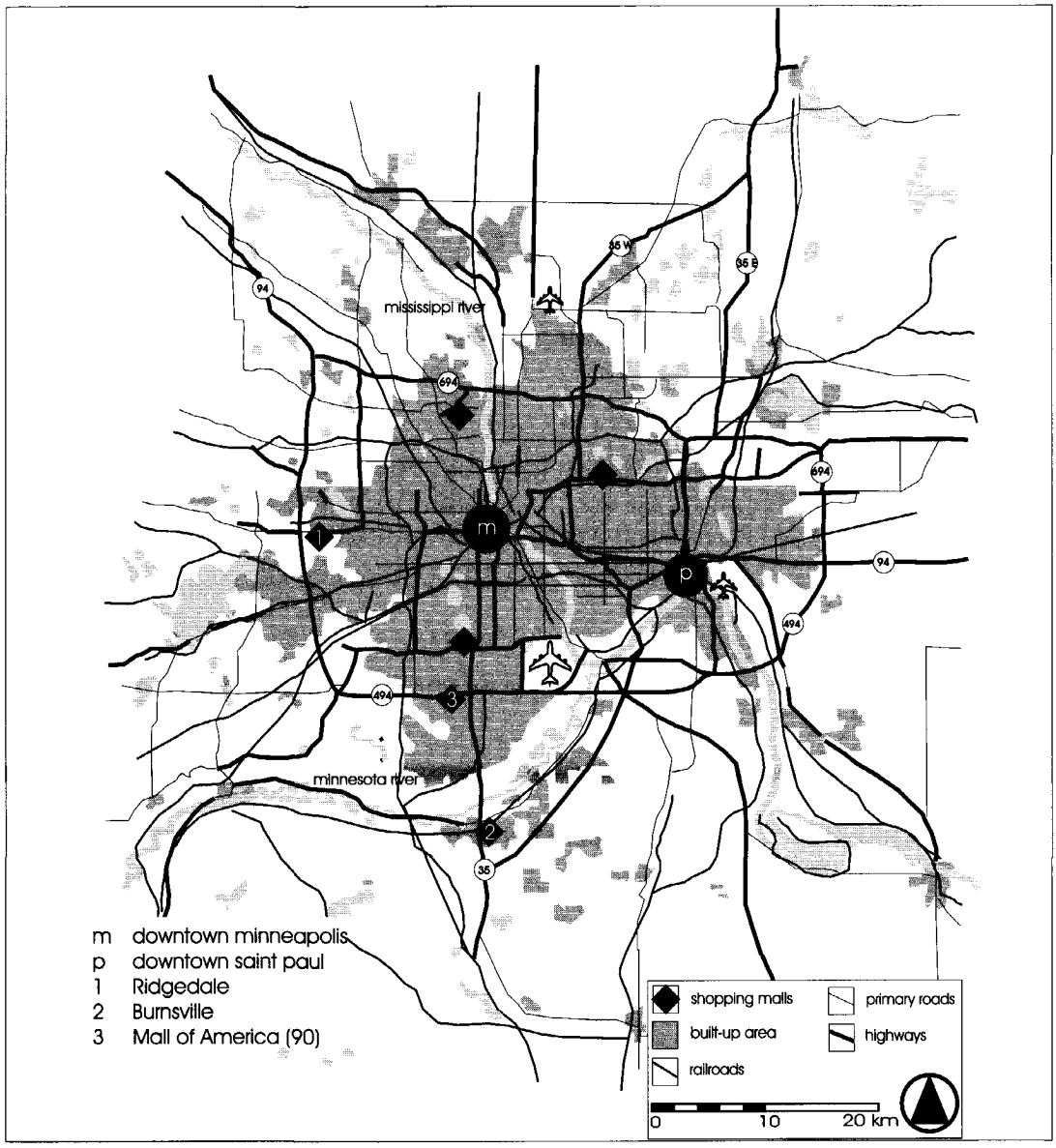


Figure 5.14
New shopping malls, 1980

this case there are no new collective activities at the regional level. System formation in the Twin Cities can therefore not be supported by the new shopping areas. The remaining activities, such as Orchestra Hall and the Guthrie Theater, do serve a regional function and are indicative of system formation in this period.

5.3.6 The Development of a Complex Multinodal Structure

The last period that is examined with respect to the development of Minneapolis – Saint Paul reveals a sharp change in the functional structure. That change is often described as the third wave of suburbanization, as it came after the suburbanization of the population and the ensuing suburbanization of shopping facilities. Roughly, this means that companies and offices tend to move out of the inner cities and establish premises in the suburban landscape. The image presented by a map of Minneapolis – Saint Paul shows that this change has also taken place here. Concretely, since 1970, numerous new companies have sprouted up on the edge of the cities, creating a multinodal structure. In the period around 1960, there was a turning point from interference to system formation in the Minneapolis – Saint Paul region and indications have been found for this system formation. Mobility increased further, particularly due to the development of the road network and the growth of car ownership. In that light, it may be

expected that in the period after 1960, the new urban system of Minneapolis – Saint Paul would develop further.

Between 1960 and 1980, 590 kilometers of roads were added to the system of highways in the region, bringing the total length of roads up to 750 kilometers. Meanwhile, the rate of car ownership increased to 1.6 autos per household. Besides the previously constructed highways that were directed toward the city centers, a number of beltways were built, reducing the time it takes to drive from one suburb to another. Partly because of these new ring roads, it is in theory possible to reach a large number of other locations in the metropolitan area within 45 minutes. That possiblity is restricted by congestion, however. In 1980, the congestion was severe on 60 miles of highway (Metropolitan Council, 1963). The bus company, which reached its peak performance around 1980, carried roughly 92 million passengers in a year (approximately 260,000 per day). That figure is negligible compared to the number of trips by private car (about seven million a day) (Metropolitan Council, 1993).

Besides the shopping malls that were already in place, several smaller shopping centers and two new malls – Burnsville (118,000 sq. meters in gross floor space) and Ridgedale (114,000 sq. meters in gross floor space) – were built in the region. The latter two locations are indicative of an orientation toward the new residential areas that were developed in this period. That orientation confirms the earlier supposition that these shopping facilities serve a subregional function. The concentrations of shops in the centers of Minneapolis and Saint Paul lost their regional function, particularly after 1980. "In the 1990s, it can safely be said that virtually any retail item available downtown also can easily be found in the suburbs, which claim a market share of more than 75% and more than $4 billion in gross annual sales" (Adams and VanDrasek, 1993, p. 114). In that regard, there seems to be an extensive system of facilities that all serve a regional function, at least in part, from their base in their own subregional market. All centers that the Metropolitan Council classifies as supra-regional and regional can be reached within 45 minutes from anywhere in the entire metropolitan area. This leads to the conclusion that Minneapolis – Saint Paul forms a single urban system in which a number of competing regional or subregional shopping concentrations of the same level all serve a function in that system.

After the recession of the 1970s, the service sector increased sharply. In the period 1980-1990, employment in this sector rose by 46.5 percent:

Growth in employment 1980-1990

Services	46.5
Trade	22.4
Finance/insurance/real estate	10.3
Government	9.4
Manufacturing	5.3
Transportation/communications	4.7
Construction	1.4
Total	100

Source: Minnesota Department of Jobs and Training; U.S. Labor Department

Not only did services show the highest growth in the number of jobs but this is also the most important employment sector in Minneapolis – Saint Paul. On the grounds of the volume of employment in the other sectors, it is fair to say that the regional economy is diversified.

Volume of employment 1992 (x 1000)

Mining	0.4
Construction	46.6
Manufacturing	257.9
Transportation/communications	77.1
Trade	331.7
Finance/insurance/real estate	101.3
Services	408.9
Government	195.0
Total	1426.6

Source: Minnesota Department of Jobs and Training; U.S. Labor Department

In the period around 1960, there was a large proportion of industrial activities whereby the choice of a location appeared to be strongly influenced by the presence of heavy infrastructure and the need to limit nuisance. These criteria led to the consolidation of employment in the railroad corridors. The change in the industrial activities themselves and the emergence of the service sector opened up new options for locational choice. The majority of the companies were not longer dependent

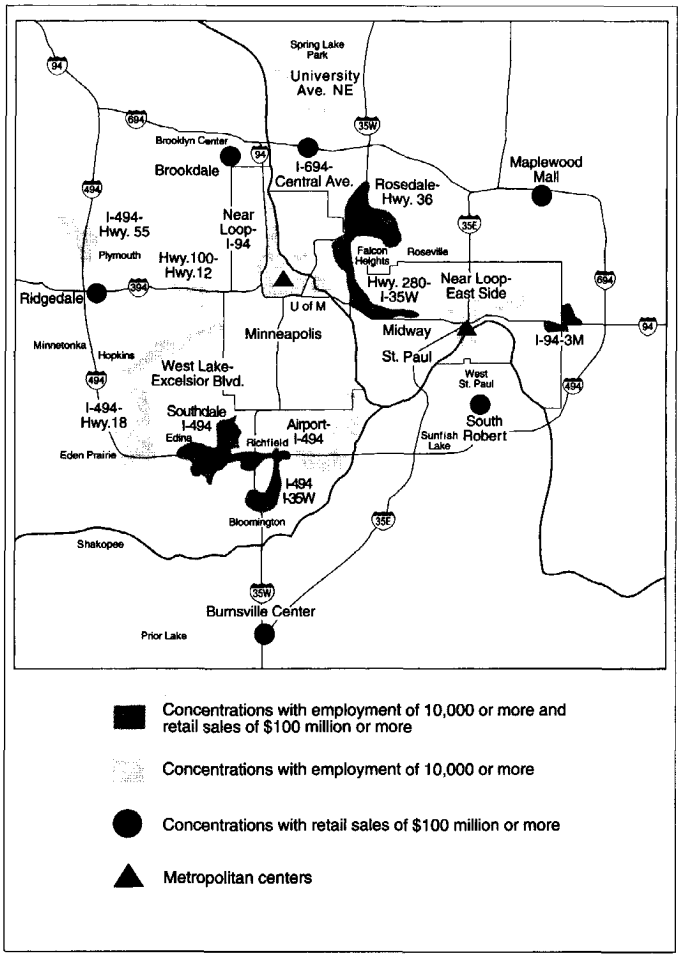


Figure 5.15 Location of employment (source: Adams and VanDrasek, 1993)

for their transport needs on access to a railroad in their immediate vicinity, while transport by road and air became more important. Moreover, the manufacturing industry in Minneapolis – Saint Paul places emphasis on high-tech products such as computers and components, pacemakers, and parts for military equipment and civil aviation (Adams and VanDrasek, 1993, pp. 50-52). Only a small number of companies remained dependent on heavy infrastructure and the presence of resources.

In 1980, employment in the suburban areas increased sharply. Nearly two-thirds of the job growth took place in these areas (Carlson, 1994). Moreover, the volume of employment was virtually the same as that in the inner cities (Adams and VanDrasek, 1993, p. 189). In the decade 1980-1990, there was a vigorous development of employment along the southern beltway (I-494), and the suburbs, including the zones along the beltway, accounted for 75 percent of the job growth. "Interstate I-494 is one of the freeways designed to carry through-traffic around the Twin Cities. Increasingly, though, the freeway carries commuters from their dispersed suburban homes to their dispersed suburban jobs. The increase in jobs along the freeway added 80% to traffic volumes between 1976 and 1986 as the seventeen-mile stretch from I-394 to the airport became the main street of the southwestern metro area" Adams and VanDrasek, 1993, pp. 188-189).

The kind of employment found in the central cities (Minneapolis and Saint Paul; centers and other areas) shows remarkably little difference from that in the suburbs. Only the share of employment in sales (10 percent in the central city versus 15 percent in the suburbs) and skilled crafts (seven percent in the central cities versus 10 percent in the suburbs) is different. These proportions differ partly because of the big shopping malls and the new specialized companies (Carlson, 1994). The concentration of employment at the local level, in contrast, does differ strongly. The center of Minneapolis has an employment base of 278,314 persons, while the center of Saint Paul has one of 172,504 employees (Minnesota Department of Jobs and Training, 1990). In this respect, these centers differ from the other areas. These centers are most clearly distinguishable from other areas by their physical form: a concentration of high-rise buildings versus a landscape with free-standing office buildings and industrial plants.

The employment at the various locations performs a function at the regional level. This proposition is supported by the increase in the average commuting distance, which rose from 10.6 kilometers in 1970 to 13.0 kilometers in 1986 (Adams and VanDrasek, 1993, pp. 190, 203). In view of the fact that the employment locations could be reached within 45 minutes from anywhere in the entire urban area, though it should be noted that traffic congestion could be a disrupting factor, it can once again be confirmed that Minneapolis – Saint Paul is a full-fledged urban system.

The drastic change in the differences in accessibility in

the urban area may be ascribed to the increase in the use of the private car and the construction of both radial highways and beltways. The classic image of an easily accessible center due to radial roads – in this case, the centers of Minneapolis and Saint Paul – is replaced by a situation in which the differences between the city center and the urban fringe are negligible. The conditions for accessibility that this creates are then exploited by various companies, small and large. After the periods in which interference and system formation have been determining factors in the development of the conurbation, the new urban system became subject to a transformation. That process is characterized by deconcentration and decentralization of employment.

5.4 Conclusions

Some key points in time may be distinguished in the development of the Minneapolis – Saint Paul conurbation. The first is the greater importance of the automobile around 1940 and the emergence of new shopping areas. The next is the increase in the number of roads around 1960, when the first shopping malls were built and a number of regional facilities were established. The last period is marked by the deconcentration and decentralization of employment, which started in the 1970s.

According to the theory, interference can occur when, based on the most important mode of transport, the accessibility value of a location is greater than or equal to the accessibility value of the centers of the urban systems in question. Until the period in which the automobile became the most important mode of transport, no location in Minneapolis – Saint Paul met this criterion. Hypothesis 3 (interference) would have to be rejected if activities were found that undeniably benefitted from the proximity to another urban system in their daily functioning, while that location would not meet the accessibility criterion. These activities did not take place prior to 1940. The shopping areas that were developed around 1940 between Minneapolis and Saint Paul are situated at places that do meet the criterion for accessibility. In terms of size, they prove to surpass the level of their own urban system. This indication lends support to the hypothesis.

The development of highways in the period around 1960 allowed locations to arise that could be reached within 45 minutes from anywhere in the entire urban area. Because of that development, the condition for system formation is present. The locations of the shopping malls that were developed in the period around 1960 satisfy this criterion for accessibility. The strong orientation toward the new suburban areas, as well as the level of these malls, suggests that these are subregional facilities. For that reason, these observations do not lend support to the hypothesis. However, a number of unique facilities are also created, such as the sport stadiums, Orchestra Hall, the Walker Arts Center, and the Guthrie Theater, all of which clearly perform a regional function. The hypothesis that system formation will occur if there are locations that can be reached from the entire urban system within 45 minutes is thereby confirmed. For this research, it is important to emphasize that no regional functions are established at locations that do not meet the accessibility criterion. Thus, the hypotheses are not refuted.

The late timing at which system formation arises with respect to employment is noteworthy. Around 1960, a large share of the employment appeared to perform a regional function already. Nonetheless, that function only became clearly visible in the 1980s, when new employment areas were developed and the volume of traffic increased. Only then were there grounds on which to conclude that Minneapolis – Saint Paul had developed into a single urban system. The difference between the development of the locations for employment and those for services might be explained on the basis of a large differential in spatial conditions. Facilities (stores, stadiums) are directly dependent on their accessibility to visitors (their economic base). Many companies, and particularly manufacturing industries), have been dependent on transport possibilities and transport costs till well into the 1970s. At the same time, they also had to be allowed to create some degree of nuisance in the surrounding area. Only when the production processes changed, which started to occur in the 1970s (Alonso, 1975a), could companies become less dependent on the traditional location factors. From then on, they seemed to become freer in their choice of a location.

Notes

1.
In the period between 1860 and 1880, very few changes took place in the economy, in the distribution of collective activities, and in the size of the population. Therefore, this section depicts the changes over a 40-year period rather than *sticking to the 20-year time* frame set forth in the study design.

2.
For the sake of comparison, in the same period, Rotterdam had a tram network of 200 kilometers (Koster, 1984).

3.
For the sake of comparison, the metropolitan area of The Hague (1.5 million inhabitants) has a regional center with roughly 200,000 sq. meters of gross floor space as well as a number of subregional centers varying from approximately 50,000 to 100,000 sq. meters of gross floor space (source: Municipality of The Hague). These figures should be interpreted with some caution, however, for two reasons. First, differences exist in the use of space and purchasing power. Second, the boundaries of the city centers are not always clear, particularly for Dutch cities.

6.1 The Scale of System Formation in the Netherlands

The Randstad, which is the highly urbanized western part of the Netherlands, is developing into a multinodal metropolis, according to the Netherlands Ministry of Housing, Spatial Planning and the Environment, abbreviated VROM (Ministerie van VROM, 1988, p. 115). Niek de Boer (1996) takes the opposite standpoint, stating that there is no such thing as the Randstad metropolis. In the Netherlands, no end is in sight to the ongoing discussion about the Randstad – about aspiring to the status of a metropolis and about whether or not this dispersed urban area may be considered as an urban entity. For the present research, the main issue is the level of scale at which the process of system formation takes place. Should an incipient system be sought at the level of the Randstad or at that of the areas that are presumed to be its constituent parts: the North Wing (the urban areas of Haarlem, Amsterdam, Almere, and 't Gooi) and the South Wing (the urban areas of Leiden, The Hague, Rotterdam, and Dordrecht) (Randstad Overleg Ruimtelijke Ordening, 1990).

The spatial development of the western part of the Netherlands seems to be a classic example of the development of a multinodal urban system consisting of a number of large cities. At least, as far as what the government of the Netherlands says in the Fourth Policy Document on Spatial Planning proves to be true. That document states that the Randstad can develop into a polynucleated metropolis, which implies the further development of the large agglomerations: Amsterdam, Rotterdam, and The Hague (Ministerie van VROM, 1988, p. 115).

The relatively small distances between these cities (80 kilometers at most) and an overtaxed network of roads – in itself, an indication of a large number of mutual relations – as well as the social recognition of the existence of the Randstad and the due planning attention do indeed seem to confirm the existence of this metropolis. If the government is right, then the Randstad constitutes an interesting object of study with respect to system formation, as it may be assumed that a new urban system is currently developing. Doubts about whether the government is correct lead to other questions. Is there incipient conurbation at the level of scale of the Randstad? Or is it more likely to occur at the level of the component parts of this area, namely in the North Wing and the South Wing? Another possibility is that different processes of change are taking place concurrently at both of these levels. Before the object of research can be determined for this case, it is necessary to find out at which level of scale the process of system formation is taking place here.

The existence of the Randstad as a metropolis is confirmed in the book entitled Four Metropolises in Western Europe. It states that, "The Randstad can be designated as an extended polynuclear metropolis both in terms of its appearance and in terms of its spatial and functional organisation: a ring of cities and medium-sized towns interlinked by a highly advanced infrastructure and grouped around a central open space mainly comprising agricultural land, countryside and areas for leisure activities" (Van der Cammen, 1988, p. 120). Musterd and De Pater take a more critical stance with respect to the Randstad. They asked whether it is a utopia or a reality, an ideal to be realized or an eternal illusion. The Randstad is not a metropolis as long as we continue to uphold the traditional mononuclear definition of this type of city, as they put it. Musterd and De Pater reason that the concept of centralization, which emanates from the traditional organization of power, administration, and production, is making way for concepts such as urban networks and networks of cities, which otherwise fall under the heading of decentralization. As part of a revision of the concept of the metropolis – the metropolis would then not by definition have to consist of a contiguous built-up areas – the Randstad can, in fact, be considered as a metropolis (Musterd and De Pater, 1992). Hubert de Boer (1992, p. 8) points out that in the course of history, the concept of the metropolis was perceived differently. The metropolitan character is determined not by the form or size but by the concentration of the three metropolitan functions – politics, the economy, and culture – but most of all vitality. For these functions, accessibility back and forth, which is the condition for a continuous interaction, is decisive for the functioning of a metropolis, according to Hubert de Boer, who also

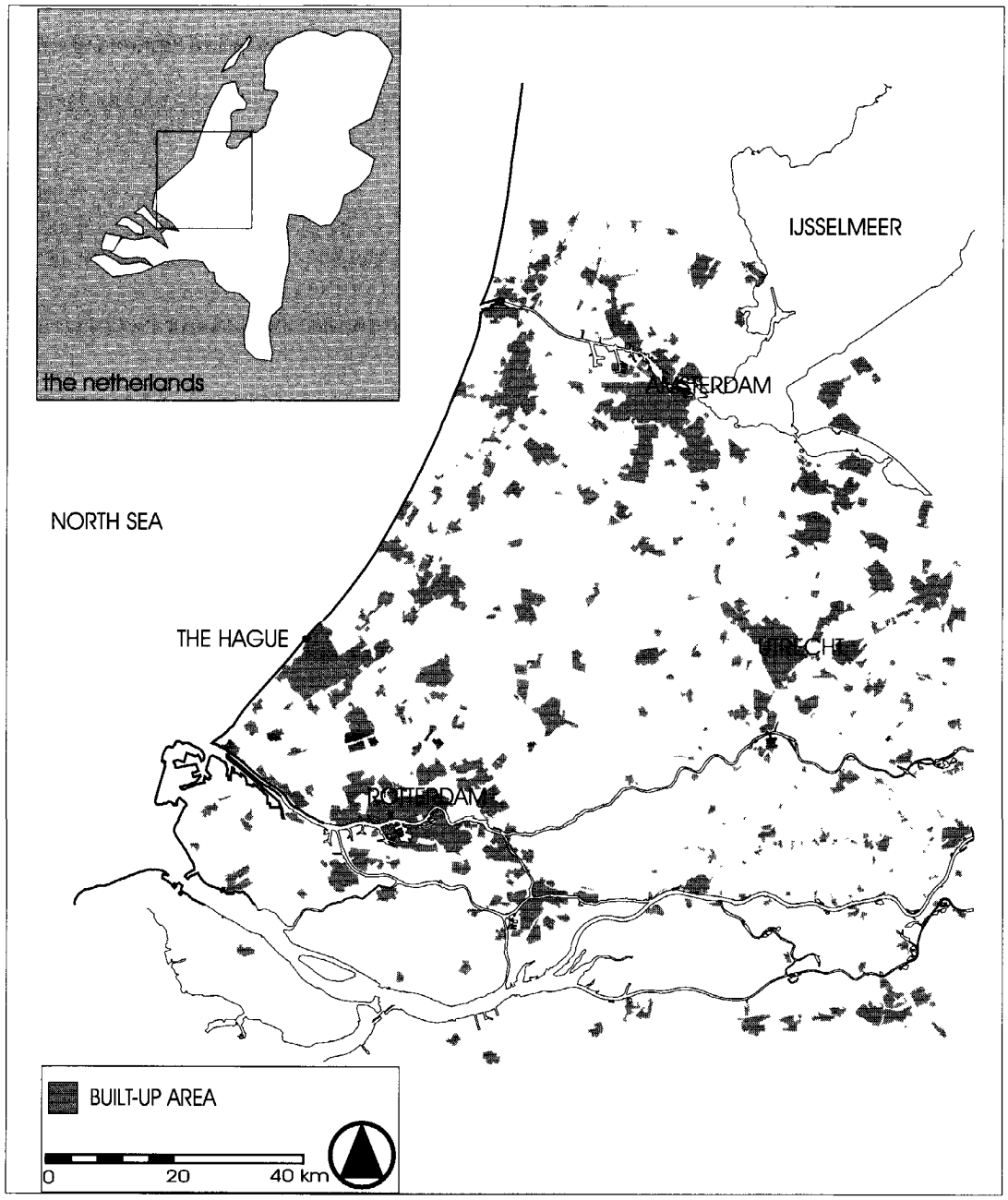


Figure 6.1
Randstad-Holland
(insert: position in the Netherlands)

believes that the Randstad falls far short of the mark in that respect (H. de Boer, 1992, p. 13). Niek de Boer (1996) even observes that the Randstad does not exist as a metropolis. The lack of a core shopping district in the Randstad, the lack of metropolitan theaters and the large theater-going public, and the presence of merely a slight number of authoritative head offices of international firms are, in his view, the most important pieces of evidence in support of his standpoint. Then perhaps it is not a metropolis, but it could possibly be a coherent urban system. Deeper insight is therefore needed into the nature and magnitude of those relations that confirm the functional organization, and thereby the existence of the Randstad, both as an urban system and as a system of cities. Only with such insight is it possible to establish the significance of selecting the Randstad as a case.

The discussion on whether or not the Randstad is a metropolis keeps turning into an exchange of vague opinions due to the lack of a distinction between the various relations that exist between the cities. These are

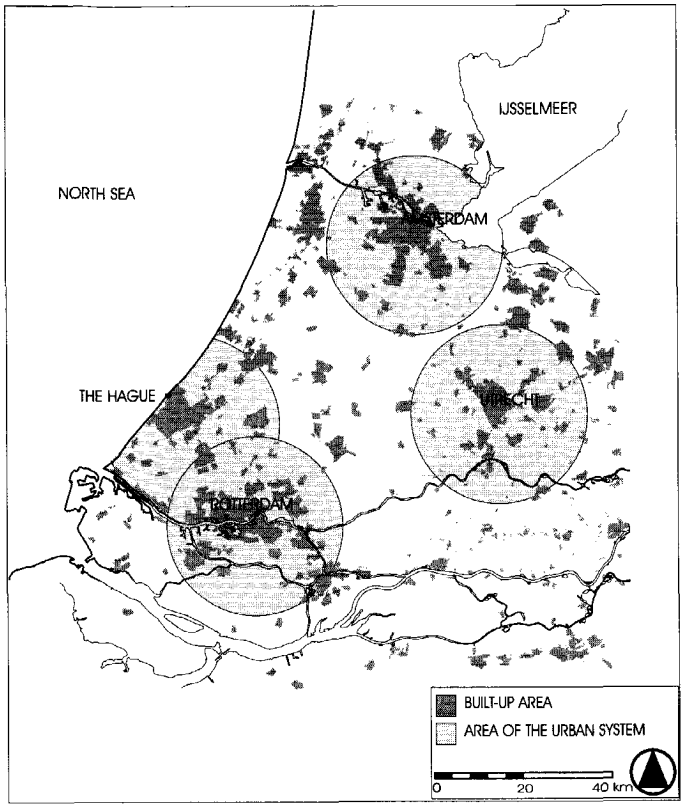


Figure 6.2 The influence of seperate cities
(based upon 20-km spheres)

the relations that confirm the coherence among the constituent parts of the Randstad. In the absence of such a distinction, it remains unclear if it is a highly urbanized area with or without overlapping urban systems or if it is one single urban system.

The Randstad may be construed to be a daily urban system if some degree of coherence proves to exist in terms of the daily journeys in this area. A daily urban system presumes that a significant number of daily relations are present in the form of the journey to work, to the store, and other trips. Jansen and Van Vuren (1985) concluded, on the grounds of their investigation of the mobility patterns in the four large agglomerations of the Randstad, that there is a definite increase in the number of trips as well as a shift in the pattern of mobility. Instead of the traditional pattern, which is directed toward the regional center, they observe an increase in tangential trips in the agglomerations (Jansen and Van Vuren, 1985). On the grounds of the figures they used, however, it is not right to conclude that a significant number of trips take place between the constituent parts of the Randstad.

	Total trips number (x 1000)	Crossing agglomeration boundaries number (x 1000)	
Amsterdam	2130	257	(12%)
Rotterdam	1862	235	(13%)
The Hague	1680	181	(11%)
Utrecht	1204	192	(16%)

(Source: Jansen and Van Vuren, 1985)

As the table shows, the average number of cross-agglomeration trips is no more than 13 percent. Whether or not this applies to the Randstad or other urban areas in the Netherlands is unknown. The figures on the journey to work for the four agglomerations shown below demonstrate that merely 15 percent of the total number of trips that cross the boundaries of the agglomeration.

Number of trips between home and work for the four agglomerations (number x 1000)

	Destination: Central city	Agglomeration	Surrounding area	Total
Point of origin:				
Central city	886	198	236	1320
Agglomeration	203	628	182	1013
Surrounding area	238	189	n.d.	427
Total	1327	1015	418	2760

(Source: Jansen and Van Vuren, 1985)

In view of the very low proportion of trips that cross the boundaries of the agglomerations, it is clear that the Randstad could not be an urban system. The figures do, however, indicate that the agglomerations can be considered urban systems.

Is the Randstad really a coherent entity, as it is presumed to be by many authors and urban designers (See, for instance De Architect, No. 36. 1989)? Or should the four big cities in the Randstad be seen separately as cities, each with a supra-regional function for a large part of the Netherlands?

The system of cities as described by Bourne (1975) – a cohesive spatial entity in an economic sense – is presumed to consist of a large number of economic relations (Bourne, 1975; Pred, 1980; Robson, 1992). The economic structure is manifest in the number of business-related trips between the parts of that entity.

De Wit and Jansen (1989) conclude that the Randstad relations account for 21 percent of all business traffic in the Netherlands. That is, the greatest number of trips for business purposes will begin and end in the four metropolitan areas of the Randstad.[1] It is not clear whether these are relations between the component parts of the Randstad or relations with other areas. De Wit and Jansen do bring up an important point with regard to the action radius of the business traffic. The fact is that for all means of transport, the average length of a trip is 16.5 kilometers for business-related travel, whereas the journey to work is 12.2 kilometers on average. For business travel by car, this figure is roughly 20 kilometers, in contrast to 68 kilometers by train. On the basis of these figures, and in view of the distance by road between the four big cities, which ranges from 20 kilometers (Rotterdam-The Hague) to 80 kilometers (Rotterdam-Amsterdam), it may be concluded that the Randstad could possibly be a system of cities. The reason is that *infrastructure and mobility* provide sufficient conditions for a system of cities. Of course, the distance for the average trip for the whole country does not say enough about business traffic in the Randstad itself. For lack of that specific information, it is not possible to confirm or refute the existence of the Randstad as a system of cities. Indeed, as De Wit and Jansen (1989) write, it is necessary to gain more insight into the business-related traffic.

Beside a large number of business relations between the big cities, perceiving the Randstad as a system of cities also presumes that the inhabitants of the Randstad make a significant amount of use of diverse organizations that serve a supra-regional function for the Randstad as a whole. In the report entitled 'Grote Steden, Grote Kansen' [Big Cities, Great Opportunities] (Externe Commissie Grote Stedenbeleid, 1989, p. 3), it is stated that the four big cities complement each other in terms of their functions. The report outlines a functional specialization, whereby Amsterdam is cast as the financial and cultural center, among other things, while Rotterdam is depicted as the center of international trade (p. 28). This sketch is based on the premise that the whole Randstad forms the hinterland for the supra-regional cultural facilities in Amsterdam. The number of persons going to the theater or concert halls is an indicator for the use of supra-local amenities (Molenaar, 1992). The results of research conducted by the Planning Agency of the Province of North Holland on visits to the theater in Amsterdam demonstrate that people living in the provinces of Utrecht and South Holland – that is, the inhabitants of two of the four provinces in which the Randstad is situated – attend a performance in Amsterdam 0.06 times per year. In contrast, people living in the center of Amsterdam go to the theater 5.70 times a year, while those living elsewhere in the agglomeration attend a performance 1.15 times in the course of a year (PPD Noord-Holland, 1986, p. 9). Thus, there is no evidence that the inhabitants of the Randstad make significant use of supra-local facilities in the Randstad as a whole. In that light, the idea that the Randstad is a system of cities, as defined by Bourne (1975), must be rejected.

On the basis of the average distance traveled in the journey to work (12.2 kilometers, De Wit and Jansen, 1989), the constituent parts of the urbanized area of the Randstad – that is, the North and South Wings as well as the separate agglomerations – form the level at which change might be expected to occur in the functional structure, as described in Chapter 3. The reason behind that expectation is that *mobility and mutual distance* provide the conditions for a change in the structure of a single urban system or a change in the structure as a result of the process of system formation. Especially in the South Wing – with The Hague and Rotterdam as the main cities – the conditions for system formation are present. This fact makes the South Wing the obvious choice as the object of study for this case. In view of the fact that the distance between Rotterdam and The Hague is 20 kilometers from center to center, in combination with the limited number of trips that cross the borders of the agglomeration (roughly 12 percent; Jansen and Van Vuren, 1985), it is unlikely that the South Wing could be considered an urban system. Therefore, it may be expected that the process of system formation in the South Wing will probably be limited to interference. Some recent plans for this area are interesting. A plan called Parkstad tussen hof en haven[2] [Park city between court and port] has been worked out by the Agency for Spatial and Ecological Planning for the Province of South Holland. And the coordinating conference for the

four provinces in which the Randstad lies have drafted a proposal for the Tussengebied[3] (Randstad Overleg Ruimtelijke Ordening, 1990). Both of these plans indicate the intent to develop the area as a conurbation. Another interesting development in the South Wing is the fact that the time it takes to travel by train between Rotterdam and The Hague was already under half an hour at the beginning of the 20th century. For that reason, there might possibly be some interference on the basis of the public transport. It is assumed that at the local level of scale, this historical development has led to the concentration of collective activities near the stations. This pattern differs from interference on the basis of automobile traffic, whereby, as may be seen in the case of Minneapolis – Saint Paul, the pattern is one of deconcentration at the local level of scale.

6.2 The South Wing in the 20th Century

The Working Party on the West of the Country described the South Wing in 1958 as a bow-shaped complex between Leiden and Dordrecht (Working Party, 1958, p. 10). The working party perceived that complex as a conurbation, whereby they emphasized the highly cohesive densification of the built-up area, emanating from a few large centers. The South Wing, in turn, comprised two groups of cities, namely The Hague-Leiden and Rotterdam-Dordrecht, both of which in turn were made up of agglomerations.

The distance between the two largest centers (the main shopping areas) in the South Wing, namely The Hague and Rotterdam, is 20 kilometers as the crow flies. The amount of time it takes to cross that distance by train is 25 minutes (source: Netherlands Railways, 1996). Even though the same distance can be covered by car in about 20 minutes, the congestion on the roads increases the travel time to about 45 minutes, especially during rush hour. The total size of the population of the South Wing[4] is 2,506,000 inhabitants (CBS, 1994). The history of the South Wing goes back about 750 years. Delft, for instance, was granted city rights in 1245. Around 1700, the basis was laid for the present structure. In the meantime, The Hague had already become the seat of government, while Delft (with its breweries) and Leiden (with its cloth-making industry) were thriving industrial cities. Rotterdam and Dordrecht, like Amsterdam, were geared to trade and transport (Van der Cammen, 1988, pp. 125-126). Transport by water played a key role in this early functional differentiation between trading and industrial cities. In fact, the system of canals, some with towpaths for barges, and other waterways formed the backbone for the urbanization pattern.

After the Golden Age, the cities started to decay and their population declined. Only after the French occupation under Napoleon did trade and, to a limited extent, industry revive in the Netherlands. Between 1840 and 1890, numerous infrastructure projects were carried out. The railroad was extended from Amsterdam to Haarlem in 1839. Later, it was again extended, running via Leiden, The Hague, and Delft to Rotterdam. The Nieuwe Waterweg [the New Waterway] was dug in 1886, making Rotterdam easily accessible to seagoing vessels. By 1890, there was an extensive network of railroads and waterways in the Netherlands. The time it took to travel from The Hague to Rotterdam was 35 minutes by train (Faber, 1989).
The sharp increase in the population of the cities of the Randstad was due to several factors that came into play around the same time. One was the increasing volume

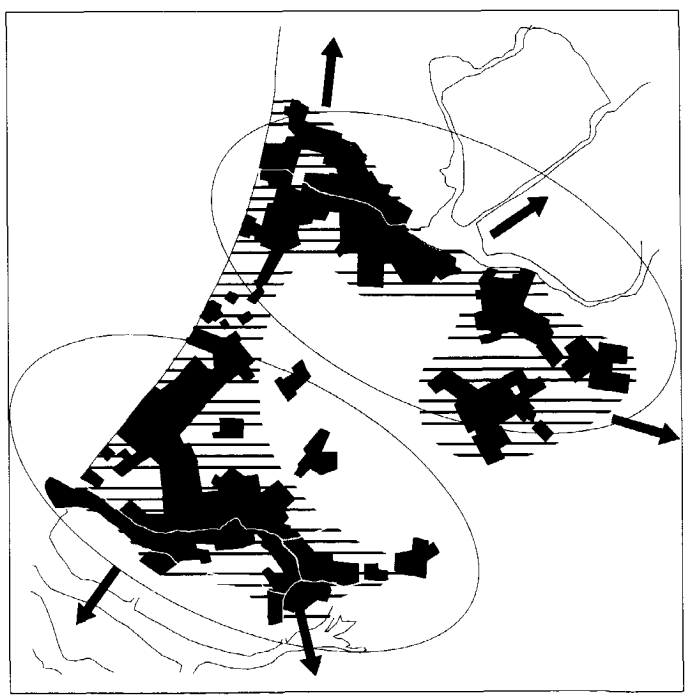


Figure 6.3 North and South Wing

(based upon Working Party West of the Country, 1958)

of trade and transport, which was directly related to the agricultural and industrial developments in the south and east of the Netherlands, but also in the hinterland in Germany. Another factor was the gradual emergence of industry in the cities in the western part of the Netherlands. The population growth was reinforced by the crisis that struck agriculture in 1870. The steep drop in prices that farmers got for their crops caused many people to leave the countryside and move to the cities.

	Population size:		
	1850	1900	1930
Municipality:			
Amsterdam	220,000	515,000	752,000
Rotterdam	110,000	323,145[i]	581,000
The Hague	72,000	206,023[ii]	436,000
Utrecht	48,000	102,000	150,000

(Source: Van der Cammen, 1988; i) Municipality of Rotterdam, 1900; ii) Municipality of The Hague, 1900)

The industrial revolution only got going in the Netherlands in 1913, when, among other things, Unilever and the Shell refinery were established in Rotterdam. Moreover, the port area of Rotterdam was expanded from 200 to 1900 hectares. Numerous economic crises, particularly in the 1930s, obstructed further development of industry and trade up till the Second World War.
In the first half of the twentieth century, there was a sharp increase in the number of inhabitants of Rotterdam and The Hague, making expansion of these cities imperative. For both The Hague and Rotterdam, the installation of tram lines paved the way for the construction of new residential areas. At the scale of the city, the tram was in fact the most appropriate means of transport. Out-of-town tram lines – such as the yellow tram, which ran from The Hague to Leiden, and the "Hofpleinlijntje", which was built in 1907 as the second rail link between The Hague and Rotterdam – served the need for regional transport (Freijser, 1991, p. 88). Up till the Second World War, both Rotterdam and The Hague kept growing and became compact agglomerations, each with a radial network of trams.

To this day, the bombardment of Rotterdam in May of 1940 is still a determining factor in the structure of the urban design of that city. Because the city center was destroyed, Rotterdam does not have a historical inner city, as is found in many cities in Western Europe. On the other hand, the open spaces in the central part of the city offered opportunities for the development of a new center. In view of its high structures, Rotterdam's center is unlike any other in the Netherlands. The Hague did not come through the war unscathed either. Nonetheless, the excavations for the Atlantic Wall and bombardments in 1944 have had a limited effect on the urban structure.

In Rotterdam and The Hague, the postwar period has been characterized by the enormous building effort in the new urban extension areas. Based on the conceptual legacy of the CIAM, whereby urban functions such as housing, employment, and recreation are physically separated and connected by a rational system of transportation, new districts arose. These included Pendrecht and Zuidwijk in Rotterdam and Moerwijk in The Hague. The Hague continued to extend the existing tram system when developing The Hague South and Mariahoeve, for instance. But Rotterdam developed the metronet in the 1960s, which opened up the urban extension area in Alexanderpolder, among other places.

During that same period, the port area of Rotterdam was enlarged from 1900 to 4154 hectares (Van der Cammen, 1988, p. 133). In a short time, a great many international corporations established a presence in the port area. These were mainly in the fields of petrochemicals, metal products, shipbuilding, and transhipment of freight. In The Hague, which was the seat of the central government, numerous international organizations and corporations – including the petrochemical industry – established their headquarters. There was vigorous job growth in the service sector.

Employment rate per sector in The Hague and Rotterdam (1987)

	The Hague	Rotterdam
Sector:		
Agriculture and fisheries	0.6	0.2
Manufacturing	6.2	15.3
Public utilities	0.9	1.4
Construction and installation firms	4.9	5.9
Trade, catering, repairs	16.6	17.3
Transport, communications	7.4	19.0
Business services	20.1	13.4
Other services	43.3	27.1
Total	100	100

(Source: CBS, 1988)

The 1970s were a turning point in the urban development of both Rotterdam and The Hague. The resistance to 'city forming' – that is, allowing offices to take over the inner cities, which is believed to require demolition of older dwellings and cutting new roads through the built-up area – led to a shift in accent from urban extension to urban renewal. Nearly coinciding with that urban renewal effort, a solution was sought for the housing shortage and the suburbanization trend. The answer was believed to lie in the development of new towns, both close by and at some distance. The town of Zoetermeer was developed as a satellite of The Hague, and Spijkenisse was developed as a satellite of Rotterdam. Both were intended to provide housing for the people who had been living in the urban renewal areas. That goal was not achieved, however; it was mainly the middle class that moved to the new towns.

	Population size			
	1950	1960	1980	1990
Municipality:				
Rotterdam	675,905	729,852	571,000[i]	576,850
The Hague	558,849	606,825[ii]	456,883[iii]	444,800

(Source: Van der Cammen, 1988; i) Municipality of Rotterdam, 1980; ii) Municipality of The Hague, 1960; iii) Municipality of The Hague, 1980)

Starting in the mid-1980s, the suburbanization trend gradually declined. Then the population of the central municipalities remained stable. The declining number of persons per dwelling (Musterd and De Pater, 1992, p. 101) kept up the demand for new dwellings and thereby kept up the growth of the urban area. In order to counter the trend toward an ever greater spread of residential areas and to curb the associated (and presumed) growth in driving, the central government proposed to locate the major new urban extension areas of The Hague and Rotterdam on the edge of the existing large agglomerations (Ministerie van VROM, 1991).[5]

6.3 System Formation in the South Wing

In comparison with the process of system formation in Minneapolis – Saint Paul, several differences should be mentioned, as they are pertinent to this case.
First, the government plays a greater role in the spatial planning of the area. Restrictive measures with respect to the location of residential areas, employment, and services as well as the deliberate prevention of urbanization between The Hague and Rotterdam by designating buffer zones[6] have the effect that available spatial opportunities often remain unutilized. It may be expected that, without the regulatory intervention of the government, the map image would show a different spatial pattern that it does at present. The position of the transport companies is another important element of comparison. The private tram company in Minneapolis – Saint Paul, which was set up as a profit-making enterprise, played a pioneering role in the spatial development by taking the initiative to develop the areas along the new tram lines. In the South Wing of the Randstad, in comparison, the construction of tram lines followed the planned spatial developments set forth by the municipalities. The decision on which direction the city should expand was thereby not based primarily on the operating possibilities for the tram company. For this reason, it may be expected that the role of the tram will have been more limited than the role of rapid transit in the development of Minneapolis – Saint Paul.

6.4 The Development of the South Wing

6.4.1 The Ascendancy of Train and Tram

Prior to the development of the Dutch railway system and the network of tram lines, both local and supra-local, the main mode of transport between the cities in the South Wing was by water. In fact the many quays and little harbors for inland water vessels were characteristic for the spatial structure of the cities of South Holland around 1850. Besides walking, the horse-drawn tram formed the most important means of transport in these cities, which were relatively small in terms of areal surface.
The railway lines Amsterdam-The Hague (via Leiden, completed in 1843), The Hague-Rotterdam (completed in 1847), Rotterdam-
Gouda (in the direction of Germany, finished in 1870), and Rotterdam-Hoek van Holland (for the connection by sea to London, ready in 1893) offered new opportunities for companies to establish their premises (Sluiter, 1961). In the Hague, for instance, industrial districts such as the Laakhavens were systematically laid out from 1890 on (Freijser, 1991). Just as in many other cities in the

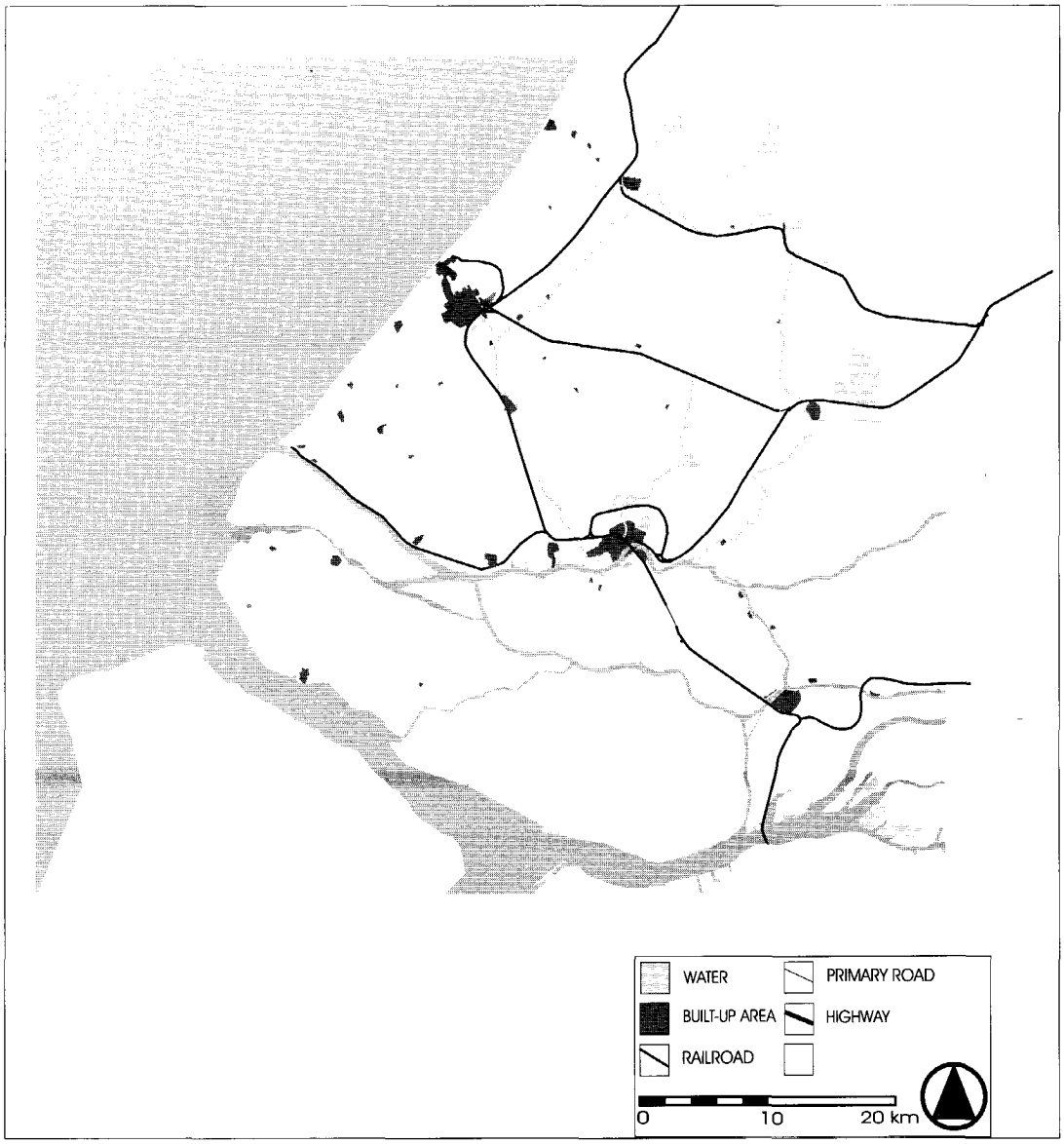


Figure 6.4
The South Wing, 1900

Netherlands, the railroad was laid out on the edge of 19th-century center of The Hague, which at that time was the edge of the built-up area. It is interesting to note that the majority of the new offices were not established near the train station Holland Spoor, which was located on the city's edge. The relation between the railway stations and the supra-regional accessibility that these stations entail, on the one hand, and the sites for office premises is thus not supported by these observations. New offices were situated for the most part near the existing offices of government organizations. The mutual proximity and the opportunity for face-to-face interactions may then be identified as an important (and necessary) condition in this period.

Around the turn of the century, numerous tram lines were put in, such as the Blauwe Tram [Blue Tram] and the Eilandennet [Islands Network], which provide transport both in the city and out of town. Right after the turn of the century, the tram companies started on the electrification of the system (Koster, 1984).

Around 1900, the industrialization of the Netherlands was not yet in full swing. In that period, employment in The Hague was predominantly in government jobs. Meanwhile, domestic and international trade and shipping dominated the economy of Rotterdam. For instance, the Rotterdamsche Droogdok Maatschappij [Rotterdam Drydock Company] was founded in 1903, giving impetus to the development of an employment base for Rotterdam (Gemeente Rotterdam, 1990).

The spatial structure of both cities was strongly influenced by the increased concentration of offices in the existing historical centers and by the industrial zones near the heavy infrastructure, namely railroads and waterways. This structure is comparable with the structure found in Minneapolis – Saint Paul in the same period.

The sharp increase in the size of the population as a result of the urbanization that was going on throughout Western Europe led to major housing problems. Roughly 90 percent of the inhabitants of The Hague were housed within the city limits that were set in the 17th century. The housing density was more than 100 dwellings per hectare. The demolition of the slums and the need to build new dwellings that met the rules of the housing act led to the first large-scale urban expansion schemes in The Hague and Rotterdam (Freijser, 1991). Hand in hand with the extension of the tram system, new districts were built in Rotterdam, among which the neighborhoods of Oude Noorden and Feijenoord. The latter was built almost exclusively to house the migrants from the rural areas of Zeeland who were moving to the city (Camp and Provoost, 1990, p. 52). In The Hague, several districts were developed, including Laakkwartier, Transvaal, Statenkwartier, and Bezuidenhout (Freijser, 1991). Because of these extensions, the two cities became too large for people to be able to make their daily trips by foot. Thus, the tram then came to play a more important role in urban mobility. In 1900, the tram companies in The Hague counted a total of 6,256,569 passengers on the local lines. Based on the number of inhabitants of The Hague – i.e., 206,023 (Gemeente Den Haag, 1900) – this comes down to 0.08 trips per person per day. On the lines to Delft, Leiden, and the Westland area, more than 500,000 passengers were counted (Gemeente Den Haag, Jaarverslag 1900). The proportion of the modal split that may be ascribed to the tram is thus smaller than the share of trips by foot. Even so, the tram was the predominant means of transport for journeys at the level of the city and the region. The increase in bicycle traffic took place after 1900 (Van der Meer and Van Schuppen, 1987). In Rotterdam, the tram carried about 12 million passengers per year (Rotterdamsche Elektrische Tramwegmaatschappij, 1905). As the city had a population of 332,145 (Gemeente Rotterdam, 1900), at roughly 0.1 trips per person per day, it may be concluded in this case too that around 1900, the tram was not the most important mode of transport in Rotterdam. In light of the fact that it took over an hour by tram to travel between The Hague and Delft, it is clear that this mode of transport did not provide the condition for interference between the two cities, nor in the South Wing on the whole. On the basis of the travel time, the train does provide the condition for interference. In 1900, it took approximately 35 minutes to get from Rotterdam to The Hague by train (Faber, 1989). Taking 45 minutes as the upper limit, this implies that interference was indeed possible here. The high cost of a one-way trip of that distance – roughly four percent of a week's wages for a craftsman (Musterd and De Pater, 1992, p. 23) suggests that the train played a minor role in the journey to work in the South Wing at that time. In fact, the number of passengers was less than one million per year (Gemeente Den Haag, Jaarverslag 1990). The automobile played an even more limited role. Car ownership in 1909 was 0.3 vehicles per 1000 inhabitants (Goudappel, 1096), which was negligible in comparison with the other means of transport.

The site chosen for the Royal Academy for Civil Engineering (which later became Delft University of Technology) in 1842 might be an indication of interference, long before 1900. This impression is strengthened by the fact that the choice to locate in Delft, according to Baudet (1992), is strange, to say the least, in view of the very low volume of manufacturing there. A more obvious choice would have been Amsterdam or Rotterdam. Baudet sheds light on that decision, however, pointing out that the choice for Delft was partly determined by the availability of the building in which the former military school had been housed (the school for artillery and corps of engineers). There is no evidence of any relation with the railroad connecting The Hague and Rotterdam, which was not built until five years later. The reaction on the part of Dutch architects to the intention to build the Academy in Delft, and to the associated intention to house the college for architects in that new structure, is another indication that there were no relations yet with Rotterdam or The Hague, certainly not at a supra-urban scale. Their response

reveals that the Academy functioned primarily at the level of the city: they showed hardly any enthusiasm for a quiet small town like Delft, where little if anything was going on that had anything to do with the visual arts (Baudet, 1992, p. 433). Incidentally, the availability of space for offices and manufacturing activities is an indisputable location factor for organizations (Dewulf and De Jonge, 1994). In the same vein as the present analysis, which is based on accessibility, it seems fruitful to investigate the significance of accommodation and its scarcity as a condition for the pattern of distribution of companies and institutions. Of course, that would imply that the availability of accommodation may be subject to short-term changes, whereas accessibility appears to take a more stable course of development, which will also show up as different influences on the functional structure.

Around 1900, there were no activities that would suggest interference within the South Wing. Therefore, the hypothesis remains unrefuted.

6.4.2 1920: Economic Expansion and Modern Urban Design

Up till 1914, Rotterdam had enjoyed a period of vigorous economic growth. The connections with the sea were improved, industry in Germany's Ruhr Area (which was and still is important as a hinterland of Rotterdam) was growing strongly, and imports of grain from the United States picked up; all these developments led to numerous new activities in the port area (Camp and Provoost, 1990). The post was expanded from 200 to 1900 hectares and provided space to many firms, including the multinational concerns of Shell and Unilever (Van der Cammen, 1988). Besides the establishment of trading enterprises in the inner city of Rotterdam, many offices were situated near the port, as in Delfshaven. The Hague strengthened its position as a seat of government. Because of the presence of embassies, among other reasons, The Hague became a preferred location for international institutions and companies to establish premises. The majority of the offices were situated in the area in between the historical center and Benoordenhout. The latter area was partly opened up by the tram line known as the Hofpleinlijntje, which was laid in 1907 to provide a direct connection from Scheveningen on the coast to the Hofplein in Rotterdam. There are no indications of any relationship between this line and the establishment of office premises.

Even though the Netherlands remained neutral during the First World War, Rotterdam in particular suffered severe economic repercussions from the war, since the transport of goods to and from Germany stagnated. The port industry and the shipbuilding sector revived quickly after the war. In 1925, the Netherlands even ranked fourth on the list of top-ranking shipbuilding nations in the world (Camp and Provoost, 1990). The sector only flourished for a short time, however, due to the economic crisis of the 1930s. The Depression hit Rotterdam harder than The Hague, partly because the employment base in The Hague was already dominated by the central government. In 1936, Rotterdam had 50,000 people registered as unemployed, out of a total population of about 600,000 (Camp and Provoost, 1990).

The population increased sharply in both cities. In 1920, The Hague had 359,610 inhabitants (Gemeente Den Haag, 1920) and Rotterdam had 506,071 (Gemeente Rotterdam, 1920). Thus, the spatial image of Rotterdam changed not only through the economic expansion but also due to a number of urban extension schemes. The design and architecture of those new areas may be considered no less than spectacular.[7]

The Hofpleinlijntje, which was opened in 1907, was used chiefly by affluent people from Rotterdam who left their dwelling in the city to live in one of the small towns on the railway line (Van der Cammen, 1988, p. 149). The two direct railway connections made it possible to travel from The Hague to Rotterdam within 45 minutes. In light of the figures for 1937 on the number of passengers who rode on the lines between The Hague and Rotterdam (roughly five million passengers per year), it may be concluded, though cautiously, that the train was not the most important mode of transport.[8] Instead, the tram was the most important mode of transport in The Hague, carrying 57,389,967 passengers per year in 1920, which amounts to 0.44 trips per person per day (Gemeente Den Haag, 1920). The rising popularity of the bicycle threatened to undermine the position of the

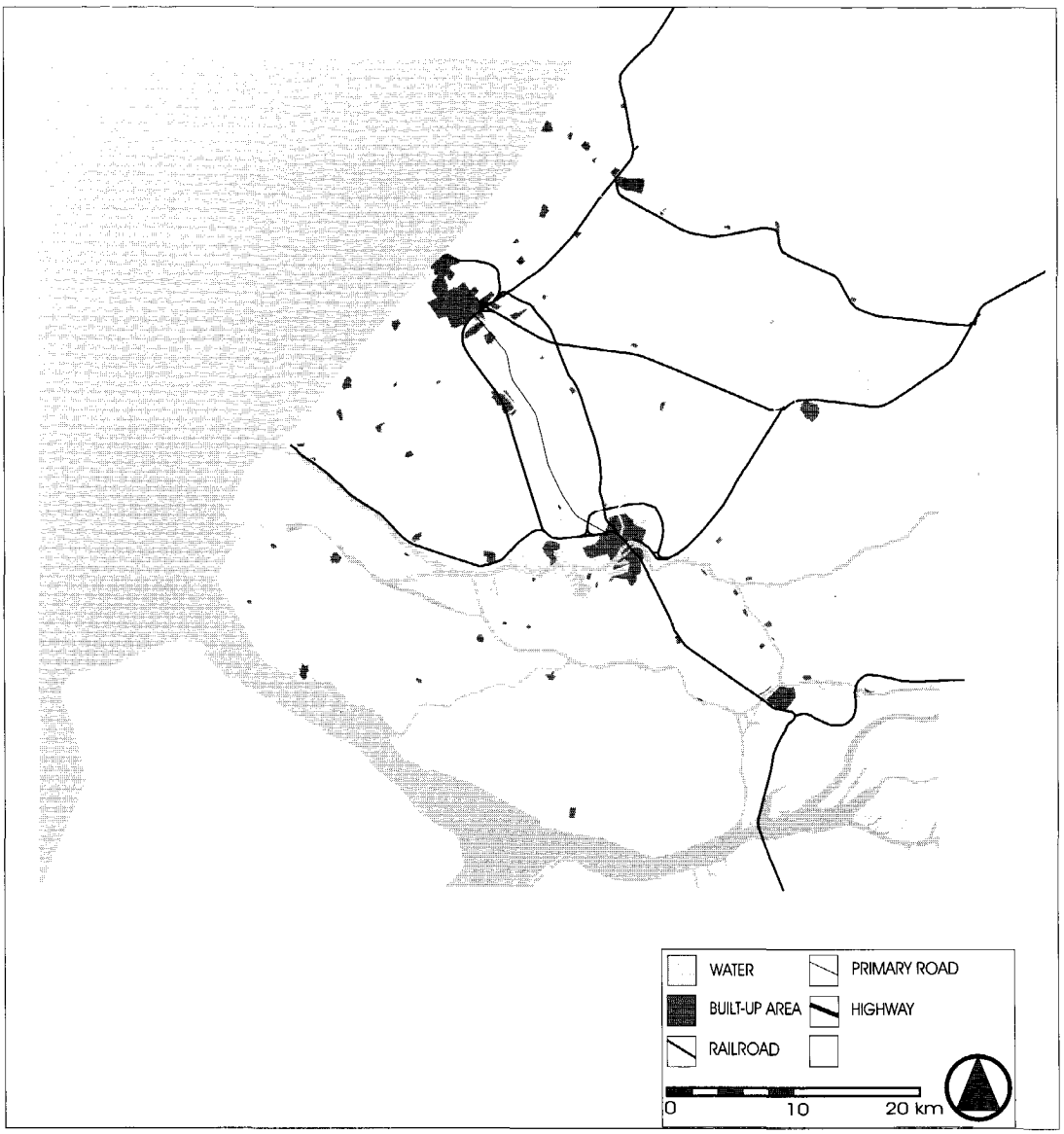


Figure 6.5
The South Wing, 1920

tram, however. The rate of bicycle ownership increased from one bicycle per 15 inhabitants in 1907 to one in six inhabitants in 1920. The bicycle then went on to become the most important means of transport in the succeeding years (Van der Meer and Van Schuppen, 1987). In 1920, the role that the tram played in Rotterdam (carrying about 25 million passengers per year; RET, 1927) was considerably smaller than in The Hague. At a mere 0.19 tram rides per person per day, slow traffic proved to predominate in the modal split. The influence of the tram on the functional structure of the city was therefore of limited significance. The rate of car ownership nationwide was 1.6 per 1000 inhabitants in 1920 (Goudappel, 1965).

It is not plausible that the radial pattern of tram lines had a decisive influence on the functional structure as it was in 1920. The arguments in favor of such an influence are not convincing. The volume of passenger flows in The Hague does, of course, indicate that the tram was the most important mode of transport there during the period 1900-1920. Nevertheless, there is no direct evidence that collective activities were sited at intersections of tram lines, as we observe in Minneapolis – Saint Paul. The location of these activities may also be explained in terms of the good accessibility of the inner cities for slow traffic. The close proximity of previously established institutions does seem to be more important, however. It should be noted, however,

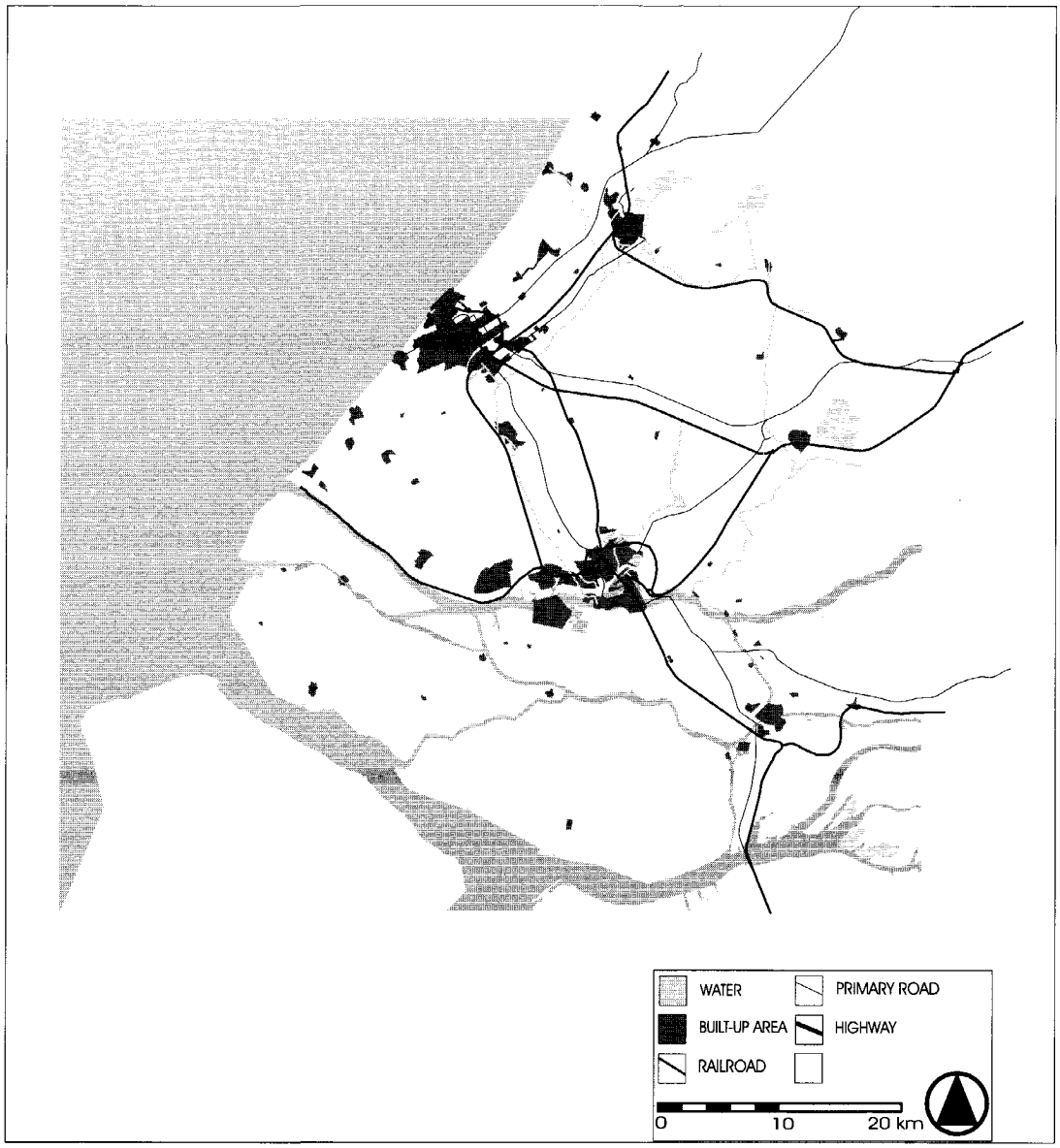


Figure 6.6
The South Wing, 1940

that both the tram and slow traffic offered sufficient accessibility.

In 1920, it was possible to cover the distance between The Hague and Rotterdam by train in less than 45 minutes. The role played by the train in comparison to that of the other means of transport is quite limited, however. On that basis, it may be concluded that there is no condition for interference between the two cities. The offices in both Rotterdam and The Hague are situated in or near the existing historical centers, where they are easily accessible by tram and bicycle. Near the stations along the railroad lines from The Hague to Rotterdam, there are no activities that might indicate interference. Partly on that basis, the conclusion is inescapable: the hypothesis is not rejected.

6.4.3 Harbingers of the Spatial Separation of Functions

The Great Depression of the 1930s gave impetus to the restructuring of industry. In the process, companies gave up their locations in and near the inner cities in favor of sites in the new industrial estates and port areas (Van der Cammen, 1988, p. 151). In Rotterdam, this led to a further shift of economic activity toward the harbors. In The Hague, the industrial estate Binckhorst, which was accessible by water and by rail, offered industries the space they needed. Meanwhile, government jobs predominated in the employment base

of The Hague. The civil service underwent a strong period of growth, particularly after 1930 (Freijser, 1991). In the period 1920-1940, a large number of banks and big department stores such as the Bijenkorf established premises in the inner city, while several important facilities serving the city as a whole were in fact situated outside of the city center. One such facility was the new museum Boymans (1935), designed by the architect Steur and built on the edge of the inner city of Rotterdam. The municipal museum of The Hague (1934), which was designed by Berlage, was located in the zone between The Hague and Scheveningen. Instead of choosing a site in one of the inner cities, which were already well endowed with cultural amenities, the planners gave preference to the peace and quiet of a park-like setting. Both museums could be reached within 45 minutes from anywhere in the respective cities.[9] The number of inhabitants increased to 495,517 in The Hague (Gemeente Den Haag, 1939) and 612,372 in Rotterdam (Gemeente Rotterdam, 1939). The population growth led to further urban expansion schemes. The rate of car ownership in the Netherlands just before the outbreak of the Second World War was low: 17.7 cars per 1000 inhabitants. Yet signs of the impending influence of this mode of transport were already showing. "The growing pressure on the cities continued the suburbanisation of the better-off population groups, a phenomenon facilitated by rising car- ownership and the rail-network" (Van der Cammen, 1988, p. 131). Nonetheless, the extent of the suburbanization as well as the spatial effect of the use of the automobile was limited. Typical facilities catering to the use of the car, as found in Minneapolis – Saint Paul since the 1920s, are not found in the Netherlands at that time. The Netherlands did get its first multi-storied parking garage (Torengarage, by the architect Greve) in 1930. The number of passengers riding the tram and the bus per year declined in The Hague during the period 1920-1940. With only 51 million passengers per year (Gemeente Den Haag, 1939), which comes down to 0.28 trips per person per day, the use of public transport was nearly half of what it had been in 1920. The number of passengers on the tram and bus lines in Rotterdam was 72 million in 1937 (RET, 1938), which represents a slight increase up to 0.32 trips per person per day. A survey held in The Hague in 1938 revealed that the bicycle was the most important means of transport. The bicycle accounted for 72.6 percent of the commuter traffic, while public transport carried 9.7 percent. Motor vehicles carried 4.4 percent of the commuters, while 13.3 percent walked to work (Gemeente Den Haag, 1948).

In 1938, more cycles were counted than motor vehicles even on the national highway between The Hague and Rotterdam: 25,810 bicycles in contrast to 12,860 motor vehicles per year (Gemeente Den Haag, 1948). On the grounds of the number of people who took the train on the stretch from The Hague to Rotterdam, approximately 12,000 per day (Gemeente Den Haag, 1948), it is fair to say that the train was the most important mode of transport for supra-regional traffic. The significance of the train in the modal split is limited, however. For that reason, no interference should be expected. Indeed, no collective activities are found near the stations of The Hague, Delft, or Rotterdam that could possibly indicate a clear interaction between the cities in the South Wing. Therefore, the hypothesis remains unrefuted.

6.4.4 1960: The Development of the Functional City

The period following the Second World War was one of reconstruction. Besides the pursuit of economic recovery, the Netherlands was faced with the challenge of meeting gigantic housing targets. The task at hand was not only to replace the dwellings that had been taken out of the stock by the war but also to provide housing for the postwar baby boom. Rotterdam had suffered severe damage from the bombardment in 1940. Thus, Rotterdam also had to develop a whole new center, a process that would last until well into the 1980s.

Rotterdam acted as the port of entry for aid from the Marshall Plan. Partly for that reason, the port economy was able to recover at a rapid pace. Scale enlargement was the key word for the development that took place in the port of Rotterdam. New shipyards were opened up. And a large number of petrochemical processing companies were established in Rotterdam, for several reasons. One was the decision on the part of the oil companies that the area around the Persian Gulf was politically too instable to warrant major investments

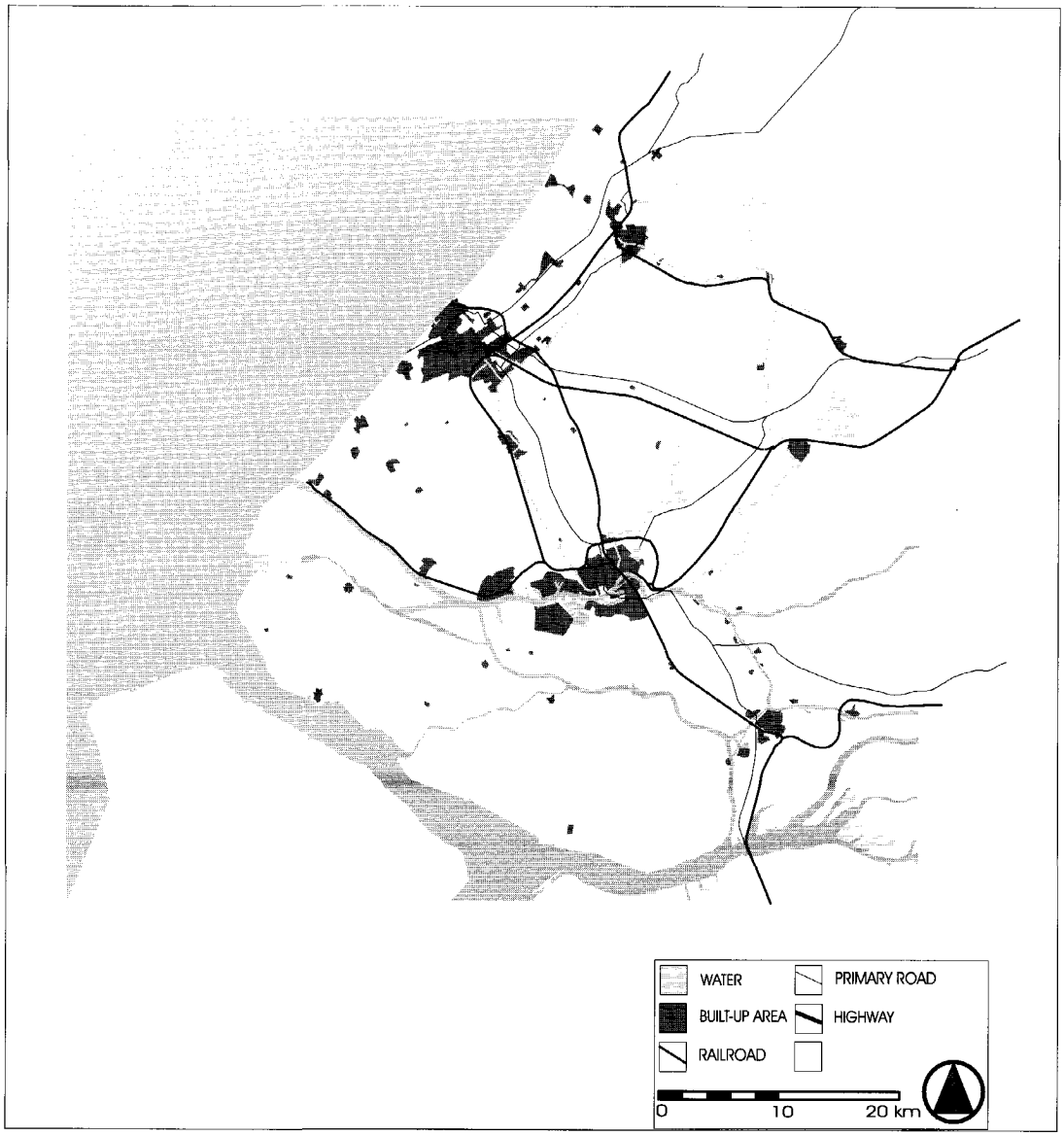


Figure 6.7
The South Wing, 1960

there. Another was the favorable position of Rotterdam, both with regard to accessibility for the supertanker and in terms of the proximity to a hinterland that was growing strongly. The demand for labor was even so great that in the mid-fifties, a request to put up an automobile manufacturing plant was refused for that very reason (Camp and Provoost, 1990, pp. 70-71). In 1960, the Rijnmond region (i.e., greater Rotterdam) counted 304,000 jobs, of which 38 percent were in manufacturing and 45 percent in services (Camp and Provoost, 1990), out of a population of 1,005,913 (Openbaar Lichaam Rijnmond, 1976). In this period, The Hague did not have the space for enlargement of scale in industry. The central government and the service sector thus accounted for most of the growth in employment in The Hague. In 1960, the region of The Hague counted 281,204 jobs, whereby 27 percent were in manufacturing and 70 percent in the service sector (of which roughly 25 percent were working for the central government), at a time when the population numbered 735,030 inhabitants (Provinciale Staten van Zuid-Holland, 1965). The service sector in The Hague had great difficulty in finding enough skilled personnel to fill the jobs. In the 1960s, the growth in employment began to stagnate. In part, this has been ascribed to the housing problems faced by new personnel, especially those who come from other parts of the country. A commission headed by Minister of State Dr. W. Drees

drew the conclusion in its report of 1961 that it was both desirable and feasible to move certain governmental institutions in order to relieve some of the pressure on the agglomeration of The Hague (Provinciale Staten van Zuid-Holland, 1965). That recommendation was subsequently incorporated into the Second Policy Document on Spatial Planning, in part because it would help disperse the level of affluence across the entire country. In turn, that policy has led to decentralization at the national level of a number of governmental institutions (F. de Jong, 1985, p. 99).

The document on a basic plan for the reconstruction of the inner city of Rotterdam, dating from 1946, laid out the main directions for the spatial development of Rotterdam in the years immediately after the war. Ideas about how the city and its parts should perform, based on the idea of the functional city, formed the core of this plan. The new center would have the highest position in the city and the region, in terms of a hierarchy of services. Functions such as manufacturing and housing were expelled from this center, whereas new and monofunctional areas for living and working were created (F. de Jong, 1985, pp. 255-261). This rapidly led to the development of neighborhoods such as Pendrecht (1949), Overschie (1952), and Zuidwijk (1955) as well as the industrial estate Spaanse Polder.

On the basis of the structural plan for The Hague that was worked out by Dudok, several new areas were developed: The Hague South was expanded, the district of Mariahoeve was built, and part of the outlying town of Voorburg was realized. Here too, the functional city was the leading concept. There was to be a hierarchically structured system of services, with the inner city forming the main center and with monofunctional areas for living and working. A striking element of the plan was the design for the system of main roads, which was based on a grid with cells measuring approximately 800 meters (F. de Jong, 1985, p. 246). Problems arose in the implementation phase. The main difficulty was in trying to run roads right through the existing center. These problems called for adjustments, whereby a ring road was built around the center. A plan called 'The Hague, a rapidly growing city', which dates from 1957, may be considered an adaptation of the plan from 1949. On the basis of this revised plan, the industrial estate Plaspoelpolder was developed near Rijswijk in order to accommodate the companies that were being moved out of the central city (Freijser, 1991).

The construction of the road system in The Hague, as well as the projected highways, was a response to the rapid growth of automobile traffic. Prognoses of developments in traffic in the 1950s indicated strong growth in automobile traffic. The often cited prognosis made by Van Gils (1952) included, for instance, an expected growth from the 1950 rate of 22 cars per 1000 inhabitants to roughly 75 cars per 1000 inhabitants by 1970. That prognosis proved to be too low, however. By 1962, the number of cars was already up to the level expected for 1970 (Goudappel, 1965). In view of the rate of car ownership, however, the use of the automobile was still limited, of course. In 1960, only eight percent of the commuters chose to drive to work, whereas 41 percent took public transport and 49 percent took the bicycle or motor scooter (Jansen and Van Vuren, 1985). On the grounds of the number of passengers getting on or off at the stations in The Hague and Rotterdam – 60,000 in The Hague and 70,000 in Rotterdam (Jansen and Van Vuren, 1985) – it is fair to say that the role of the train in the modal split was limited. In 1960, the tram carried 90 million passengers in 1960, while the city bus carried 63 million people in Rotterdam[10] (RET, 1960). In The Hague, the figures were 55 million tram passengers per year, and 48 million bus passengers (HTM, 1960). This comes down to 0.44 trips per person per day in the Rotterdam region and 0.42 trips per person per day in the region of The Hague. Especially for trips within the city, the public transport system, together with the bicycle and the motor scooter, were the most important means of transport in 1960.

The structure of both cities in 1960 appeared to connect seamlessly to the radial tram and bus lines. The intersections of the radial systems coincide with the biggest concentrations of services and employment in the centers. The planned development of the hierarchical system of services, as well as the reactive character of public transport, implies that there are no grounds on which to conclude that the public transport systems have led to the development of these centers.

Rather, the conclusion that the public transport systems did not initiate alternative developments, such as concentrations of activities in peripheral locations does seem warranted. The peripheral planned industrial estates Plaspoelpolder near The Hague and Spaanse Polder near Rotterdam are used by firms that are mainly operating at the level of the city or its districts. Even though these industrial estates are located near the highway between Rotterdam and The Hague – which means that with a travel time of 25 minutes between these two cities would constitute a sufficient condition for interference – none of the firms, institutions, or services that serve the entire South Wing have their premises at these locations. This means that the hypothesis remains unrefuted.

6.4.5 1980: Interference between Court and Port

When the Botlek and the petrochemical ports were constructed in 1960, thereby increasing the size of the port of Rotterdam to 4153 hectares (Van der Cammen, 1988, p. 134), Rotterdam reinforced its economic position as an oil town. Further enlargement of scale in the petrochemical sector as well as the introduction of the supertanker led to the decision to expand the harbor

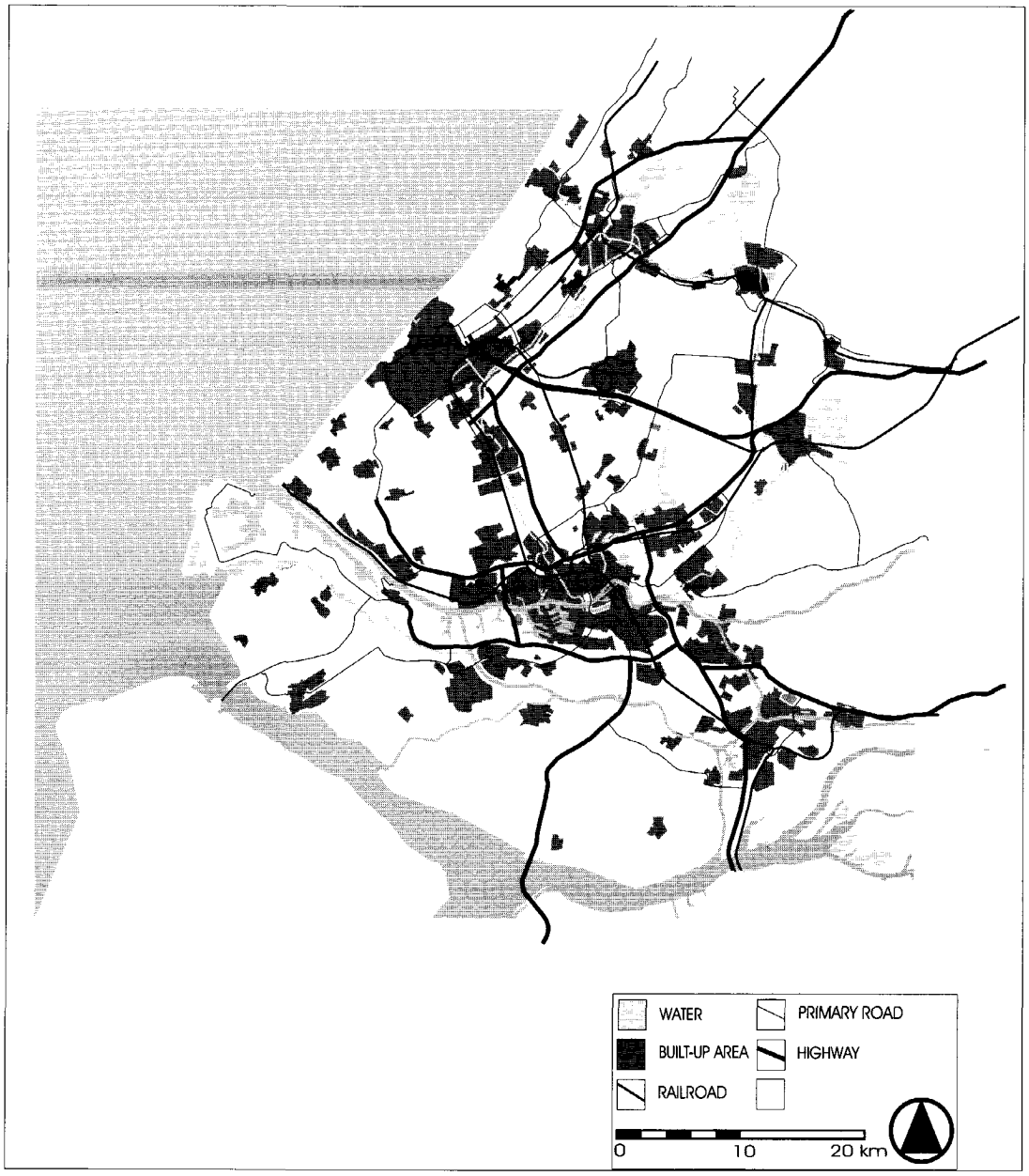


Figure 6.8
The South Wing, 1980

by creating the Maasvlakte. That landfill increased the size of the port area to 10,233 hectares in 1972 (Van der Cammen, 1988, p. 134). In 1970, Rotterdam was at the zenith of its postwar economic development, with 315,000 jobs. But at the same time, the first signs appeared of the major changes that lay ahead in the structure of the urban economy. Shipbuilding, and with it much of the subsidiary economic base, faded away, while the number of jobs in the tertiary and quaternary sectors increased sharply. The restructuring of the urban economy was given a boost by the oil crisis and the shrinking volume of world trade that lasted from the early seventies till the mid-eighties. The port and the petrochemical industry have been and still are the defining elements of Rotterdam's image.

Notwithstanding the revived strength of these traditional sectors, the tertiary and quaternary sectors accounted for 76 percent of the employment in Rotterdam in 1990 (Camp and Provoost, 1990, pp. 70-71). The significance of the port for the national economy remained undisputed. The port was a spearhead of national spatial planning, whereby the Port of Rotterdam, alongside Amsterdam's Schiphol Airport, are referred to as mainports (Ministerie van VROM, 1988).

In 1960, The Hague accounted for 69 percent of the employment base of the region. At that time, the economy of The Hague was strongly dominated by the tertiary and quaternary sectors (Provinciale Staten van Zuid-Holland, 1965). That share increased even further, reaching 80 percent in 1990 (F. de Jong, 1985, p. 254). The policy mentioned above whereby agencies of the central government would be moved to other parts of the country – initially to relieve the pressure on The Hague but later to spread the affluence throughout the Netherlands – led to the relocation of various divisions of the Central Bureau of Statistics, the Algemeen Burgerlijk Pensioenfonds, and part of the Post and Telecommunications as well as a number of smaller government agencies. Partly because private companies did not follow the example of the government, the effects of this decentralization policy on The Hague have been limited.

The plans for the city that date from the early sixties were mainly concerned with slum clearance and the creation of space for offices and businesses. From that perspective, diverse plans emerged for The Hague that entailed overwhelming the inner city with offices. The thrust toward a predominance of offices can still be recognized in the form of the tall buildings of the Ministry of Justice and the Ministry of Internal Affairs, as well as in a number of traffic routes that cut through the center. For the area to the south of the inner city, called the Schilderswijk, proposals were made for clearance and large-scale new construction. Sharp criticism was aimed at the manner in which planning was conducted – blueprint planning – and at what has been called city formation. That wave of criticism led to the democratization of spatial planning. After the implementation of urban extension areas and growth poles in the 1970s, urban renewal was the major challenge of the 1980s. The vision of what the city centers themselves should be changed too. Instead of monofunctional office areas – a legacy of the CIAM ideas on the functional city – the centers then had to be multifunctional. In Rotterdam, this change led to a revision of the Basic Plan of 1946. Office construction and road-building, whereby traffic arteries were to cut through the inner city, were halted, though temporarily. In the Structure Plan entitled 'Rotterdam inside the diamond' (1975-1982) the accent was placed on building new housing and on the construction of urban facilities. Only in later plans – the Inner-city Plan for Rotterdam (1985) and the plans for two areas in The Hague, namely the Spuikwartier and the area around Central Station – was the emphasis once again on the development of offices in the inner cities (F. de Jong, 1985).

Prognoses for population growth in The Hague – it was expected to grow to approximately 750,000 inhabitants by 1975 (Gemeente Den Haag, 1948) – in combination with the declining occupancy rate of the city's dwelling stock led to a continuation of the housing shortage. After the development of the district of The Hague South and the neighborhood of Mariahoeve, The Hague had no more opportunities to expand within the boundaries of the municipality. Furthermore, the possibility of extensions in Delft and Leiden was considered to offer inadequate scope to compensate for

the shortage in The Hague. Therefore, plans were made to build a new city, along the lines of the New Towns around London. Heated discussions led to the proposal for the construction of a new city in Zoetermeer. Originally, it was intended to provide housing for people who had been displaced from urban renewal areas. But Zoetermeer grew as a result of suburbanization, mainly driven by young families with children from the middle class of the population. From 3000 inhabitants in 1963, Zoetermeer grew at a rapid pace to 105,009 inhabitants in 1995 (Freijser, 1991; CBS, 1995). The expected growth of the population of the big cities in the South Wing did not take place, however. Whereas the number of inhabitants stagnated, the demand for new dwellings remained unfulfilled because of the declining average rate of occupancy.

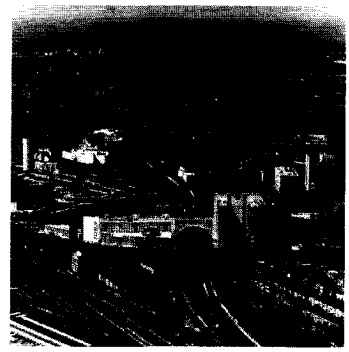
Population size of the large municipalities in the South Wing:

	1980	1995	Increase (%)
The Hague	456,886	442,937	-3
Rijswijk	52,650	46,415	-12
Voorburg	44,227	39,671	-10
Leidschendam	30,016	34,387	15
Delft	83,939	92,457	10
Zoetermeer	63,832	105,009	65
Leiden	103,046	115,442	12
Rotterdam	579,194	598,239	3
Dordrecht	107,435	114,089	6
Papendrecht	24,995	28,670	15
Sliedrecht	22,504	23,915	5

(Source: CBS)

Unlike the situation in The Hague, there was sufficient opportunity for new residential construction in Rotterdam during the sixties and seventies. For instance, a new sector was added to the city, called Alexanderpolder. Analogous to the development of the

The Hague, Malietower



The Hague, A12-entrance

new growth pole of Zoetermeer near The Hague, the part of the Third Policy Document on Spatial Planning that refers to urbanization (Ministerie van VRO, 1976) designated three settlements as growth poles for Rotterdam: Capelle aan de IJssel, Hellevoetsluis, and Spijkenisse.

A characteristic feature of that document is the policy to prevent the agglomerations of Leiden, The Hague, and Rotterdam from growing together by maintaining buffer zones in between. That policy was also retained in the Fourth Policy Document on Spatial Planning (1988). Recent plans such as Park city between Court and Port (Agency for Spatial and Ecological Planning for the Province of South-Holland) have superseded this policy in the meantime. Those plans seem to have paved the way for the urbanization of the area between The Hague and Rotterdam.

In the seventies and eighties, the volume of automobile traffic grew considerably. The car exerted more and more influence on the structure of the city. Nationwide, the rate of car ownership increased from 190 vehicles per 1000 inhabitants in 1970 to 320 in 1980 and 372[11] in 1990, whereby the total number of vehicles was 5,509,000 (CBS). The growth of mobility is almost entirely accounted for by the private automobile. As the following table shows, the number of kilometers traveled by public transport has scarcely grown (for the Netherlands as a whole).

Passenger kilometers (billions of kilometers)

	Total	Auto	Public transport	Population (millions of inhabitants)
1968	40.6	16.6	17.5	12.8
1970	83.2	77.4	17.9	13.0
1980	106.8	103.9	20.6	14.1
1990	169.2	125.5	21.7	14.8

(Source: CBS)

Jansen and Van Vuren (1985) demonstrate that the shift in the modal split that occurred in the period 1966-1982 has been largely at the cost of bicycle use. The share of public transport in the modal split did not drop; in some cities, it even increased. Rotterdam put in a metro system in 1968, which since 1982 consists of two transverse lines that penetrate a large proportion of the municipality (see Fig. 6.9). There, the number of passengers did actually increase, though slightly. In The Hague, the number of passengers declined; since the 1960s, the car became the most important mode of transport. This situation led to a change in the accessibility of a large number of locations in the South Wing and should thus be expected to lead to a transformation of the functional structure and possibly to interference and system formation. Transformation, interference, and system formation are determined in part by the changes in the network of roads. Around The Hague, however, this network has changed strikingly little. Highways such as the A44 (which runs via Wassenaar in the direction of Leiden), the A13 (connecting The Hague and Rotterdam), as well as the A4 (between Rijswijk and Amsterdam) were widened, turning them into highways with four to six lanes. The construction of the roads proposed in the regional plan of 1965 – such as the national road A14, which is supposed to serve as a tangent for The Hague

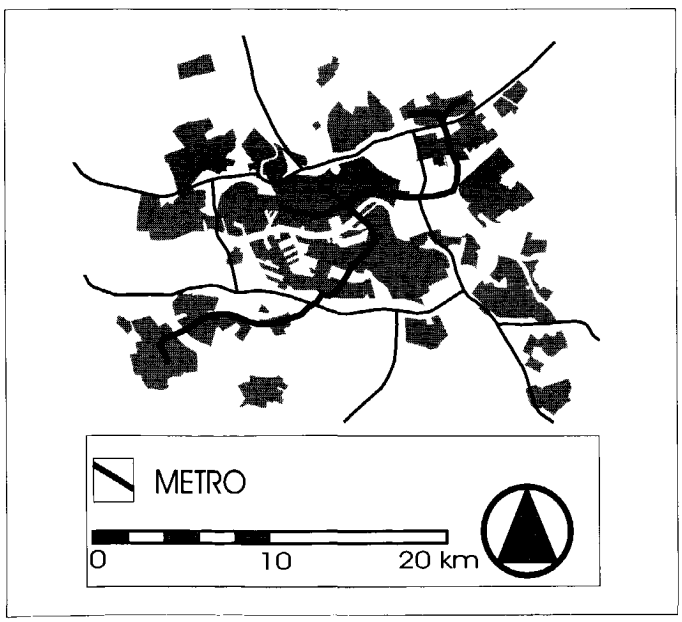


Figure 6.9
Metro Rotterdam 1960-1980

Northwest, national road A11 (connecting Leiden and Utrecht), and that part of the national road A4 between Rijswijk and Rotterdam – took a long time to get started. It was not until the 1990s that construction work began. The main change in The Hague was the preparation of the route that the A12 would take up to the city's central station. The existing road from Amsterdam to Rotterdam (A4-A13) took care of keeping through traffic out of The Hague. In Rotterdam, through traffic still crossed the city by way of the tunnel under the River Maas. The increase in the volume of automobile traffic led to congestion and nuisance in the city, which meant that the need for new roads was considerably greater than in The Hague. In 1975, the 'diamond' around Rotterdam was built, serving as a ring road via the Brienenoord Bridge and the Benelux Tunnel (Camp and Provoost, 1990).

A number of office buildings were envisioned near the planned multifunctional city-sector centers of 'In de Boogaard' in Rijswijk and 'Oosterhof' in Rotterdam's district of Alexanderpolder. Those offices were presumed to serve a regional or supra-regional function with respect to employment. The degree to which offices are concentrated near two other district centers, namely 'Zuidplein' in Rotterdam and 'Leidschenhage' in Leidschendam is limited, however. Other concentrations, particularly monofunctional ones, of employment at the regional or supra-regional level – such as the office zone along the A12 between The Hague's Central Station and the edge of the city; the extension of the Plaspoelpolder near the interchange of the A4 and the A13 at Rijswijk; and the new site for Delft University of Technology – are also found at locations that are well accessible from anywhere in the South Wing. Furthermore, over the past few years, office locations have been developed along the A12 at Zoetermeer, along the A4 at Leidschendam, along the A13 at Delft, along the A20 at Rotterdam in the direction of Gouda, and along the A15 in Rotterdam, to the north of the Nieuwe Maas River.

The most pronounced development is in the form of concentrations of large-scale retail trade – chiefly in the furniture and automobile branches – along the highways or near the main roads leading out of town.

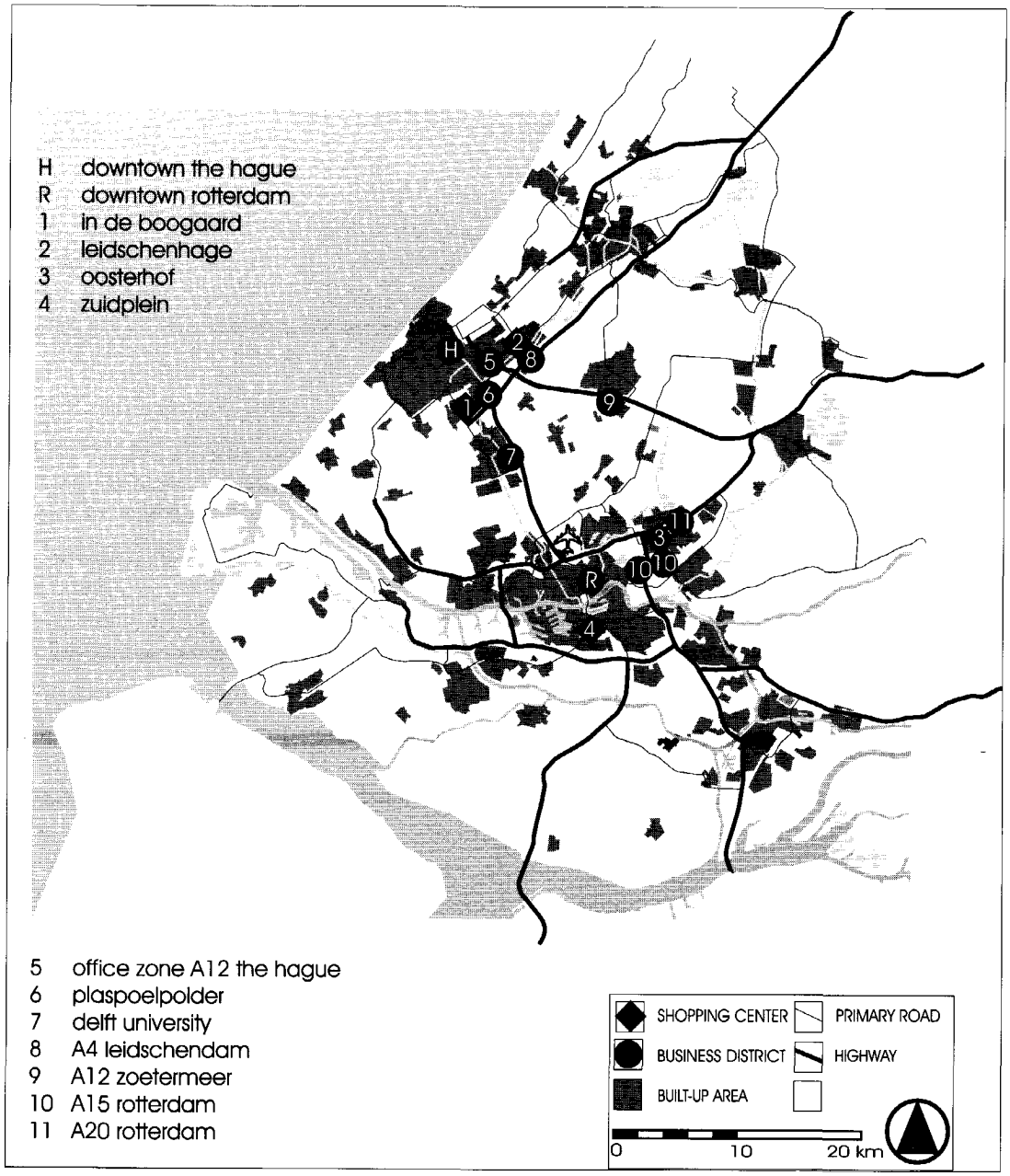
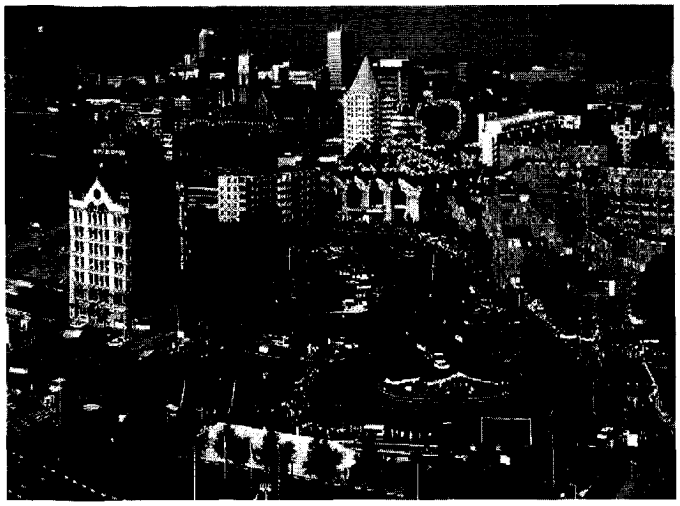


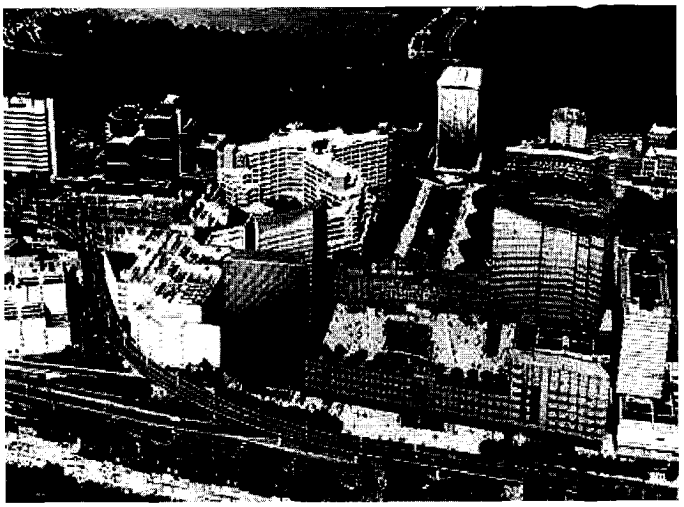
Figure 6.10
Shopping centers and business districts

Deconcentration of the more small-scale branches in the retail sector is restricted by national policy (Klaasen, 1993). The new locations for that large-scale retail trade are found chiefly along the A4 at Leidschendam and close to Leiden, along the A13 at Delft, and along the A20 at Rotterdam-Alexanderpolder (in the direction of Gouda) (see Fig. 6.10).

During the period 1974-1984, people spent less money on durable goods in the inner-city shopping areas, whereas the expenditure on such items rose at the national level. Knol (1986) explains this discrepancy in terms of the suburbanization of many middle-class families, whereby the center of gravity of the market shifted out of town. At the same time, in the inner cities, cultural amenities as well as eating and drinking establishments drew more customers. This was due to the increase in the number of young families in the higher-income categories who were living in the city center (Knol, 1986). Despite the shifts, the shopping areas and the concentrations of cultural amenities are still organized according to a clear hierarchy. In that structure, the centers of Rotterdam and The Hague have almost the same position with respect to their size and



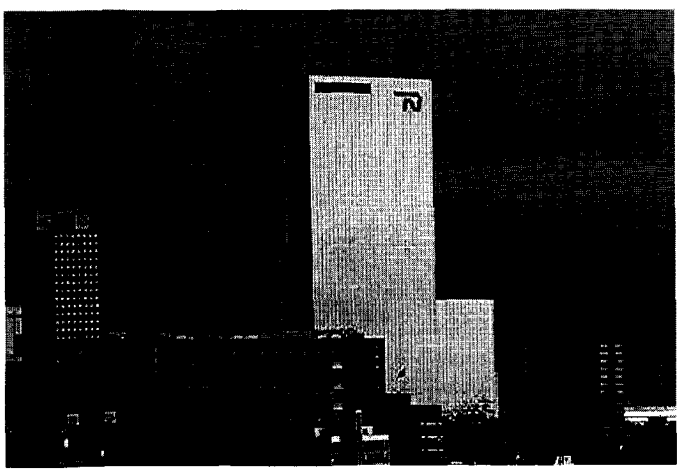
Rotterdam, old harbour



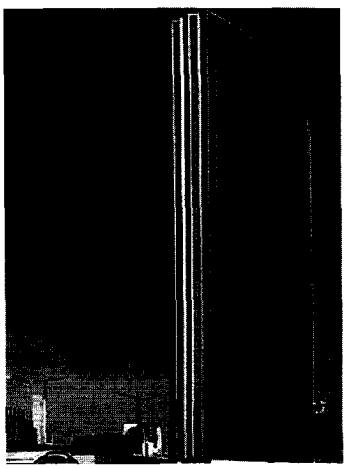
The Hague, highrise around highway and railway station

the retail facilities and cultural amenities they host. The center with the next highest position is Delft, followed by Leiden, Dordrecht, and Zoetermeer and the four large district centers.

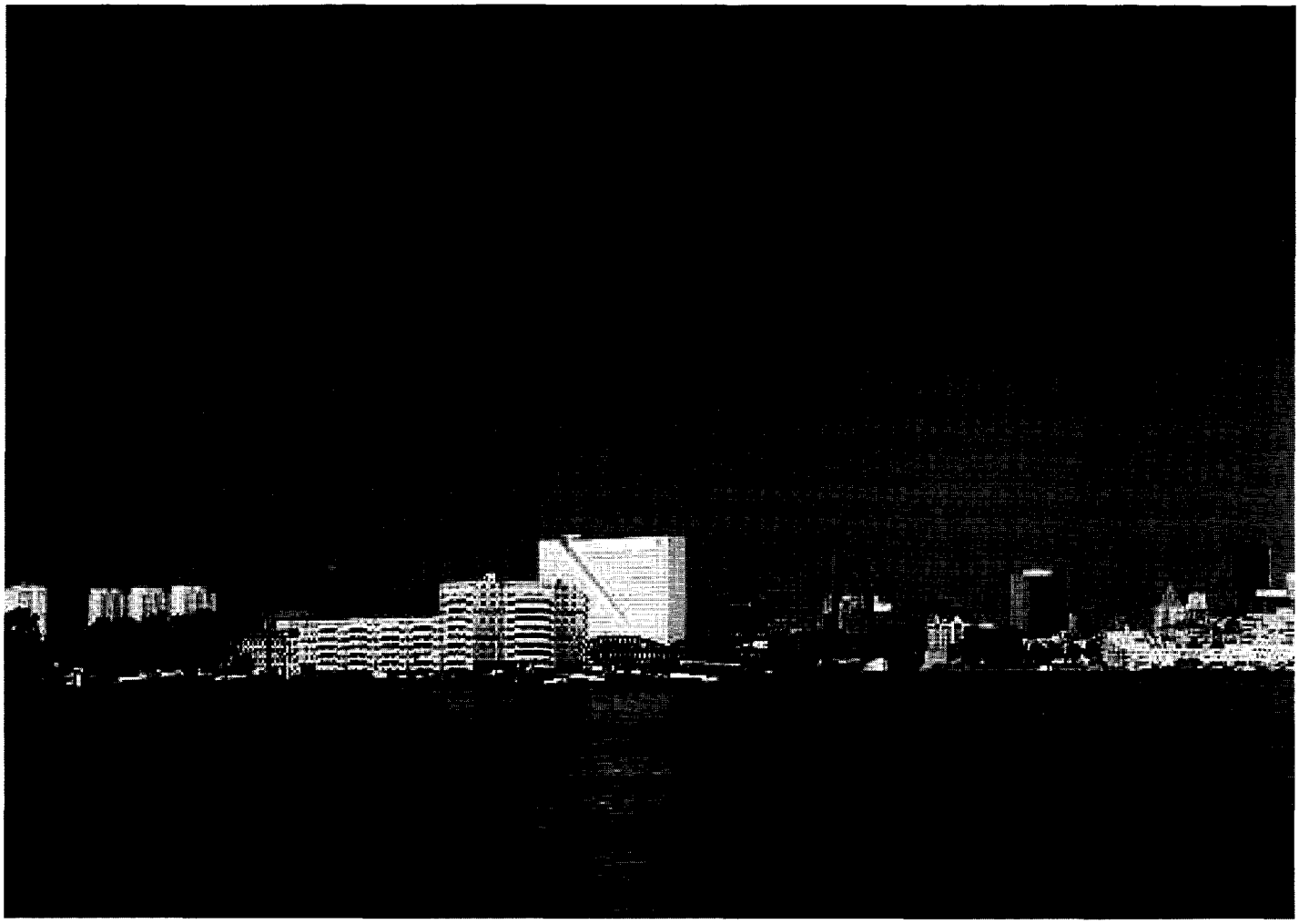
Virtually all of the new concentrations of regional and supra-regional services and employment are situated at locations that satisfy the accessibility criterion for interference. The reason is that the accessibility value of these locations is greater than or equal to the values of the city centers of Rotterdam and The Hague. Moreover, a large proportion of those locations can be reached within 45 minutes from anywhere in the South Wing, which makes system formation possible. Van der Laan (1994) states that the two regions in the South Wing operate independently of one another and therefore do not constitute an urban system. Having studied traffic patterns for the journey to work in the South Wing, he demonstrates that the commuter flows between the region of The Hague and the Rotterdam region are limited. With regard to the existing and the new locations for offices and firms, it must be concluded that there is no system formation whatsoever. Unfortunately, Van der Laan (1994) does not pursue the topic of the possible effects of the equality of the two regions. The point is that in both cities, the employment base is dominated by the tertiary and quaternary sectors, while the level of the shopping facilities and other amenities such as concert halls and museums is very similar. It is only fitting to ask whether the number of reciprocal relations would be larger than is currently apparent in the event that the difference in the nature of the employment and facilities were wider between both parts of the South Wing. In posing that question, it may



Rotterdam, 'Delftse Poort'



Rotterdam, World Trade Center



Rotterdam, skyline

be suspected that besides accessibility as the primary condition, the difference in the nature of the employment and the amenities, or rather the degree to which these elements are unique, might constitute a supplementary condition for interference and system formation.

In the early 1990s, a branch of the furniture warehouse IKEA was opened near Delft along the A13 between Rotterdam and The Hague. This is one of the few indications of system formation. The location is accessible within 45 minutes from the entire South Wing, and the facility in question is of supra-regional level. It should be pointed out that other branches of the same store chain are also found elsewhere in the Netherlands near smaller agglomerations with a smaller economic base than the South Wing. In that light, there is no conclusive evidence that the establishment near Delft is a facility that may be ranked at the level of scale of the South Wing as a whole. Not enough is known about the place of origin of the customers. Nor is there enough insight into the volume of sales in comparison with other branches. Thus, there are grounds for doubt about the extent to which this is an indication of interference or of system formation. In the absence of any confirmation of interference or system formation, it may be stated that this case, just as the other developments in this period, would not give cause to reject the hypothesis.

6.5 Conclusions

6.5.1 The South Wing

Up till the 1960s, when the automobile began to play a major role, there were no signs of interference in the South Wing. Already in 1900, train connections in this

area, with an approximate travel time of half an hour between The Hague and Rotterdam, provided the opportunity for the establishment of collective activities with a regional significance. Nonetheless, the very small share of the train in the modal split was the main reason for the absence of such developments. The limited significance of the train in the South Wing may be partially explained by the high price of a ticket, particularly in the period prior to 1940. In addition, it should be kept in mind that because of the limited degree of accessibility – in 1995, there were only eight stations in the agglomeration of The Hague (not counting Delft) and 12 stations in the Rotterdam agglomeration – the rail system that was in place could not meet the mobility needs in the South Wing, not to mention the mobility needs at the level of the agglomeration.[12] In the period from 1900 to 1960, the modal split was recurrently dominated by the tram and the bicycle. Virtually all collective activities with a regional significance – which in this case means serving the individual agglomerations – were found at those locations that were sufficiently well accessible by these means of transport. There is no evidence of a clear relationship between putting in the tram lines and the establishment of new activities. First of all, the tram lines were put in after the new urban areas were developed (in that case, the tram line did not constitute a condition). Secondly, the role allotted to spatial planning itself refutes such a relationship. Particularly in the period 1940-1970, in light of ideas on the desirable functional structure of the city, locations for residential and employment areas as well as concentrations of services were designated in the plans. According to the theory, interference can occur if and when, on the basis of the main modes of transport, the accessibility value of a location is greater than or equal to that of the centers, existing or projected, of the urban systems in question. Until the emergence of automobile traffic, no location had met this criterion, which means that there were not grounds on which to accept the theory. In view of the fact that no collective activities were found that suggest interference, the hypothesis remains unrefuted.

After 1960, the functional structure of the agglomerations changed. The increase in the volume of automobile traffic and the construction of highways affected the accessibility of diverse locations. The industrial estate called Plaspoelpolder near Rijswijk along the national highway A4 was originally intended for companies operating at the local level. After 1970, various offices with a regional employment function were situated there. Similarly, in the district center called 'In de Boogaard' in Rijswijk, the hierarchy that had been created through planning was disrupted by the establishment of office premises. The functional structures of the agglomerations were subject to the process of transformation in that period. The ongoing growth of the automobile traffic and improvements in the road system, as well as the construction of a beltway around Rotterdam, led to further changes in the functional structure. Around 1980, various collective activities with a function at the regional level were established at locations that met the accessibility criterion for interference. Concretely, new offices and premises for large-scale retail stores were situated along the northern beltway of Rotterdam, the A20, along the A13 at Delft, the A4 at The Hague, and the A12 near The Hague and Zoetermeer. An increase in the automobile traffic and the new roads have led to interference in the South Wing.

In 1990, the South Wing did not constitute an urban system, in that the number of daily trips was limited. Yet the conditions for system formation were present, specifically, along the A13, the highway between Rotterdam and The Hague. Even though there was some large-scale retail trade situated along this road, namely near Delft, the significance of these premises for the entire South Wing can nonetheless not be demonstrated. Partly due to the absence of other indications, the conclusion cannot be avoided that there is definitely no system formation in the South Wing. Several explanations are conceivable. First of all, it is possible that the mobility was still insufficient for the development of a single urban system in an area of this size – consider, for instance, the fact that the average distance that people travel to and from work is just 12.2 kilometers. Secondly, it has been observed that great similarities exist between The Hague and Rotterdam with regard to the level of employment as well as the range of amenities. It is plausible that if the mutual differences were greater – for instance, one city that is

obviously larger, or two or more cities whereby there are clear differences in employment base and range of amenities – the number of trips in the entire area would by many times greater, allowing an urban system to development. The third explanation might lie in the influence of spatial planning. Spatial developments between The Hague and Rotterdam are deliberately prevented by designating buffer zones. In this regard, it should be noted that until recently, regional plans and structure plans in particular have taken the individual agglomerations, and not the South Wing, as the object of spatial planning. In fact, the planning level that lies between that of the agglomeration and that of the Randstad has been grossly underexposed.

6.5.2 The South Wing and Minneapolis – Saint Paul, a Comparison

The main difference in the development of the functional structure between Minneapolis – Saint Paul and the South Wing of the Randstad lies in the phase of development that the urban areas are currently going through. Minneapolis – Saint Paul has evolved into a single new urban system by way of interference and system formation. There has been some subsequent transformation in this new urban system. In 1995, the South Wing showed no clear indications of system formation. Interference still had a strong effect on current developments. This difference may be ascribed largely to the different timing of the role of the automobile: the time when it became the most important mode of transport and the time when the highways were built and expanded. In Minneapolis – Saint Paul, the car has been predominant since 1940. In the period 1940-1960, a number of shopping centers were built as a result of the interference in the area. In 1960, the highway system in the region of Minneapolis – Saint Paul was over 500 kilometers long, as compared to a total length of 140 kilometers in the South Wing. In fact, interference was not observed in the South Wing till after 1970, when the change in employment was seen at a number of existing locations and new locations for large-scale retail stores were established. The difference in distance between the two main cities in each pair – Minneapolis and Saint Paul are 15 kilometers apart, while The Hague is 20 kilometers from Rotterdam – partly determined the later development, at least in the South Wing. Incidentally, there is a striking similarity in the average distance traveled to and from work: 13.0 kilometers in Minneapolis – Saint Paul and 12.2 kilometers in the South Wing.

Another important difference lies in the developments with respect to where employment is located. In the South Wing, interference was first observed on the basis of the development of office locations and only later on the basis of shopping facilities. The opposite applies in the case of Minneapolis – Saint Paul. On the one hand, the majority of the locations of shopping facilities in the South Wing are planned, and legislation is in place to ensure that only in certain branches are retail stores allowed to open outside of the planned shopping centers. But even more important is the timing of the processes of deconcentration and decentralization. In both cases, these processes started to take place in the 1970s, the point at which companies in particular became less dependent on traditional location factors (Alonso, 1975a). On the grounds of accessibility alone, long before 1970 there may have been a sufficient condition for the establishment of employment. Nonetheless, the employment only started to become footloose in the 1970s. It was only from that time on that this sector has made a contribution to processes such as transformation, interference, and system formation. These are processes that take place almost at the same time in both urban areas with regard to employment.

The difference in planning also has a decisive effect on the difference in the development of both areas. Specifically, the ideas on the 'functional city' and the 'hierarchy of centers' have had a determining influence on the location of district centers in The Hague and Rotterdam. The inner cities of The Hague and Rotterdam are the most important service centers, and the competition from the district centers is limited. Competition comes chiefly from the large-scale retail trade at peripheral locations – particularly furniture stores. In Minneapolis – Saint Paul, the choice of a location for a shopping mall is a private matter. There are strikingly many centers in Minneapolis – Saint Paul that compete with one another on the regional market. The central business districts of Minneapolis and Saint Paul do not seem to be strong enough to win against

such competitors. Instead, they are characterized by a small but specialized range of goods, especially luxury items.

The spatial distribution of employment at the regional level shows large similarities. In both urban areas, the city centers – that is, the central business districts – contain the most important concentrations of employment; the other main concentrations lie at employment locations at the city's edge. There are two differences, however. First of all, in the South Wing, the locations of employment outside the main centers are sharply delineated. This is a clear example of the effect of spatial plans. Secondly, in Minneapolis – Saint Paul, the employment is more strongly concentrated in the central business districts. On the one hand, this may be ascribed to the system of skyways. The possibility to walk to one's office from the parking lot through these skyways, in a comfortable climate, has led to a clustering of dozens of buildings. On the other hand, this difference may be described as a side-effect of the very fact that the South Wing is subject to planning. The process of city forming, which has made the concentration of skilled jobs possible in Minneapolis – Saint Paul, did not take place in The Hague, partly as a result of the vehement protests against cutting traffic arteries through the center and against the construction of office towers in that period. Independent of the discussion over the pros and cons of the process of city forming, it may be concluded that the turnaround in regional planning has been one of the factors leading to the development of offices outside of the inner city or on the edge of the city center. Of course, one might wonder if this development is an inadvertent result of the change in attitude among planners and government authorities. In Rotterdam, the authorities were still occupied with the restoration of the city center at the time that city forming took place. And it was precisely in the city center that they were able to offer room for the construction of large offices, such as the Shell building which stands on Rotterdam's Hofplein.

6.5.3 Incipient Conurbation

In light of the cases of Minneapolis – Saint Paul and the South Wing of the Randstad, interference may be said to occur between two or more urban systems when the accessibility value of one location is greater than or equal to the accessibility value of the existing centers of the urban systems in question. In both instances, it proves that with the emergence of automobile traffic, the changed accessibility of diverse locations provided the condition for the development of urban and regional functions at those locations. The expectation that the train, due to its limited travel time, might lead to interference in the South Wing proved to be wrong. For interference to occur – and the same applies to system formation and transformation – there must be accessibility on the basis of the main means of transport in the modal split. In the South Wing, the train has always been subordinate to other means of transport, such as the bicycle, the tram, and the automobile. The location of the Municipal Museum in The Hague and Museum Boymans in Rotterdam appeared to falsify that proposition because the site chosen for these museums lay outside the existing city centers, and thus apparently at a location for which the accessibility value would be lower than that for the center. In both cities, however, the museums prove to be accessible from anywhere in the entire city within 45 minutes by bicycle and tram, which at that time were the main means of transport.

No indications of system formation were found in the South Wing. Nonetheless, the condition for system formation is present, because the South Wing does, in fact, include locations with an accessibility score greater than the treshold value. The conditional character of the hypothesis means that it is not falsified by the non-occurrence of system formation. Rather the hypothesis is falsified by the occurrence of system formation at locations that do not meet the accessibility criterion. Because this is not the case, the hypothesis is not refuted by the developments in the South Wing.

Developments in Minneapolis – Saint Paul lay the foundation for the theory on system formation. The reduction of travel time by the construction of highways – initially leading into the city center – was one factor that helped make diverse locations accessible within 45 minutes from anywhere in the whole area. The first collective activities that are included in the level of the newly formed urban system are found in the existing centers. Because of the construction of the beltway, even

more locations could be reached within 45 minutes, and these locations were mainly used for purposes of employment. Neither in Minneapolis – Saint Paul nor in the South Wing of the Randstad were any collective activities with a function for the entire area found at locations that did not meet the accessibility criterion.

In conclusion, it may be stated that the development of mobility – and in these cases the emergence of the automobile and the construction of both radial and tangential roads, both highways and highways – has provided the condition for the situation of collective activities outside existing centers. The fact that the accessibility value of locations has continuously changed in Minneapolis – Saint Paul has led to transformation, interference, system formation, and subsequently transformation again. In contrast, the South Wing has been subject to transformation and interference.

For this thesis, it is important to note that accessibility is the condition for the observed spatial developments, and not the other way around. This means that the hypotheses that form the foundation for the multiple case, which is presented in the following chapter, do not have to be revised.

In this thesis, it was pointed out that accessibility is the most influential condition, sometimes a necessary condition, but by no means the only one. Besides investigating the hypotheses concerned with accessibility, the analysis of the two urban areas has also yielded a number of points to include in a further study of the development of the functional structure and the conditions underlying it.

First of all, further study should give due consideration to the observations regarding face-to-face contact and mutual proximity. This would seem to be an important factor in The Hague around the period 1900-1920. That was when diverse organizations nestled in near the government offices. In Minneapolis and Saint Paul, phenomena such as this were rarely observed in a comparable period. In this connection, it should be added that The Hague already had a considerable volume of employment in the service sector early in the 20th century. Furthermore, the significance of face-to-face contacts did not apply to later periods.

Another observation refers to the availability of accommodation. Some instances of this condition include the case of the University of Technology in Delft and the development of the old warehouses in Saint Paul in particular. The dispersal of activities far and wide throughout the landscape, for instance, can only take place if there is plenty of space. Another example of the role of this spatial condition is the way old residential properties, especially in the inner city of The Hague, have been taken over by offices. In the absence of a supply of buildings, and various additional qualities of the inner-city location, it is not improbable that organizations such as these would have moved into premises on the city's edge or in another urban area.

A final comment concerns the difference between the nature of the employment and services, on the one hand, and the influence of these elements on the process of system formation. Assuming that this observation plays a demonstrable role, then system formation can be deliberately influenced. One way is by trying to spread the amenities equally (whereby every city would have a theater, a museum, a small university, for instance). The government of the Netherlands has suggested that the four big cities in the country should be complementary, which could be achieved by assigning each city its own area of specialization. If the accessibility condition could be met, that complementarity concept could accelerate the process of system formation – and thereby speed up the formation of the Randstad.

Notes

1.
That study uses the COROP classification, by which the Coordinating Committee Regional Research Program divides the Netherlands into 43 statistical areas.

2.
As the residence of the Government of the Netherlands, The Hague is also called the hofstad, or court city, whereas Rotterdam is known as a port city.

3.
The "Tussengebied", or intermediate zone, is the area between Rotterdam and The Hague.

4.
This figure is based on the population of the agglomerations of The Hague, Rotterdam, Leiden, and Dordrecht as well as the population living in the municipalities of Alphen at the Rhine, Gouda, Delft, and Pijnacker and the municipalities in the area known as het Westland.

5.
Current legislation in the Netherlands on spatial planning, whereby the location of destinations is prescribed by a land-use plan, actually restricts the establishment of a business or institution and many other functions at any given location. The legislation offers the authorities an opportunity to influence spatial development in a desired direction by way of permits. In this way, the location of offices, companies, and shopping facilities was determined largely by municipal and provincial authorities throughout the sixties and seventies. At that time, they tried to impose a hierarchical model. National and regional functions were supposed to be concentrated as much as possible in the city at the center of the metropolis. On the other hand, functions at the levels of the city or parts thereof were concentrated in district centers and industrial estates. (See, for example, Streekplan Haagse Agglomeratie, 1965.) Due to traffic congestion in the inner cities and their poor accessibility by car starting in the seventies, the hierarchical model for shopping facilities has come under pressure (Gantvoort, 1993). The location preferences of businesses no longer reflect that model. The arguments they give in favor of other locations, especially on the urban periphery, for new employment sites actually overrule the arguments based on the hierarchical model. This development has led to a wider range of options for spatial policy (see Streekplan Zuid-Holland West, 1987; Streekplan Rijnmond, 1985). Since the seventies, this has led to an ongoing deconcentration of companies in the direction of the urban fringe (Van der Cammen, 1988, p. 140). Through the legal instruments of the Spatial Planning Act, this deconcentration can be kept under control to some extent. In this respect, the situation is not comparable to the way Minneapolis – Saint Paul developed from the seventies onward. The result is a number of industrial and office estates on the urban fringe. Moreover, the same process has led to restrictions on the size of retail shops at peripheral locations. Only companies with less than 1500 sq. meters in gross floor space (for all activities) are allowed to operate there (Klaasen, 1993). The deconcentration of shopping facilities is thereby limited to the automobile sales and showrooms and furniture stores, for instance. The hierarchical model for the planning of facilities as well as the restriction on peripheral sites for facilities are diametrically opposed to the desires of the retail branch, however (Klaasen, 1993; Gantvoort, 1993).

6.
See, for instance, Streekplan Zuid-Holland West, Provinciale Staten van Zuid-Holland 1987.

7.
In The Hague, urban development continued mainly along the lines set forth in the plan made by Berlage in 1909. The Hague was working on the construction of the urban sections "Bomenbuurt" and" Vruchtenbuurt" and parts of "Benoordenhout" and "Bezuidenhout". The urban design of those areas was mainly based on elements such as axes and squares (Freijser, 1991). Meanwhile, architecture and urban design Rotterdam had been caught up in the shift to modernity. Grandpré Molière designed the garden district of Vreewijk (1916). The architect J.J.P. Oud was making sketches for the neighborhood of Kiefhoek as well as for various modern blocks in the neighborhood of "Tusschendijken" (1921-1923). Van Tijen, who was both architect and urban designer, built the first gallery flat in the Netherlands (Bergpolder, 1933).

8.
For the sake of comparison: In 1937, the tram carried nearly 40 million passengers in The Hague and 61 million passengers in Rotterdam (Gemeente Den Haag, 1939; RET, 1938).

9.
The manner in which the new sectors of the cities were designed was influenced by the concepts underlying the congress held in 1933 on modern architecture, the CIAM (Congres International d'Architecture Moderne) (F. de Jong, 1985, p. 37). One of the most important conclusions drawn at this congress, which was called 'the functional city', was that different urban functions have a detrimental effect on each other and therefore have to be spatially separated from one another. A second main conclusion was that residential areas must be given a more open character (Van der Cammen, 1988, p. 151). The expansion of Rotterdam in Blijdorp was one of the first applications of the ideas of the CIAM (F. de Jong, 1985, p. 255). The concept of the closed building block still predominated in the extensions into Benoordenhout and Bezuidenhout in The Hague, as well as in the expansion of Rotterdam into Spangen and Rotterdam-Zuid. It was not until after the Second World War that the conceptual legacy of the CIAM were applied at a large scale in the layout of for city and district plans.

10.
In 1947, the number of people traveling by tram in Rotterdam was roughly 154 million (RET, 1960). The rate of bicycle ownership had been drastically reduced by the war, while the postwar reconstruction efforts rapidly restored the tram system. These two situations explain the peak performance of the tram in that year (Koster, 1984).

11.
For the sake of comparison, the rate of car ownership in the U.S. in 1990 was 572 cars per 1000 inhabitants.

12.
For comparison, Hamburg's S-bahn, the city's light rail system, has 35 stations. In addition, there are 26 stations for the train serving the agglomeration. And there are more than 50 stations for the metro (Hamburger Schnell-bahnen Verein, 1994).

7.1 The Structuring Effect of Accessibility on the Urban System

On the grounds of the cases of Minneapolis – Saint Paul and the South Wing of the Randstad, it may be concluded that the change in the accessibility of locations is a decisive factor in the change of the functional structure of an urban system. In this regard, the process whereby the structure changes may be described in terms of transformation and – in these specific instances, in which multiple urban systems are involved – in terms of interference and system formation. As it turns out, the sites at which urban and regional functions are established are almost always at locations where accessibility is adequate. Thus, there is a conditional relation between accessibility and the location of functions. In the analysis of the process of change in the structure, presented in Chapters 5 and 6, the focus was mainly on the accessibility values for locations where new activities were established. Conversely, when trying to refute the hypotheses, the study considered the establishment of collective activities at locations for which the accessibility value was insufficient. The conclusion that changes in accessibility drive the development of the functional structure of the urban system opens up an opportunity to investigate the correlation between the structure and the sum of the differences in accessibility. Insight into this correlation is an essential element of the spatial design and the planning of urban areas. The point is that it offers the possibility to develop certain types of structure – and the characteristics associated with them – by way of the manipulation of the differences in accessibility. That manipulation can take place through spatial intervention in the infrastructure and in the spatial pattern itself. But it can also take place through flanking measures that have an effect on mobility.
In order to determine the correlation between the accessibility pattern and the functional structure, the analyses presented in this chapter first calculate the accessibility values of all locations in the research area. The next step is to examine the similarities between the observed differences in accessibility and the functional spatial structure that is present.

For the sake of this analysis, four metropolitan areas were selected in Chapter 4: Minneapolis – Saint Paul, Dallas – Fort Worth, the South Wing of the Randstad Holland, and Frankfurt a.M. – Wiesbaden – Mainz.

7.2 Minneapolis – Saint Paul

7.2.1 Context

Minneapolis – Saint Paul[1] is an urban system with a multinodal structure that is characterized by two concentrated commercial centers – the central business districts of Minneapolis and Saint Paul, which consist predominantly of office functions, hotels, cultural amenities, and eating and drinking establishments. The structure also has a number of monofunctional employment zones and shopping areas as well as a number of multifunctional centers. Minneapolis – Saint Paul comprises a single agglomeration surrounded by a large number of small suburbs and has 2.5 million inhabitants (11-county metropolitan area, U.S. Bureau of the Census, Census of Population and Housing, 1990). The development of the functional structure of the region orginated in the two settlements of Minneapolis and Saint Paul, which were founded in the last century. These two cities are also where the two central business districts of the region are found. The centers are characterized by a high concentration of high office towers, which are linked together by a system of skyways. Restaurants and shops in these centers are situated both at street level and at the level of the skyways. Old buildings – such as several old warehouses – that have been restored to their former glory, skyscrapers, and tastefully designed pedestrian areas such as Nicolett Mall in Minneapolis and Rice Park in Saint Paul give these centers their identity. In downtown Saint Paul, we find the most important institutions, such as the state government and the World Trade Center. Be that as it may, downtown Saint Paul, with 172,504 jobs, is overshadowed by downtown Minneapolis, which has 278,314 jobs (Minnesota Department of Jobs and Training, 1990). The Metropolitan Council (1992) noted that downtown Saint Paul had gone into decline as a result of the increasing competition from downtown Minneapolis, from new concentrations of employment along the beltway, as well as from new shopping malls. Besides the declining employment base (-2.5 percent in the period 1980-1990; Carlson, 1994), the decline is

noticeable in the disappearance of eating and drinking establishments. In fact, Bob Manzanec and Tim Fleetham of the Metropolitan Council blame this on differences in patterns of consumption. They contrast government employees, who work mainly in Saint Paul, with personnel of private businesses in Minneapolis. The question that immediately comes to mind is whether two or more identical centers can be justified, with respect to urban design, in a single urban system.

The second generation of centers in Minneapolis – Saint Paul consists of shopping malls. Shopping malls were built in the suburban residential areas that were created from the 1950s on, partly as a result of the increasing use of the automobile. As demonstrated in Chapter 5, each of these malls initially had a function at a level below that of the city as a whole. That situation has since changed, however. In the meantime, the free-market mechanism and the increased mobility have led to a situation whereby the six shopping malls (including the Mall of America) have become competing regional centers. With the sole exception of the Mall of America – which is not only the most recent one but also the one with the widest range of department stores, specialized retail shops but also eating and drinking establishments and several movie houses – the malls are almost identical in terms of the value of their composition (Gilhousen, 1990). In this connection, the enormous difference with respect to the range offered in the downtowns is quite noticeable. Even though the downtowns do have a number of unique specialty shops, the overall range there is too limited to serve a regional function.

The deconcentration of the employment base has led to the third generation of centers, though it must be said that in some cases, because of the way it has been dispersed at the local level, the notion of a center is hardly applicable. The new centers of employment are found mainly along the southern beltway, the I-494. Some typical features of the areas near the interchange of Interstate 494 with Highway 18 and the area near the airport are their monofunctionality, the absence of facilities such as shops and restaurants, and the high degree of single-firm occupancy of the buildings. This image is in stark contrast to that of the downtowns. There the offices buildings accommodate not only large firms and banks but also numerous small businesses. The area near the interchange of Interstate 494 and 35-W as well as the area near Southdale are actually multifunctional. There is a mixture of businesses, hotels, supermarkets, and large-scale retail trade as well as two shopping malls, namely Southdale and Mall of America. Because of the dispersal of these facilities at the local level, the automobile is the most appropriate means of transport for trips within these areas. Symbiotic activities, which do take place in both of the downtowns, therefore are not found in these areas. With regard to the employment base, it is also noticeable that the proportion of professional, technical, and clerical jobs[2] is higher in the downtowns than in the other areas. The proportions do not differ by more than ten percent per sector, however (Carlson, 1994).

As a consequence of the deconcentration of employment, the mobility from one suburb to another has increased, as people live in one suburb and work in another. On the I-494, which was originally intended to divert the interregional traffic around the agglomeration, the volume of traffic increased by 80 percent between 1976 and 1986 as a result of the developments along this road (Adams and VanDrasek, 1993, p. 188). Employment tends to grow faster in the suburban zone – that is, the zone along the beltway – than in the downtowns (Carlson, 1994). Therefore, the number of suburb-to-suburb work trips was expected to be many times higher by the year 2000 than the number of suburb-to-downtown trips (Metropolitan Council, 1992).
A characteristic feature of those suburb-to-suburb trips is the lower rate of car occupancy, namely 1.1 person per vehicle, versus 1.2 persons per vehicle for trips from suburb to downtown (Metropolitan Council, 1992).
The dispersal of employment in the suburban zone may be considered as the key to the explanation of the lower vehicle occupancy.

The spatial planning of the region is one of the core activities of the Metropolitan Council. The Metropolitan Land Planning Act of 1976 makes it compulsory for local governments to draft integrated spatial plans. This means that in addition to the land-use plan, the set of integral plans must cover transportation, sewer policy, and parks and open spaces, for instance. According to

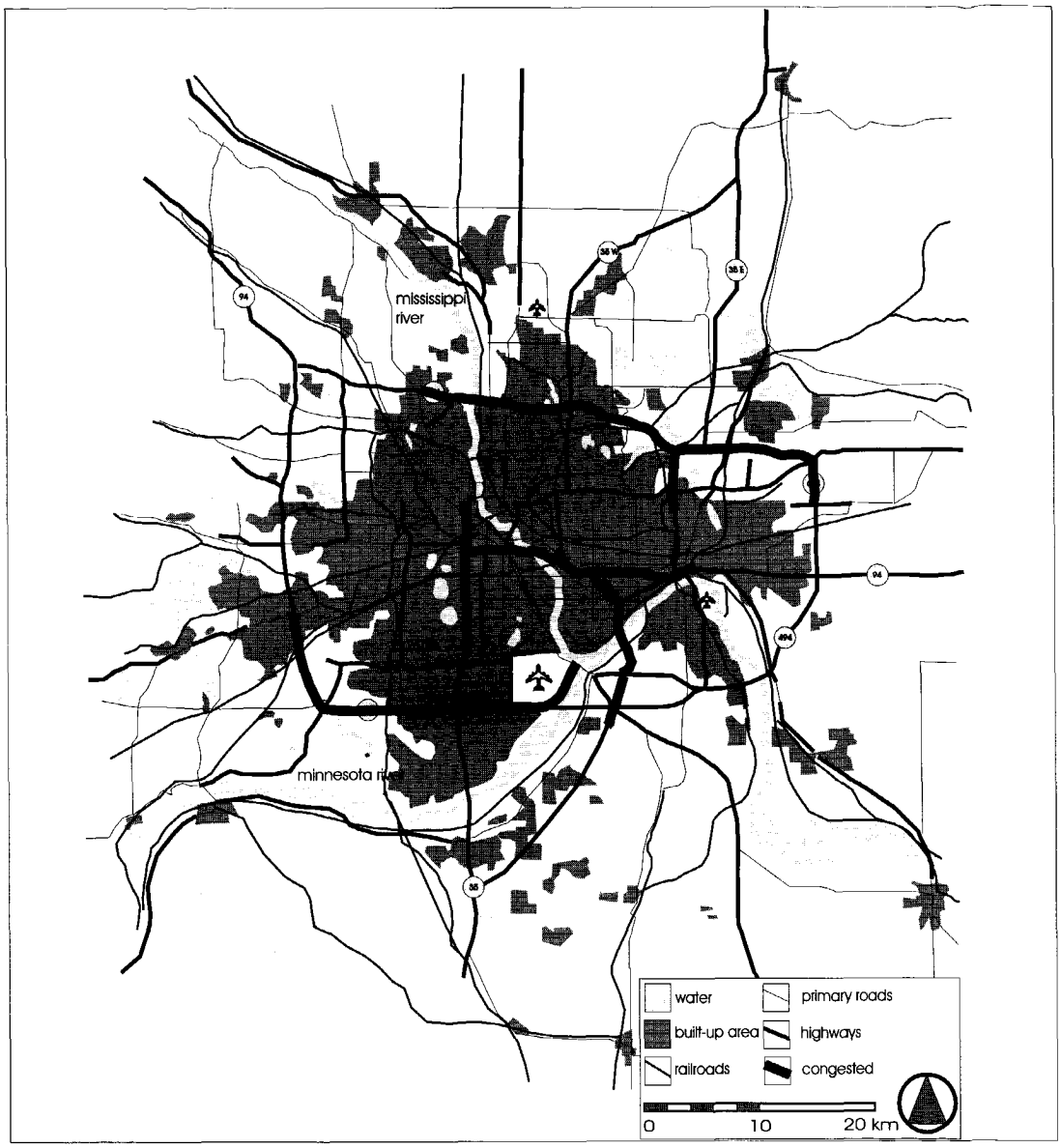


Figure 7.1
Minneapolis – Saint Paul, congested highways

the planning act, the Metropolitan Council has the task of coordinating the content of the diverse local plans. The set of instruments that the Council has for regional spatial planning is limited, however, as the following situation may illustrate. In order to curtail further suburbanization, the so-called MUSA line (Metropolitan Urban Service Area) was drawn around the urban area that was already built up or under development at the time (Martin, 1992). Outside the MUSA area, the government does not provide drinking water or sewers. For that reason, the State Council takes a strict stance on permits for stand-alone installations such as septic tanks. Bob Mazanec, who is presently the head of the Office for Policy Development and Implementation of the Metropolitan Council, acknowledges that the Council has problems due to the lack of authority, particularly with respect to traffic planning and urban renewal. As he sees it, the most important task of the Council with regard to spatial planning at this point in time is to influence public opinion by providing demonstration plans and information on developments in the region. In that light, the Regional Blueprint of 1994 contained some proposals to expand the range of instruments available to the Council in the field of spatial planning. The purpose was to ensure that the goals of the policy at the regional level would really constitute a framework for assessing the plans at the local level.

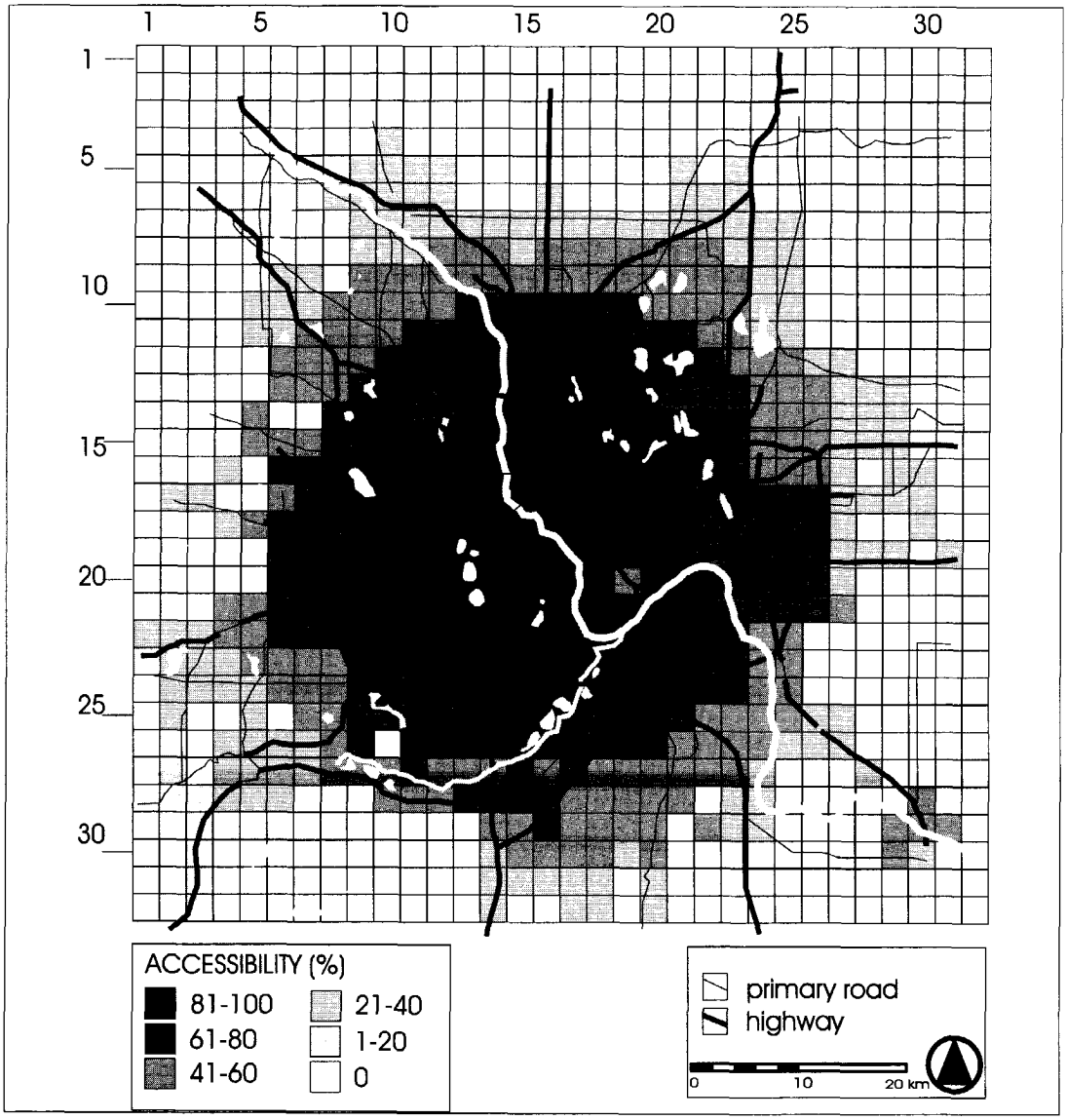


Figure 7.2
Minneapolis – Saint Paul, accessibility analysis

The regional plan is not built upon a foundation of integral planning concepts. Thus, no conscious effort is made to achieve any specific urban form or functional structure. This seems logical, in view of the absence of legal and financial instruments, in particular. On the other hand, this should also be interpreted as a lost opportunity. Those instruments that are available, such as adopting a plan for parks and open space could be used to promote a desirable spatial structure within the framework of the policy aims.[3]

7.2.2 Accessibility Analysis

As demonstrated in Chapter 5, the automobile is by far the most important means of transport in the region. In the same vein, the automobile is used as the basis for calculating the accessibility values. A distinction is made for purposes of that calculation between highways and main roads; the latter are city roads and roads outside the built-up area. When calculating the potential accessibility, traffic congestion should be taken into account too. Congestion that leads to delays of at least 15 minutes over a period of more than four hours per day occurs on the I-35 West, the I-35 East, the I-94 Central, the I-94 North, the I-494 South-West, and the I-694 North-East (see Fig. 7.1) (Metropolitan Council, 1992).

The calculations for the accessibility value were based on an average driving speed of 70 kilometers per hour for the highways and 40 kilometers per hour for the other roads.

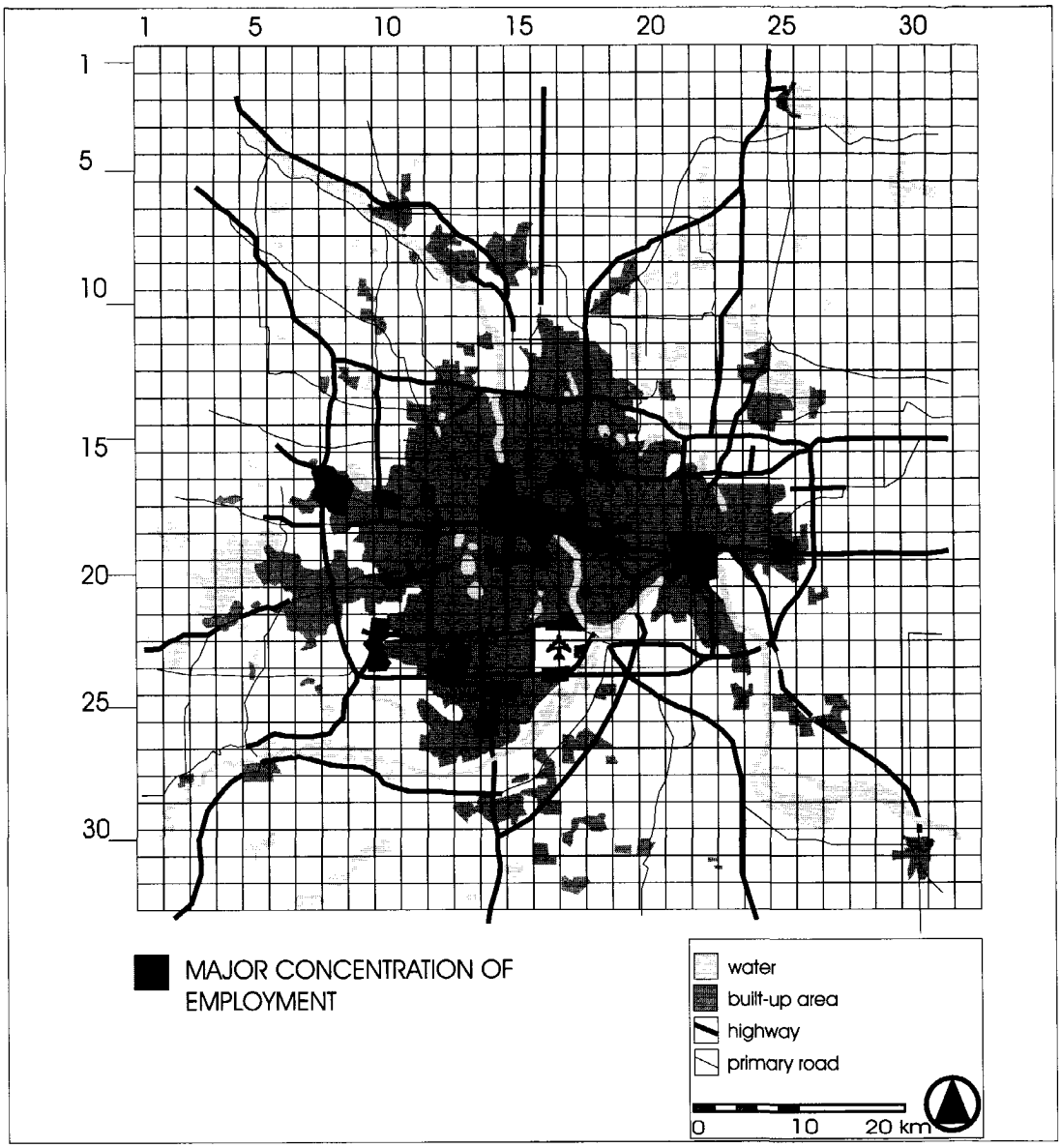


Figure 7.3
Distribution of employment
(source: Minnesota department of jobs and training, 1990)

The results of the calculation are shown in Figure 7.2. As the figure clearly shows, much of the urban area within the beltways I-494 and I-694, which have an accessibility value of more than 80 percent, offers the necessary condition for the establishment of collective activities. There is only a differentiation in accessibility differences between the area inside the beltway and the area lying outside the ring. Thus, because the differences inside the beltway are slight, it is possible to develop a multinodal structure.

Figure 7.3 depicts the dispersal of employment.[4] Some of the characteristic features are the two central business districts and the zone lying to the east of the center of Minneapolis, where the University of Minnesota, among other institutions, is located. In addition, there is a concentration at the interchange of the I-35 and the I-494, one near the airport, one on the eastern beltway (the I-494), and a concentration between Saint Paul and the western beltway (the I-694). The last-mentioned concentration is situated at a location where the accessibility value is less than 80 percent. That site is the main plant of 3M (Minnesota Mining and Manufacturing). This firm has been situated at the present location since 1905.[5] At that time, the site was next to the railroad lines running to Duluth and Chicago as well as on the line for the city tramway. The present accessibility value of that location is 73 percent,

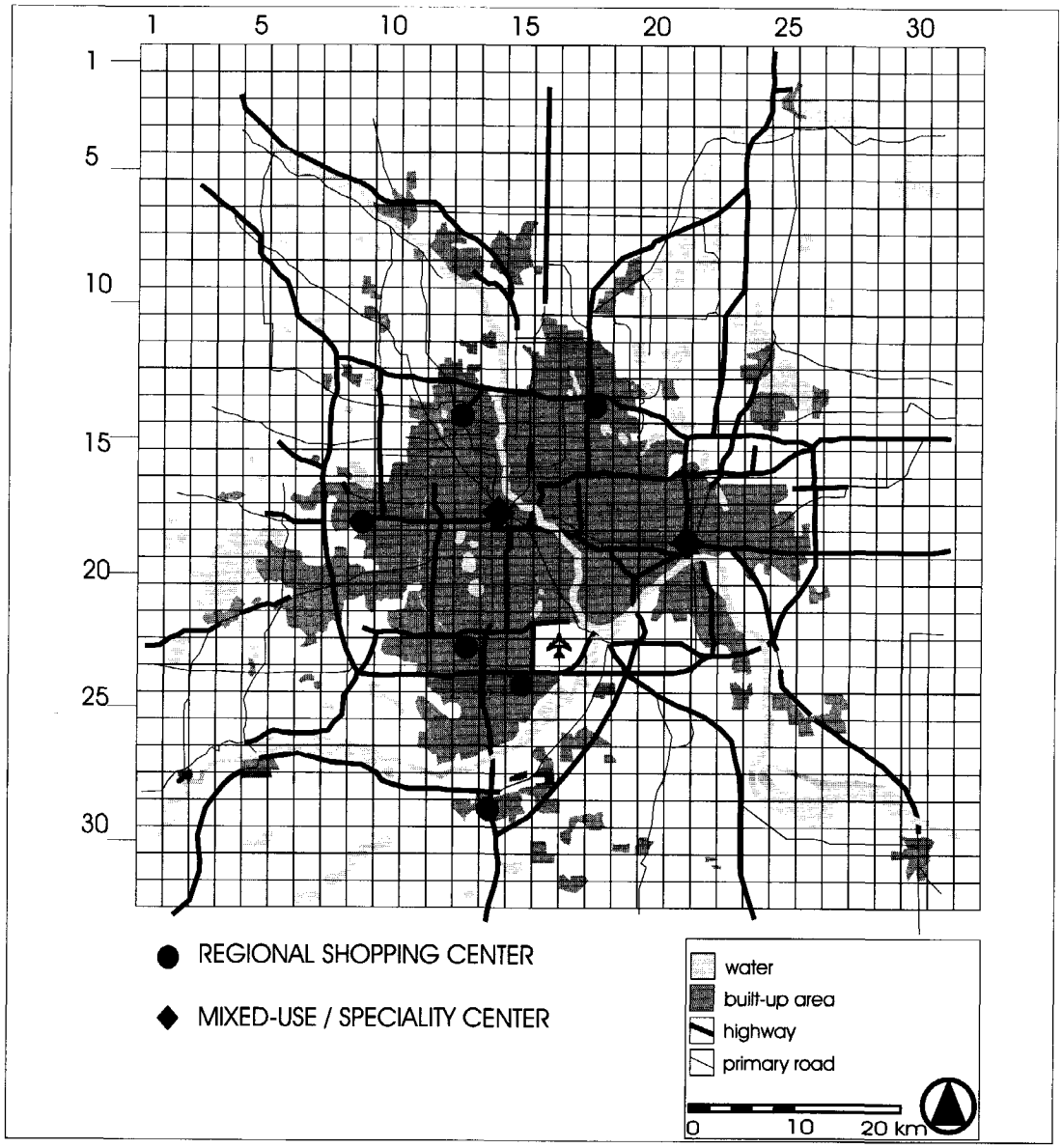


Figure 7.4
Distribution of urban and regional facilities
(source: Metropolitan Council, St. Paul)

and it therefore appears to be insufficient. On the grounds of the proposed expansion of the infrastructure (Metropolitan Council, 1972), an increase in that accessibility value could be expected. It should be noted, however, that the accessibility – whereby the automobile is the most important mode of transport – has continuously improved in the course of the past fifty years. As the same time, it should be kept in mind that 3M is an industrial enterprise. Therefore, the number of jobs in the tertiary (and naturally the quaternary sector) is lower than the map would suggest.

Table 7.1 gives the distribution of the concentrations of employment in Minneapolis – Saint Paul with respect to the weighted accessibility figures. From the table, it appears that 91 percent of those concentrations of employment are situated at a location of which the accessibility value is greater than 80 percent. The column under the heading 61-80 percent refers to the 3M plant discussed above. The proposition that a conditional relation exists between accessibility and the distribution of employment is not rejected.

Figure 7.4 depicts the distribution of urban and regional facilities in the region. Here too, the centers of Minneapolis and Saint Paul are represented, though it should be noted that the central business district of Minneapolis has the biggest concentration of hotels and

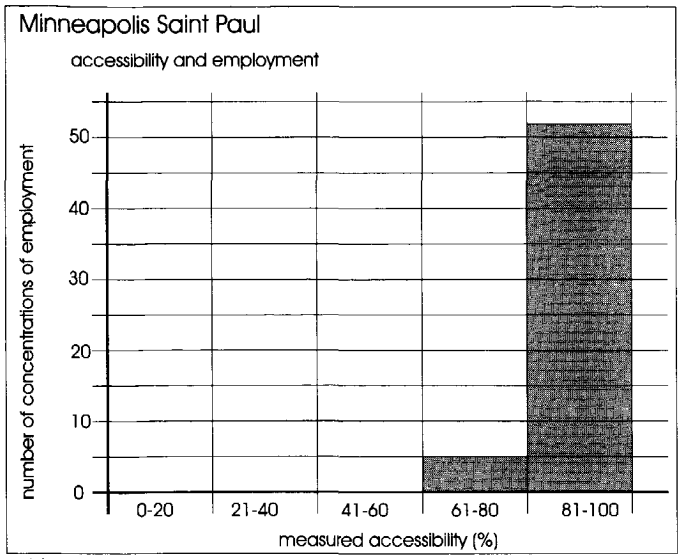


Table 7.1

cultural amenities. Besides these two centers, there are seven regional concentrations of retail facilities, all in the same range: the shopping malls. The one that lies farthest to the south, Burnsville, is the only center that is not situated at a location for which the accessibility value is higher than 80 percent. On the grounds of the expansion of the urban area in a southerly direction, and – as a consequence of that expansion – the increase in the size of the population in the area around Burnsville (Burnsville, Apple Valley, and Eagan), the development of the shopping mall is comparable with the earlier suburbanization and the emergence of the other shopping malls, as described in Chapter 5. Burnsville's shopping mall was built in anticipation of a growing market in that area. It remains to be seen if the accessibility value will ever top the value of 80 percent. No supplementary figures are available to determine whether or not this relatively new shopping mall serves a regional function.

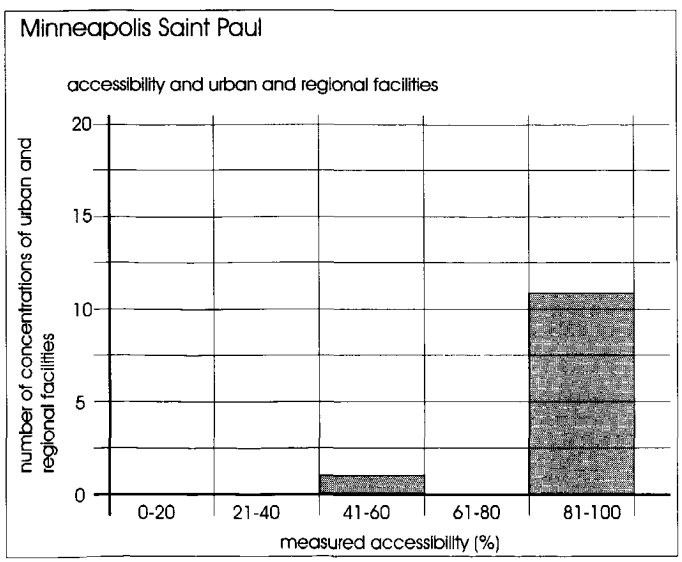


Table 7.2

Table 7.2 displays the distribution of the regional concentrations of facilities in Minneapolis – Saint Paul with respect to the weighted accessibility figures. As the table shows, 92 percent of the concentrations of facilities are situated at a location for which the accessibility value is over 80 percent. The shopping mall in Burnsville, discussed above, accounts for the remaining eight percent.

On the grounds of the outcomes of the analysis of the accessibility and the distribution of employment and facilities, the conclusion may be drawn that a conditional relation exists between accessibility and the functional structure in Minneapolis – Saint Paul. If the weighted accessibility figure for a location is higher than 80 percent, the necessary condition for the development of regional collective activities may be considered to be present.

7.3 The South Wing of the Randstad Holland

7.3.1 Context

In the analysis presented in Chapter 6, it proved that the South Wing has not yet developed into a unitary urban system. For that reason, the South Wing cannot be said to have a functional structure. Rather, a distinction must be made between the structure of the region of The Hague and that of Rotterdam. Characteristic of the functional structure of the region of The Hague is the concentration of offices in and near the historic inner city. Another characteristic feature is the concentration of office buildings along the A12 near The Hague and Zoetermeer, along the A44 near Leiden, along the A13 near Delft, and at the industrial estate Plaspoelpolder. The inner city of The Hague forms the main concentration of shops in the region. Specialized retail trade is situated in the industrial estate Binckhorst (automobile showrooms), along the A4 at Leiden/Leiderdorp (furniture showrooms), and along

the A13 (furniture showrooms). Thus, the functional structure is multinodal, whereby the inner city of The Hague has the largest concentration of employment and facilities. The development of offices outside that city center has increased sharply over the past several years. Office development has been strongest near the roads leading out of town and in the municipalities of Zoetermeer, Leidschendam, and Rijswijk (Dewulf and De Jonge, 1994).

In many respects, the functional structure of the Rotterdam region resembles that of the region of The Hague. In Rotterdam too, there is a large concentration of offices and shopping facilities in the inner city, in addition to concentrations of offices along the A20 at Rotterdam-Zevenkamp, along the A16 to the north of the Van Brienenoord Bridge, and to a lesser degree in the industrial estate Spaanse Polder. Specialized retail trade (notably automobile and furniture showrooms) is found particularly along the A20.
The developments prior to the Second World War laid the basis for the development of the city center of Rotterdam. Yet the past 50 years have had a decisive influence on the appearance of the city center. One typical feature is the concentration of high office towers near the central railway station; another is the shopping area that was developed in the 1960s. Due to the integration of housing, employment, and shopping and cultural amenities, the inner city is a multifunctional place. Similarly, the inner city of The Hague has a great diversity of functions, which give the center its multifunctional nature. The appearance of this center is determined by the historic inner city, with its countless 19th-century structures that provide premises for shops and offices but also with its new office buildings that are partly the legacy of the city forming process of the seventies and with a number of office buildings that have been built since the eighties in the vicinity of the central railway station. In both regions, the peripherally located areas of employment are predominantly monofunctional. A striking aspect of these centers is the concentration at the local scale: all offices and other businesses lie within walking distance, in an area maximally two by two kilometers in size. This compact structure contrasts with the peripheral areas of employment found in Minneapolis – Saint Paul, for instance, where employment is more widely dispersed at this scale.

Also in contrast to the situation in Minneapolis – Saint Paul, the inner cities of The Hague and Rotterdam have retained their position as regional shopping areas. Other shopping centers, such as Zuidplein and Oosterhof in Rotterdam and In de Boogaard and Leidschenhage in the agglomeration of The Hague, but also the city centers of Delft, Leiden, and Zoetermeer have no regional function (Provinciale Staten Zuid-Holland, 1987; Openbaar Lichaam Rijnmond, 1985). The development of large-scale retail trade at locations outside the planned shopping centers were restricted, till 1992, to retail establishments with more than 1500 sq. meters in gross floor space; even then, the only sectors allowed in those areas were furniture stores and lumberyards or builders' marts. For that reason, the South Wing has very few specialized service centers, other than the planned shopping centers. A revision of the legislation[6] to make it more lenient has led to a wider range of facilities in the meantime. The shopping center called Alexandrium II, which was opened in 1995 near Rotterdam-Alexander, may be taken as an example of the new developments. In view of the place of origin of the people who frequent this new shopping center (Gantvoort and Guyt, 1996), it is fair to say that it is a facility that serves a function for an area that is larger than the urban system of Rotterdam. Thus, this is an indication of system formation in the South Wing of the Randstad.

Also in the South Wing, the mobility from suburb to suburb has increased relative to the mobility from suburb to the inner city (Jansen and Van Vuren, 1985). This leads to traffic congestion, primarily during rush hour, on the highways and the urban freeways, on the radial roads as well as on the beltways. Truck traffic, particularly near the port of Rotterdam, contributes to the congestion; it makes up anywhere between 20 percent of the traffic flow on the A4 at the Benelux Tunnel and 30 percent on the A15 to the south of Rotterdam. On the other highways, the proportion of truck traffic is under 10 percent (Ministerie van Verkeer en Waterstaat, 1993). The highways in the South Wing form part of a wider network. For that reason, the provisions for through traffic made a significant

contribution to the overall flow of traffic, and thus to the congestion. Especially on the road from Amsterdam and Schiphol Airport in the direction of Belgium, which means the route A4-A13-A20-A16, the volume of traffic is on average 150,000 automobiles per day, the highest flow in the region. On the other roads, the volume of traffic is approximately 100,000 automobiles per day (Ministerie van Verkeer en Waterstaat, 1993).

In the basis of the Spatial Planning Act, the municipalities in the Netherlands are required to draft a land-use plan that sets forth the present and the projected land use in the municipality. Every building permit, as well as any permit for running a manufacturing plant or operating a business, has to be in accordance with this plan. This legislation provides the local government authorities with an instrument to prevent undesirable developments from taking place. The task of coordinating the content of each of the land-use plans falls under the structure plan[7], while these plans are evaluated in terms of the regional plan. Such plans and the procedures they entail are associated with the notion of permissive planning and place the government in a passive position, whereby the authorities have to wait and see what happens and only then are allowed to react. At the same time, municipal authorities are themselves actively engaged in spatial planning. They can develop locations by way of public-private partnerships.

Urban designs have had a strong influence on urban and regional planning in the Netherlands. Concepts derived from the field of urban design – such as the finger city, the lobate city, and the satellite city, which formed part of planning practice in the sixties and seventies – are still recognizable in the cities. Particularly in Rotterdam, during the period after the Second World War, priority was given to the development of the inner city by way of diverse plans for the city (see Chapter 6). The foundation for the current spatial development seen in both Rotterdam and The Hague lies in the concept of the compact city (Ministerie van VROM, 1990). Of course, this concept should be understood as more of a guideline for the location of residential construction than as an integral plan for urban development. Furthermore, the so-called ABC location policy is taken as a guideline for the choice of a site for various functions. In this regard, functions such as offices, large educational institutions, and regional retail facilities must be established at an A location, which means they have to be in the immediate vicinity of rapid public transport (a train station, a metro station, or an intersection where trams stop). Parking facilities are kept to a minimum at A locations. Offices and other organizations that can also benefit from being accessible by car are allowed to occupy premises at a B location, which means that it is easily accessible by both public transport and the automobile. Functions with a limited number of employees per hectare or low numbers of visitors – that is, functions that are primarily dependent on accessibility by road, such as shipping companies, manufacturing industries, and so forth – are allowed to establish a presence at C locations, which means they are accessible primarily by car.

7.3.2 Accessibility Analysis

Also for the analysis of the South Wing, the automobile forms the basis for the calculation of the accessibility values. For the calculation, an average driving speed of 70 kilometers per hour was used for the highways and 40 kilometers per hour for the other roads. Traffic congestion leading to delays of at least 15 minutes occurs on the A12 between Zoetermeer and The Hague-Center, on the A20 between Gouda and Rotterdam-Spaanse Polder, and on the A4 between Rijswijk and Leidschendam (Ministerie van Verkeer en Waterstaat, 1993).

In Chapter 6, it was established that the South Wing is not or not yet an urban system. Instead, it consists of two interfering urban systems. An important concern in this regard is the finding, also in Chapter 6, that there are not yet enough companies and organizations that explicitly serve a function for the South Wing as a whole. In the accessibility analysis, therefore, it is possible that one might look for a correlation between the functions of a city (The Hague, Rotterdam, or Leiden, for instance) that are subregional, in this case, and accessibility at the regional level. For the time being, the analysis is conducted as set forth in the protocol. The effect of interference may be brought up when discussing the results.

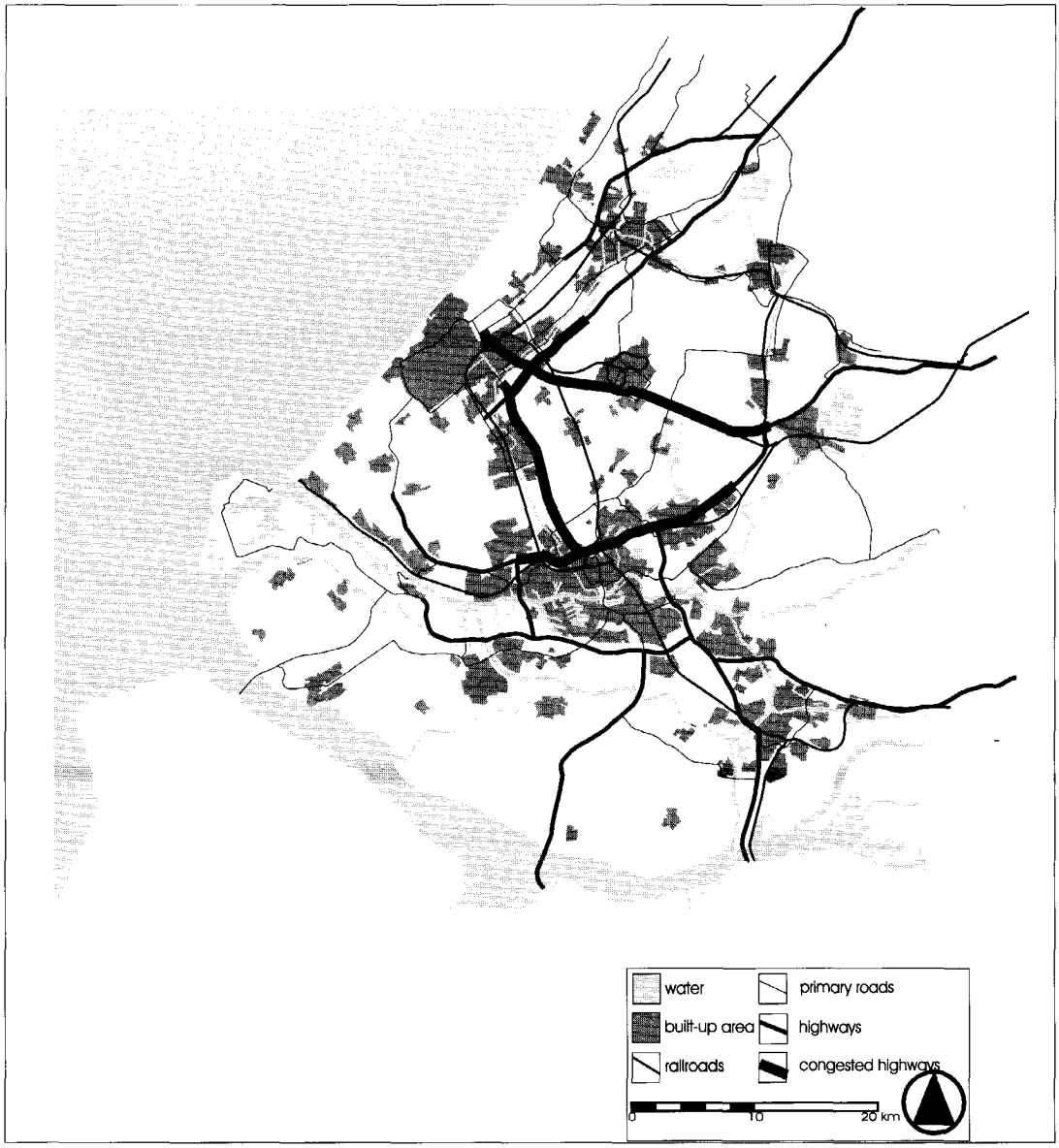


Figure 7.5
The South Wing, congested highways

Figure 7.6 depicts the outcome of the calculations. The map shows that there is a difference in accessibility between locations that lie along or close to the highways and other locations in the area. In considering that difference, it is noteworthy that the inner cities of The Hague and Rotterdam are only partially included among the locations with the highest values for accessibility. The mutual proximity of the urban areas – not only in the South Wing but in the entire area of the Randstad Holland – is crucial to the accessibility value. The locations where that value is over 80 percent are in this case the locations where the condition is present for interference and system formation.

Figure 7.7 shows how employment is distributed.[8] Typically, the inner cities of Rotterdam and The Hague lie next to the concentrations of employment near the highways. The concentration of employment at Leiden-West is situated at a location for which the accessibility value is considerably lower than it is at other concentrations. This applies to the establishment of a number of institutes of Leiden University. It is self-evident that the university should be classified as serving a regional function. Yet it should be emphasized that the university's clientele – the students – in particular make a contribution to the fact that the university functions at the local level to a large extent. Universities that are sited on a campus confirm the fact that universities operate at

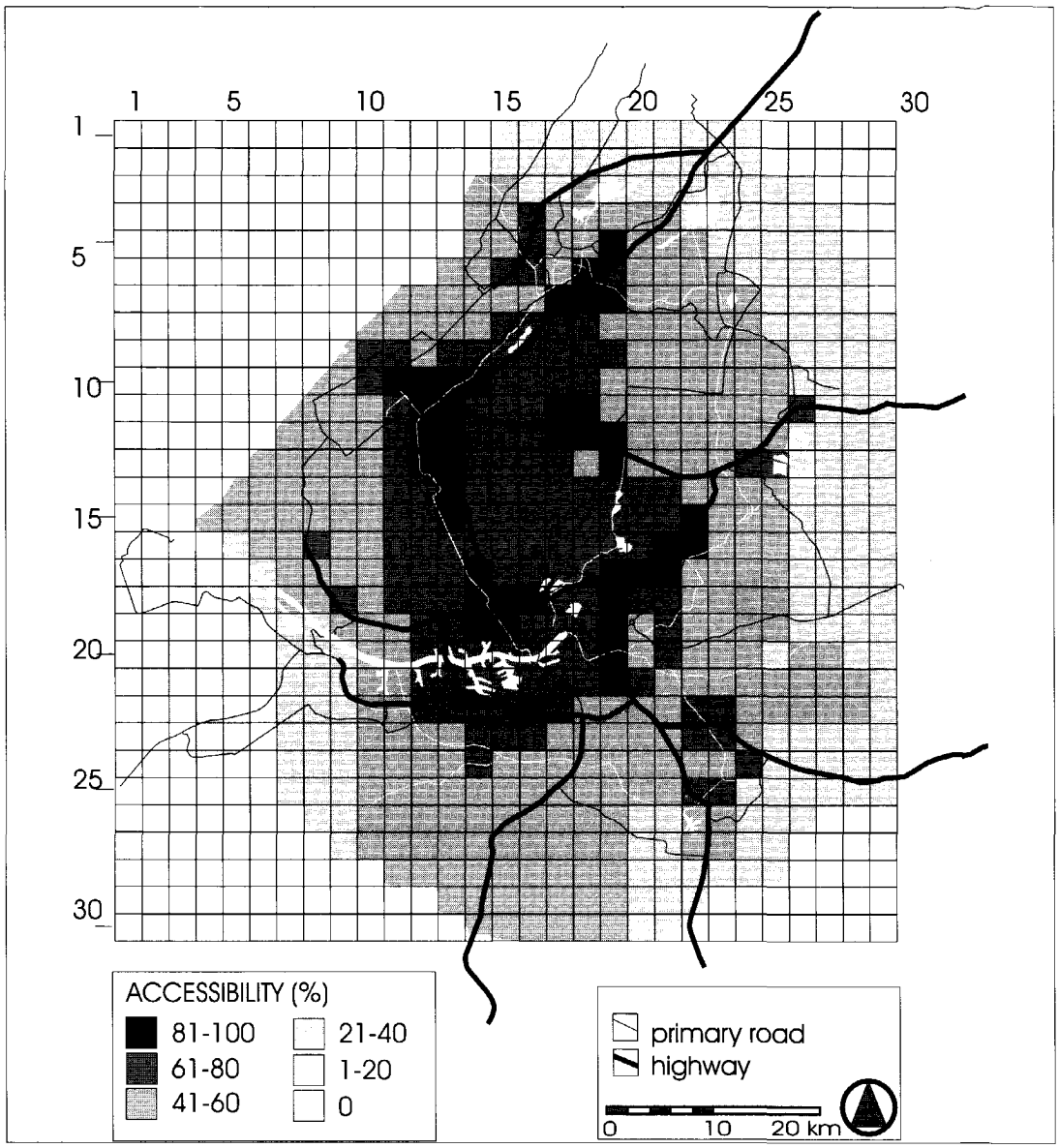


Figure 7.6
The South Wing, accessibility analysis

a local scale, even though they might also have a global range of and a supra-regional impact on research and development in a region.

If it is true that the university – on the grounds of its relationship with its clientele, who are the recipients of education – should be considered as an urban function, which in this case would imply that Leiden University is really an affair of the city of Leiden, then the accessibility value of that location must be related to the size of the urban area of Leiden. Regardless of the mode of transport – be it the bicycle, mass transit, or the automobile – that location is maximally (i.e., 100 percent) accessible in the urban area of Leiden.

For diverse concentrations of employment in the area of the South Wing, a comparable refinement of the model is called for. The South Wing cannot yet be seen as an urban system. Realistically, it should be seen as an interfering complex of urban systems (see Chapter 6). Therefore, the concentrations of employment, and further away the other collective activities too, must be related to the location value in each of the urban systems. On the basis of the pattern of relations presented in Chapter 6 with respect to the South Wing, it may be assumed that there are two systems. One is that of The Hague, which includes The Hague itself and its surrounding municipalities, namely Leiden, Delft, and Zoetermeer. The other system is that of Rotterdam,

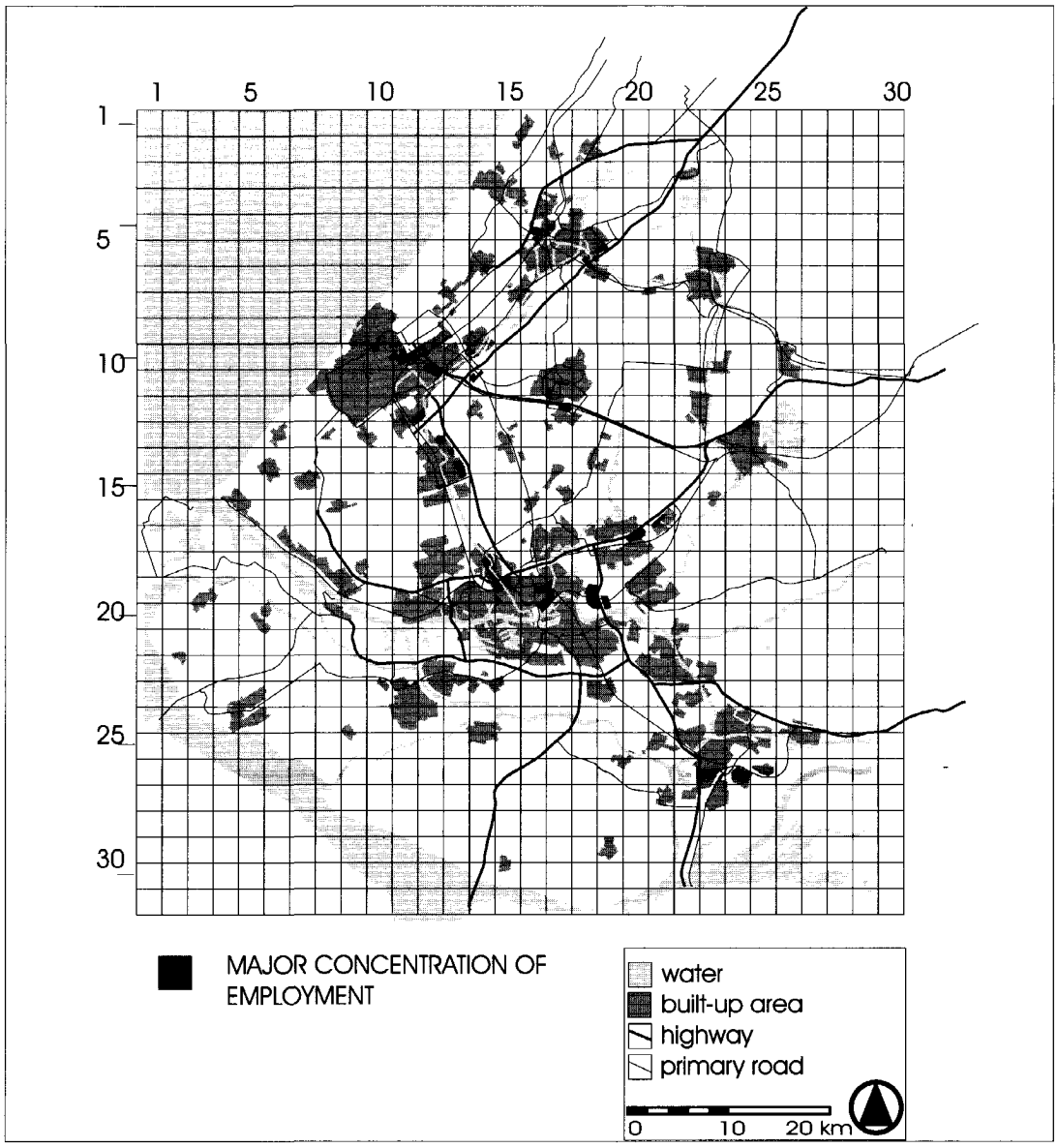
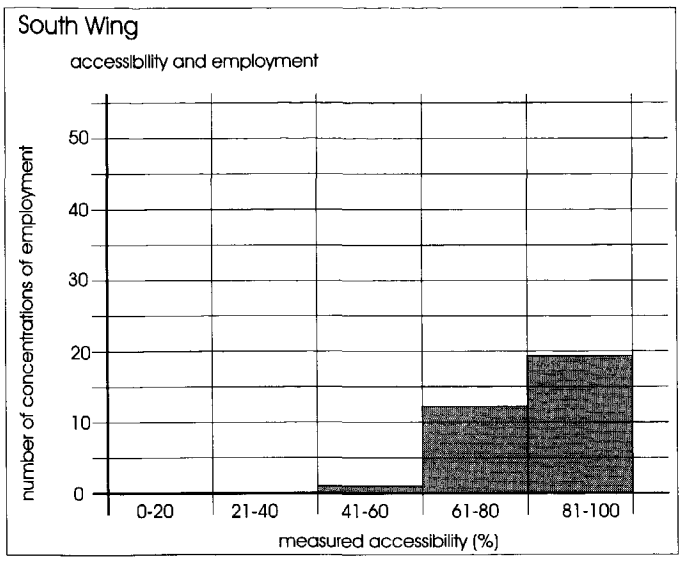


Figure 7.7
Distribution of employment
(source: Provinciale Staten Zuid-Holland, 1987; Openbaar Lichaam Rijnmond, 1985)

which includes Rotterdam itself and the adjacent municipalities of Dordrecht and Gouda. Of course – and this is characteristic of interference – it is not possible to draw a firm boundary between these two systems.

Table 7.3 shows the distribution of the concentrations of employment in the South Wing in relation to the weighted figures for accessibility. Looking at the table, it proves that only 59 percent of those concentrations of employment are situated at a location where the accessibility value is higher than 80 percent. In interpreting these figures, it should be kept in mind that the accessibility values are determined on the basis of the maximum value for the entire area. Taking the two interfering urban systems as the point of departure, the measured accessibility value must be considered in relation to the maximum value found in that urban system. The result of these considerations is Table 7.4 for the urban system of The Hague and Table 7.5 for the urban system of Rotterdam.

Table 7.4 demonstrates that the percentage of the concentrations of employment that are situated at a location with an accessibility value of more than 80 percent has now risen to 65 percent. Table 7.5, which reflects the situation in Rotterdam, shows that 64 percent of the employment concentrations are now at



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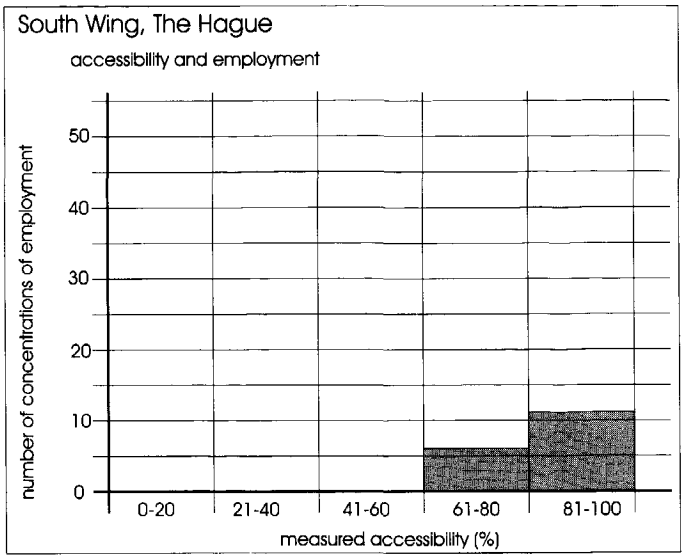
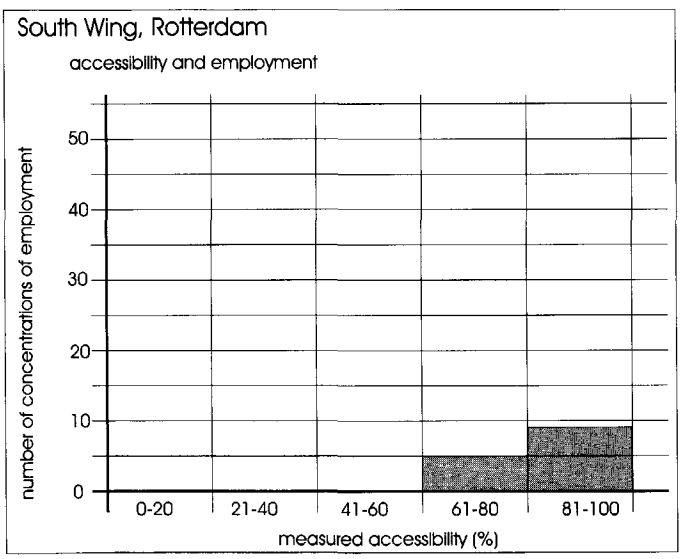


Table 7.4



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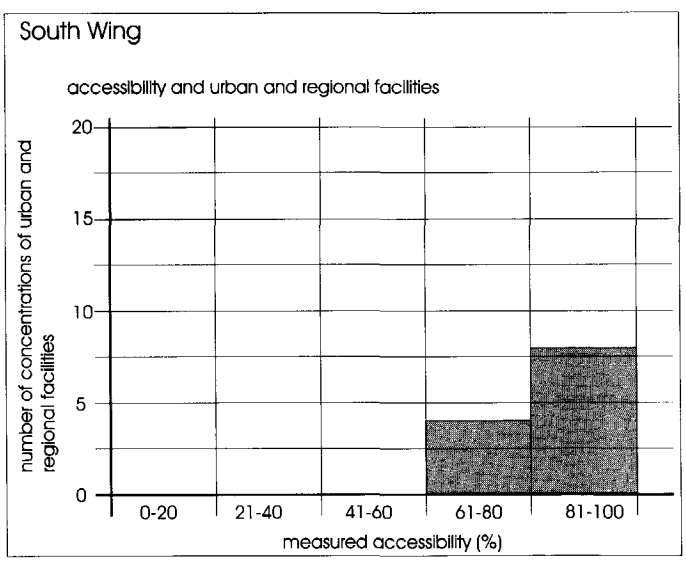


Table 7.6

a location where the accessibility value is greater than 80 percent. This outcome suggests that the hypothesis does not hold up. It may be that the threshold value (80 percent) is too high. Alternatively, there may be no correlation with the accessibility value in this case. Or there could be other factors in play that detract from the autonomous role of accessibility.

Figure 7.8 displays the distribution of urban and regional facilities. The inner cities of The Hague and Rotterdam are clearly represented. Besides these two centers, there are seven regional concentrations of shopping facilities, with a predominance of the automobile and furniture branches. The position of the two inner cities is noteworthy. Whereas the more specialized and more recent centers do not refute the hypothesis, parts of the inner cities of The Hague and Rotterdam appear to be exceptions to the rule.

Table 7.6 shows the distribution of the urban and regional facilities in the South Wing. From the table, it is clear that 67 percent of the concentrations of urban and regional facilities are situated at a location for which the accessibility value is over 80 percent. If, incidentally, the

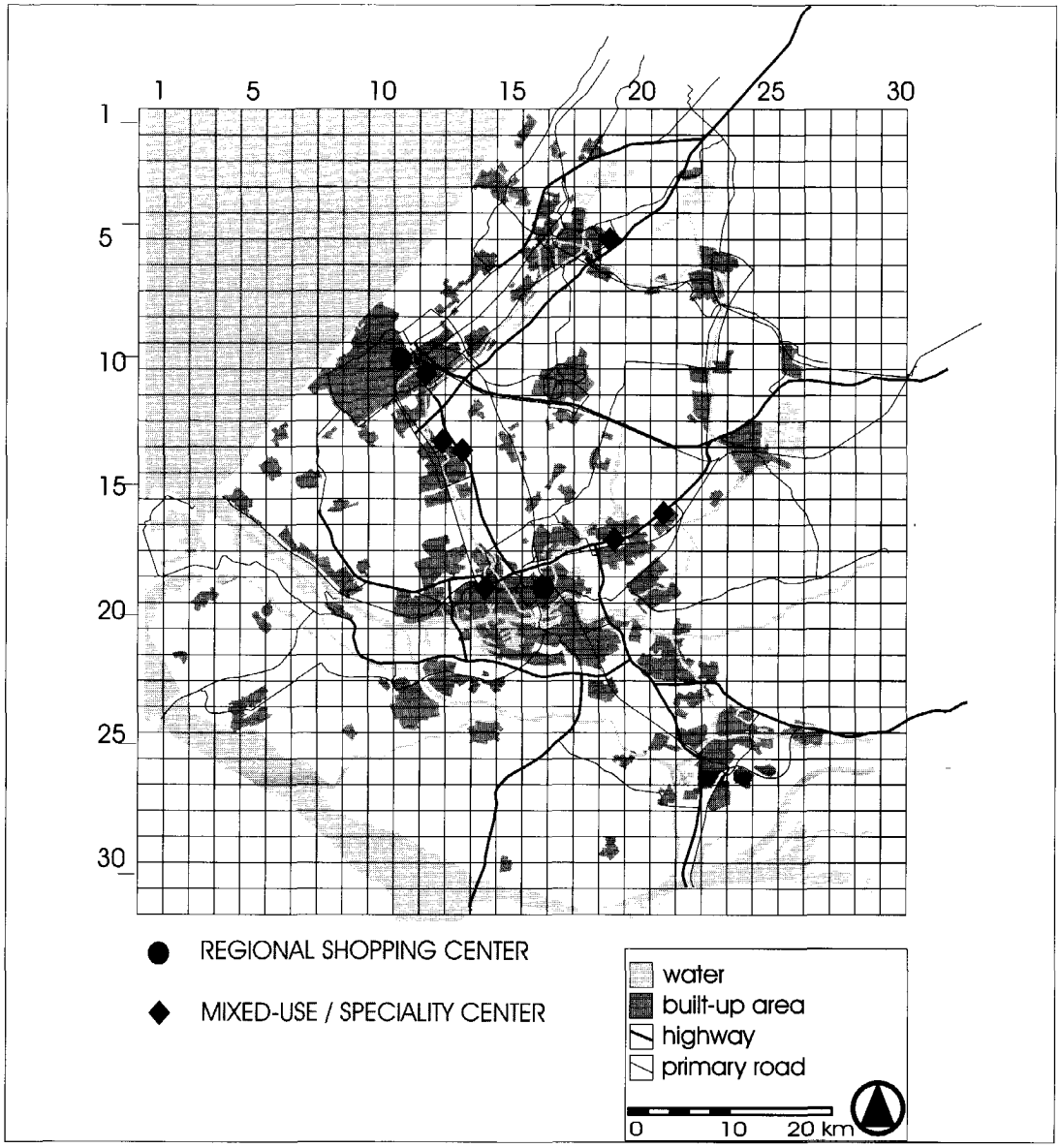


Figure 7.8
Distribution of urban and regional facilities
(source: Provinciale Staten Zuid-Holland, 1987; Openbaar Lichaam Rijnmond, 1985)

inner cities are not taken into account, then the score is even higher: 89 percent.

On the basis of the outcomes of the analysis of accessibility and the distribution of employment and urban and regional facilities, it is still too early to draw an unambiguous conclusion with regard to the existence of a conditional relation between accessibility and the functional structure of the South Wing. The inner cities of The Hague and Rotterdam are exceptions to the rule. The weighted accessibility of this specific location apparently does not have to amount to 80 percent. Although it was pointed out in Chapter 4 that the norm of 80 percent is provisionally assumed to be correct, it is still noticeable that the South Wing deviates from this norm, whereas the previous cases do have good scores. The question is whether or not other factors are in play here. For the South Wing, there is a far-reaching form of spatial planning. Throughout the postwar period, Rotterdam has continuously worked on the reconstruction of its city center, where there was room for large-scale development. Furthermore, the influence of the automobile on spatial development has only been visible since the 1980s (see Chapter 6), which means that the effects of the automobile are only manifesting themselves now. There are also signs of a national policy to stimulate people to use public transport. The spatial policy has thereby had an effect on the relationship

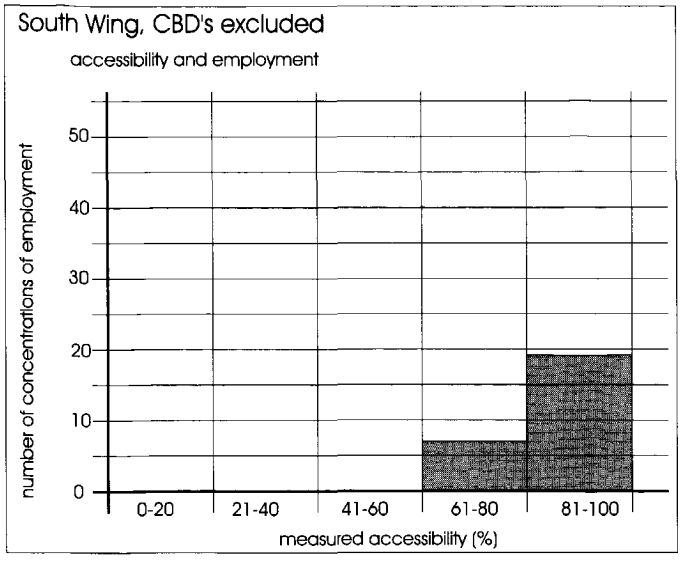


Table 7.7

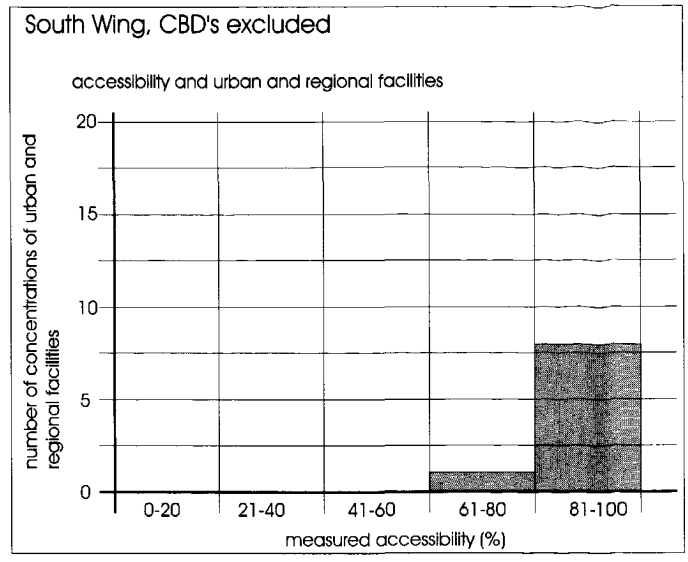


Table 7.8

between accessibility and the functional structure. It might possibly act as a limiting factor in that relation. Incidentally, the historic inner city of The Hague – including the Binnenhof, which is the seat of government – should be named as one of the location factors. This cultural and historical quality would in that sense compensate for the lower degree of accessibility. Tables 7.7 and 7.8 show the outcomes in the event that the inner cities are left out of the picture. Looking at the situation from this angle clarifies the extent to which the inner cities influence the overall impression. Now, 89 percent of the concentrations of urban and regional facilities, as well as 73 percent of the concentrations of employment, are situated at locations that have a value of more than 80 percent. New locations score particularly well here (greater than 80 percent). Spatial policy that is geared to the promotion of the existing inner-city centers and public transport appear to have an influence in that respect. A further inquiry into the influence of this spatial policy on the development of the functional structure would seem to be warranted.

7.4 Dallas – Fort Worth

7.4.1 Context

With a nickname like Metroplex[9], Dallas – Fort Worth is surely one of the best-known multinodal urban systems. And its renown is well deserved. Even more obviously than in the case of Minneapolis – Saint Paul, the map of Dallas – Fort Worth shows a classic example of a twin city. But of course, things are not always what they seem. Just as in the case of Minneapolis – Saint Paul, the functional structure is more complex than the map would suggest at first glance. In the course of the second half of the twentieth century, Dallas – Fort Worth has developed at a rapid pace. Fragments of its past economic base – a cattle and cotton market – are overshadowed by the skyscrapers where banks and oil companies have their offices. Along the many highways, the electronics industry (especially Texas Instruments) and the defense industry set the tone. Especially in the period after 1980, the phenomenon known as 'edge city' took hold in this region; the areas called Las Colinas, La Galleria, and Love Field have been outshining the central

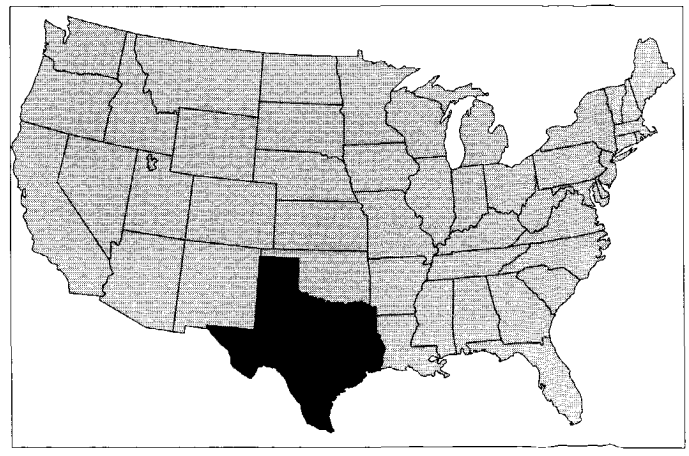


Figure 7.9 Position of Dallas – Fort Worth in Texas and in the USA

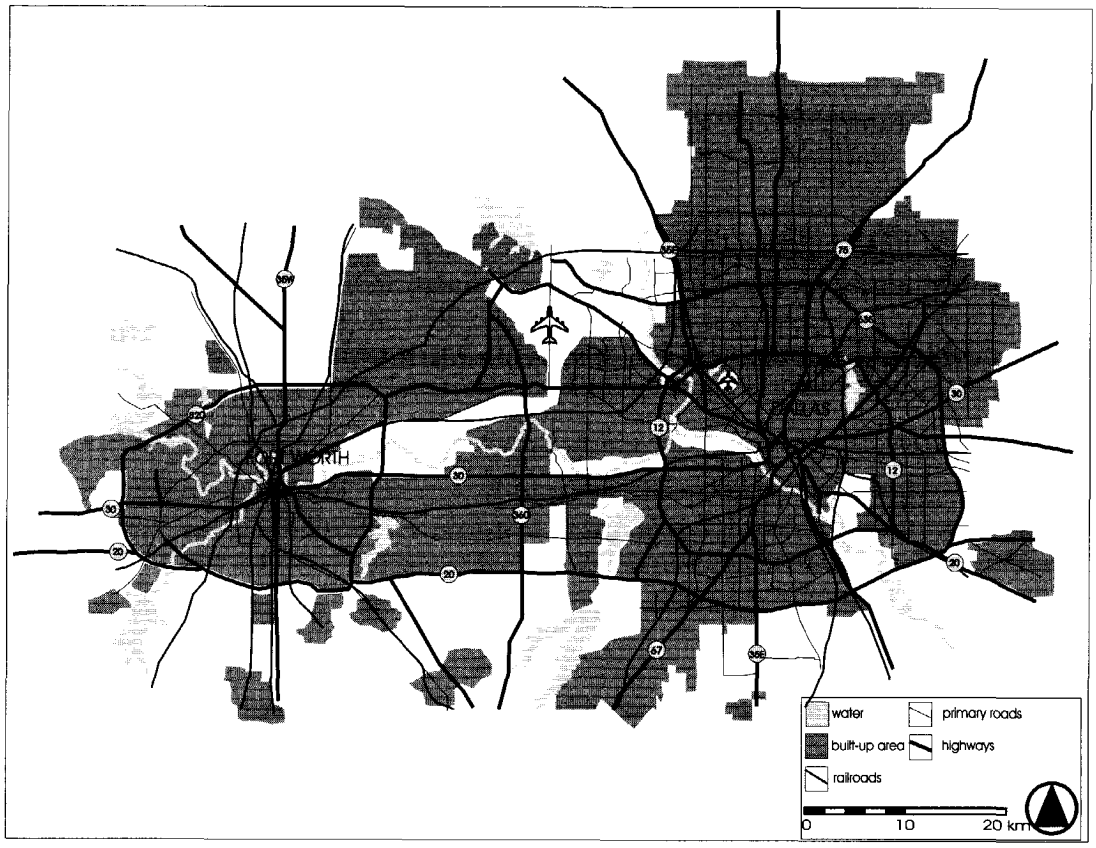
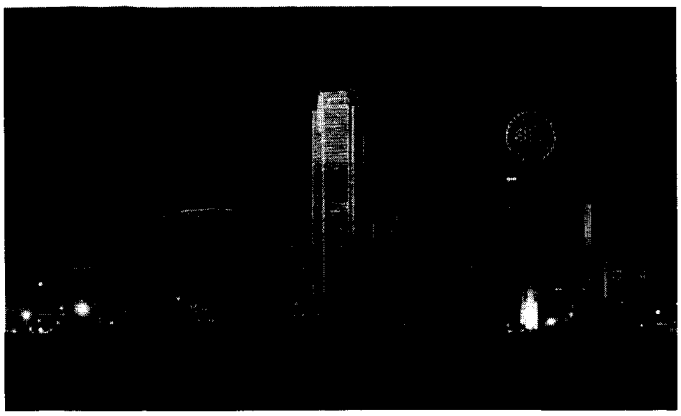


Figure 7.10
Dallas – Fort Worth, 1990

business district for a long time already. Another achievement of Dallas – Fort Worth is the airport, which was opened in 1973; since then, it has become the second-largest airport in the world. This fact is not really surprising, in light of the fact that this region ranks fourth – after New York, Chicago, and Los Angeles – with respect to the number of international head offices in the country, while it even outstrips Los Angeles in the number of national head offices.[10] The urban region of Dallas – Fort Worth has a population of 3,885,415 inhabitants.[11] Dallas itself has over a million, and Forth Worth approximately 500,000 inhabitants. For the sake of comparison, the Metroplex covers a surface area equal to that of London and Paris combined.

The history of Dallas goes back to 1841, when J.N. Bryan wanted to open up a trading post on the Trinity River. Eventually, he became a ferryman, after the disappointing discovery that the river was not fully navigable all the way to the Gulf of Mexico. Only in 1872, when the Central Pacific Railroad reached what had since grown to be a small settlement, followed by the Texas Pacific Railroad in 1873, did Dallas develop into an important distribution center. As one of the most important cotton markets around 1900, Dallas formed the main location for banks, insurance companies, and the apparel industry to establish a presence. When oil was discovered in eastern Texas in 1920, the pace of development rapidly picked up speed. Legislation that had been adopted in 1908 stipulated that a large share of the corporate profits had to remain within the state. To a large degree, this law contributed to the prosperous development of Dallas. A new period for Dallas was ushered in at the end of the 1960s, when Jack St. Clair Kilby of Texas Instruments presented the first working microchip. With that demonstration, he laid the foundation for the electronics and aerospace industries in the region.

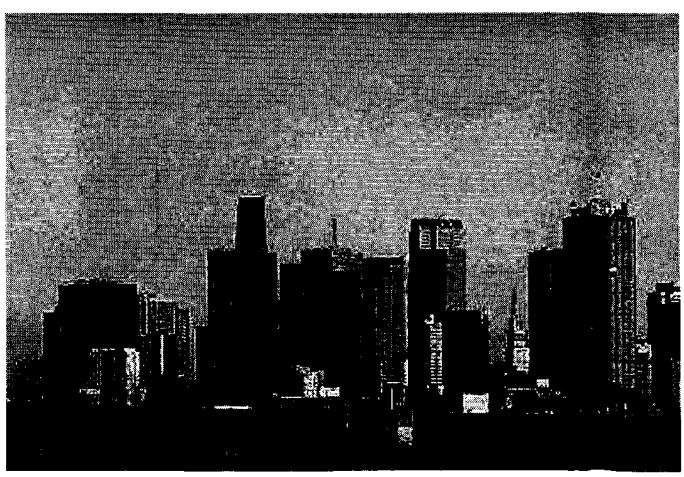
Whereas Dallas was actually founded on a misunderstanding (about the navigability of the river), the founding of Fort Worth can be easily explained in terms of the geographical setting. In 1849 (one year after the Mexican War, as a consequence of which Texas became part of the USA), Fort Worth was founded as an army outpost. Fort Worth lies at a strategically favorable point, in the zone of transition from the flat prairie lands of Northern Texas to the Hill Country. That boundary is



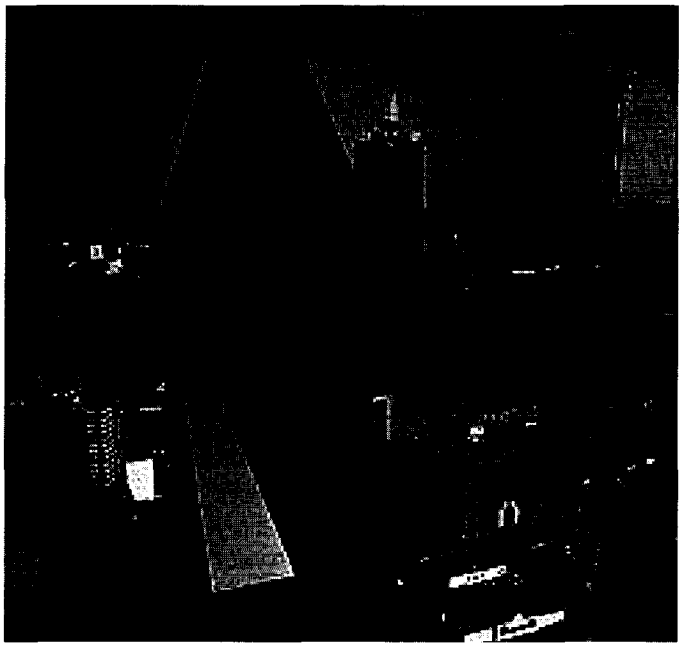
Dallas

formed by the Balcones Escarpment, a wall of rock, often steep, running from Fort Worth to Del Rio near the Mexican border. Then a few years later, the Chisholm Trail was blazed through the landscape. This was the main cattle trail from Texas to Abilene, Kansas, which was the point where the cattle were loaded onto railroad cars and transported further east. During the period known as the cattle kingdom (1860-1880) Fort Worth grew into the most important place to stop along the route. Because the railroads had been gaining ground, reaching Fort Worth in 1876, there was little use for the trail to Abilene. Then Fort Worth itself became a cattle market, a position it holds to this day. The discovery of oil in 1920 laid the groundwork for the development of the petrochemical industry, just as it had in Dallas. In the meantime, Dallas had developed a business center; because of this head start, however, Fort Worth would always remain in the shadow of Dallas.
Fort Worth is characterized by manufacturing, such as the automotive industry, the aerospace industry, and the highly developed defense industry, which thanks its existence in part to the Carswell Air Force Base, which lies on the west side of Fort Worth. A noteworthy institution in Fort Worth is the Kimbell Art Museum, which has the second-highest budget for acquisitions of any museum in the USA. The museum was designed by Louis Kahn (1972). The climate of Dallas – Fort Worth is warm and often uncomfortably humid in the summer. The fact that a large share of the public space is covered and air-conditioned is thus not very surprising.

Dallas – Fort Worth is an urbanized area which seems to have no shortage of space. Virtually nowhere is the population density higher than eight persons per hectare. The density of the structures in the commercial areas is also markedly lower than in the other cases. Downtown Dallas is literally an eye-catcher in the region, because of the sparkling glass skyscrapers. Downtown Fort Worth has just a handful of tall buildings, and these are not even half the height of the towers of downtown Dallas. Downtown Fort Worth is clearly not in the same league as Dallas. The employment outside of both downtowns is widely spread out, with an emphasis on the quadrant to the northwest of downtown Dallas. This is also where the major concentrations of facilities are found, especially in the complexes of Los Colinas, La Galleria, and Love Field. The emphasis lies on the zones around Highway 114 and Interstate 35E, in the direction of the airport; on the areas along Interstate 30 in the direction of Fort Worth; and on the areas near the beltways Loop 12 and Interstate 635.
The employment areas near Fort Worth are found not only downtown but also on the beltway (I-820). One large concentration of employment lies in the area near Carswell Air Force Base to the northwest of downtown. Another one lies to the southwest of downtown near Texas Christian University and the Southwest Baptist Theological Seminary.
Dallas – Fort Worth has a number of big sports stadiums. The most well known is the Cotton Bowl (for football and other large sporting events). It is situated in downtown Dallas, as is the stadium where the Mavericks play basketball. The Texas Stadium, where the Dallas Cowboys play football, is situated in the



Downtown Dallas



Dallas

northwest quadrant. And the Arlington Stadium of the Texas Rangers (baseball) is situated on Interstate 30, halfway between Dallas and Fort Worth.
The region of Dallas – Fort Worth went through a period of vigorous growth from 1970 to 1987. In that period, the amount of floor space for offices in the central business district of Dallas increased from about 1.58 million sq. meters to about 3.25 million sq. meters. In Dallas County, office floor space grew by almost 9.29 million sq. meters, reaching a total of 11.6 million. In considering these growth figures, it is striking that the central business district of Dallas accounted for a mere 7.5 percent of the employment, and that of and Fort Worth for only 2.5 percent. The job growth took place chiefly outside the central business districts and in the suburbs. The employment rate for 1991 was 1.5 million jobs for the entire region. The size of the secondary (goods-producing) sector was 32 percent of total employment, of which high-tech jobs accounted for 13 percent.

In the meantime, the region of Dallas – Fort Worth in general and the City of Dallas in particular have given priority to public transport by way of the development of a light rail, which runs from downtown Dallas to the airport, to diverse transit busses (DART, short for Dallas Area Rapid Transit), and to frequent bus service in downtown Dallas. Despite these initiatives, it is evident

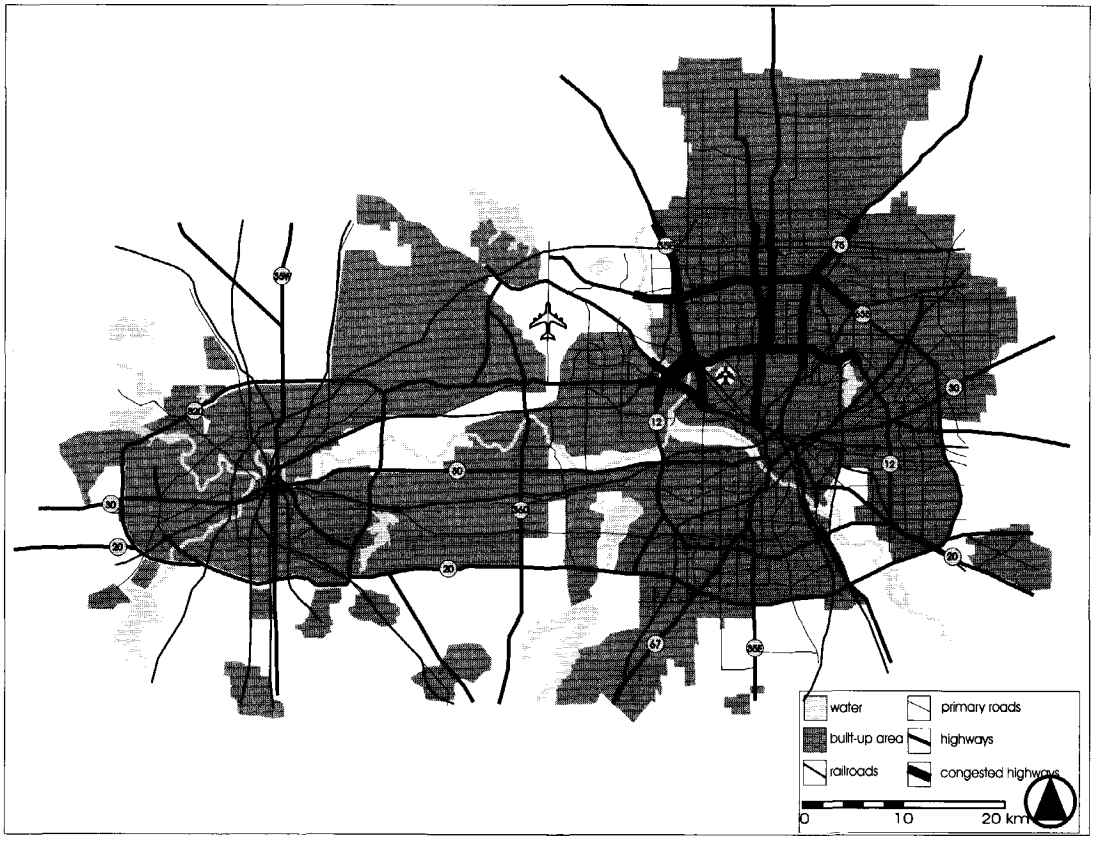


Figure 7.11
Dallas - Fort Worth, congested highways

that the automobile is the most important means of transport. The share of public transport in the modal split in the region is less than one percent[12] (Regional Council of Governments, 1995). In this regard, Brian Berry (at the Bruton Center of Development Studies, University of Texas) remarked that the bus is used mainly by Afro-Americans, who live in South Dallas and generally have low-paid jobs in North Dallas. Even though there is a system of wide roads, traffic back-ups are a fact of everyday life. In rush hour, Interstate 35 E and the Highway 75 in particular are filled beyond capacity, while the majority of the highways within Loop 12 are stopped up. Also on Loop 12 itself, especially in the northwest and on Interstate 635 (the large ring) in the north, traffic gets stopped up, even outside of rush hour. Meanwhile, the Dallas North Tollway has become accustomed to the same delays as the other roads in the direction of downtown Dallas. This picture is markedly different from that in Fort Worth, where severe traffic jams hardly ever occur.

The Dallas – Fort Worth region has two levels of spatial planning. The Regional Council of Government operates for the entire region. This council was originally instated to be able to develop the international airport. At present, the core activities of the council concern water and transportation planning. With respect to the latter, the council can obstruct plans that may be expected to create major traffic problems. The councils can do so by designating areas where commercial development is not allowed; this method is known as down-zoning. The second level of planning lies with the cities. The local authorities draft plans whereby the spatial policy is set forth in principle (as growth policies). Concretely, the cities concern themselves for the most part with the design of public space and with public-private development projects. The latter activity might require down-zoning to be lifted on condition that the developers provide part or all of the financing for public projects. Projects such as Las Colinas and Galleria were initiated in this manner (Garreau, 1991). In a liberal state such as Texas, the various government bodies must come up with good reasons to obstruct plans. The protection of a historic cityscape and the development of a nature reserve are both sound arguments. Initiatives to make room for social housing, for instance, still do not carry enough weight to prevail over the interests of the commercial development. Just as in Minneapolis – Saint Paul, planning in Dallas – Fort Worth does not play a leading role. Rather, it has a limited task: to coordinate the various plans; to participate in developments; and to present examples as translations of the planning objectives.

7.4.2 Accessibility Analysis

As in the foregoing cases, here too the automobile is the most important means of transport in the region. Therefore, the automobile is taken as the basis for the calculation of the accessibility values. Here too, a distinction is made between highways and primary roads; the latter are city roads and roads outside the built-up area. And here too, traffic congestion should be taken into account when calculating the potential accessibility. Traffic congestion leading to delays of at least 15 minutes is found on the I-35 East, on Highway 75, on the Dallas North Tollway, on Loop 12 North-West, and on Interstate 635 North. The highways running through downtown Dallas (inside Loop 12) admittedly do have to contend with congestion, but nowhere are the delays longer than ten minutes (Regional Council of Governments, 1994).

In calculating the accessibility value, the point of departure was an average driving speed of 70 kilometers per hour for the highways and 40 kilometers per hour for the other roads.

Figure 7.12 shows the outcome of the calculation. It is clearly visible that a large share of the urban area – that is, the area lying inside Loop 12 and along the I-35E in a northwesterly direction, the Dallas North Tollway, and Highway 75, as well as the centrally located I-35 between Dallas and Fort Worth – has an accessibility value that is higher than 80 percent and therefore offers the necessary condition for the establishment of collective activities. There is clearly a differentiation between North Dallas and South Dallas. Even more striking is how Fort Worth keeps lagging behind. In that light, the multinodality of the Metroplex would appear to be influenced less by the traditional twin-city principle and much more by the dispersal around Dallas.
Figure 7.13 shows the distribution of employment. Three

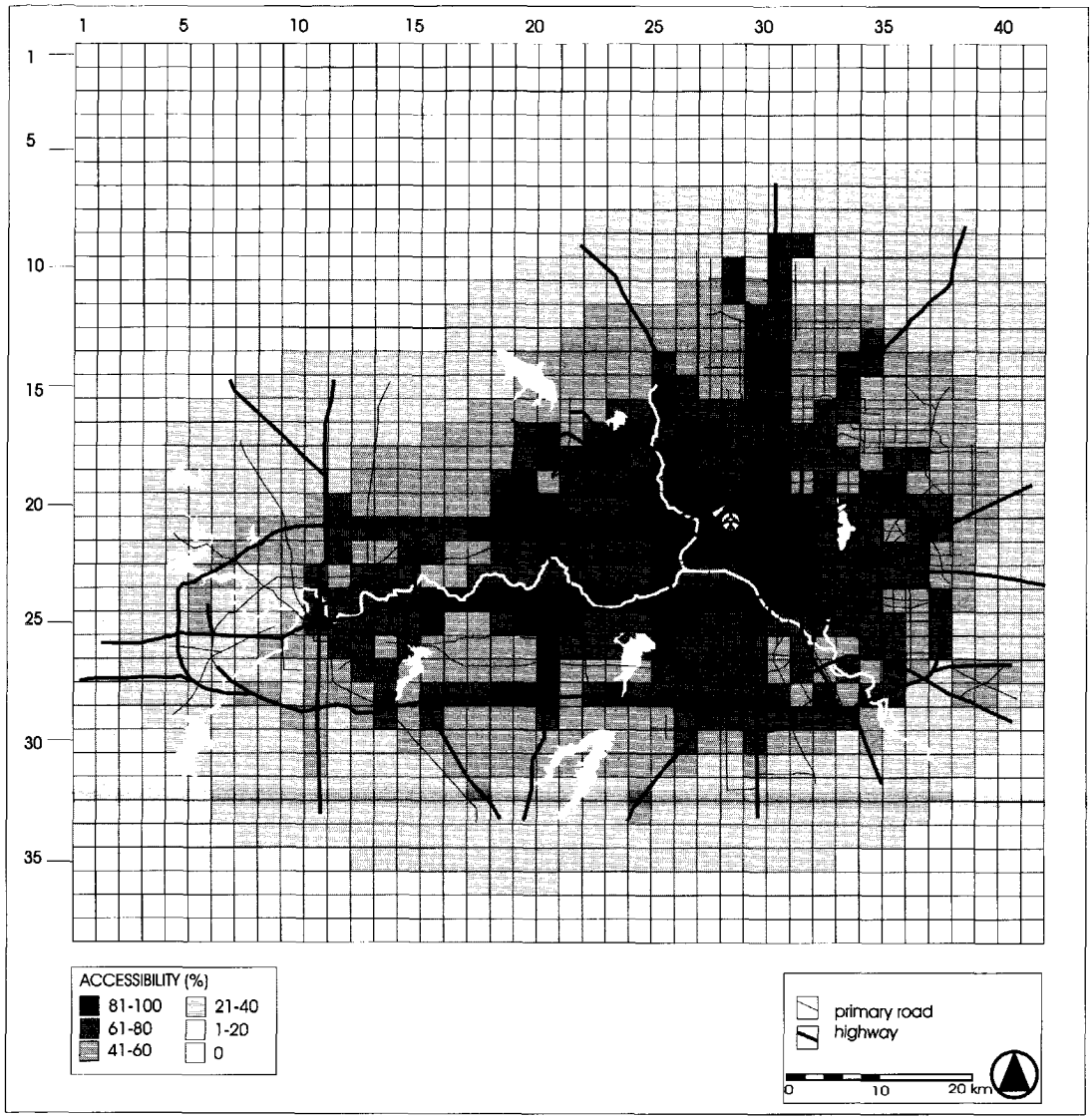


Figure 7.12
Dallas – Fort Worth, accessibility analysis

areas are characteristic: the zones of downtown Dallas; the zones to the northwest of downtown; and the zones near the airport. Besides this force field between the airport and the central business district of Dallas, there are a number of smaller concentrations of employment in Forth Worth. One is in the central business district; several more are at locations that appear to be oriented toward the beltway. The locations to the northwest of downtown Fort Worth are related to the air force base. The southern concentration spans the conglomerate of Texas Christian University and the Southwest Baptist Theological Seminary. Because of the dependence upon the air force base, the locations to the northwest of downtown Fort Worth – concentrations of employment that are associated with the base – tend to bring some bias into the overall picture. The point is that here, the choice of a location is not as unconstrained as for other sectors of employment, specifically as a consequence of security measures. Furthermore, in both its nature and its volume, the employment base in the central business district of Forth Worth can hardly be called regional. With just over 30,000 jobs (less than two percent of the total employment base) and with an accent on local government and services, the central business district of Fort Worth contrasts starkly with other locations, where international head offices predominate.

Table 7.9 shows the distribution of the concentrations of employment in Dallas – Fort Worth relative to the weighted accessibility figures. The table reveals that 75 percent of those concentrations of employment are

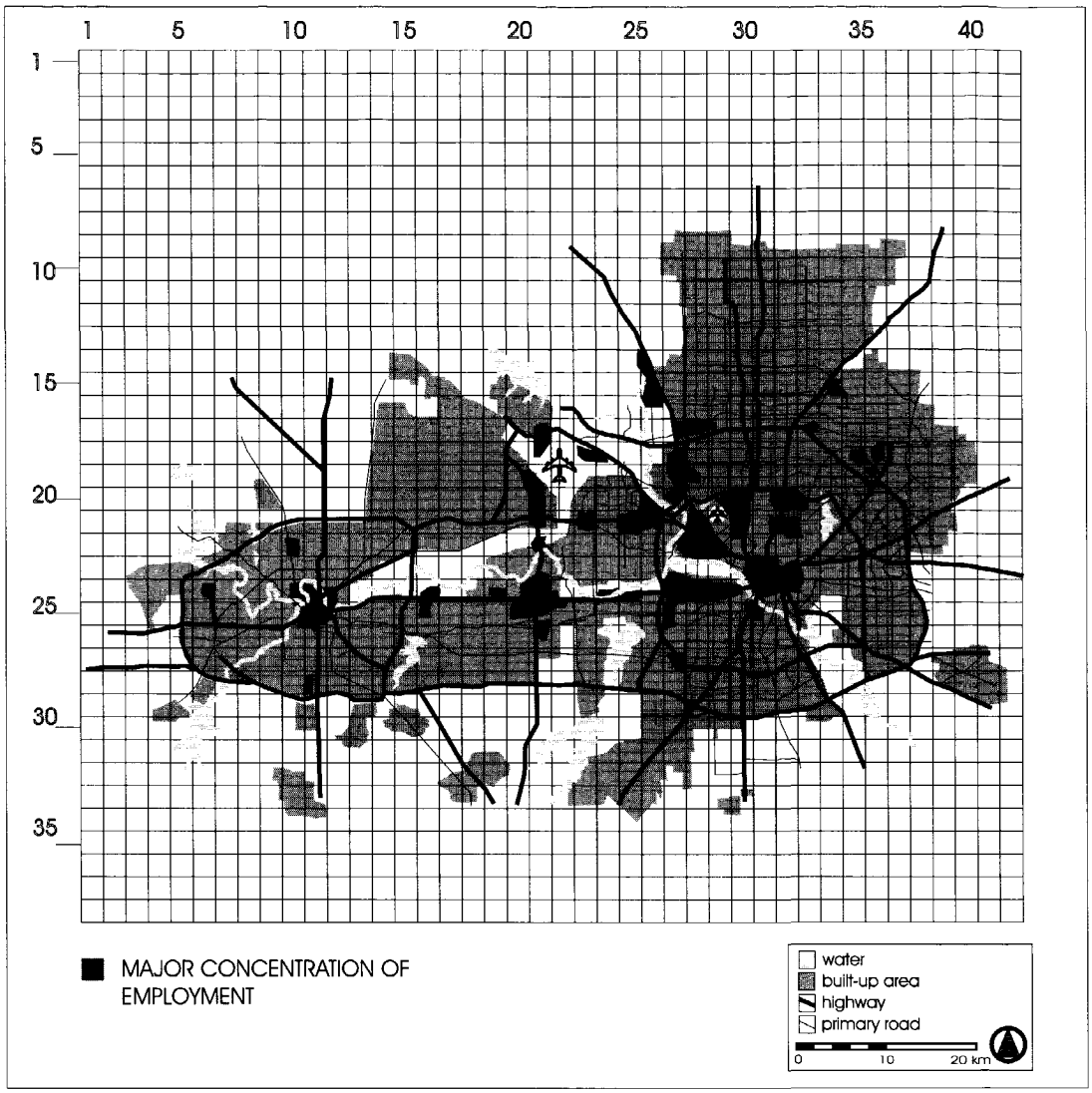


Figure 7.13
Distribution of employment
(source: State of the region 1992; Bruton center for development studies, University of Texas, Dallas land use data; North Central Texas Council of Governments)

situated at a location of which the accessibility value is more than 80 percent. With the exception of the employment at the air force base, as discussed above, and leaving out the jobs in the central business district of Fort Worth, the accessibility value is 84 percent. These figures lead to the conclusion that a conditional relation does exist between accessibility and the distribution of employment.

Figure 7.14 shows the distribution of urban and regional facilities. Among these places, the new centers in Dallas are well represented. All of these concentrations of facilities are found at a location with an accessibility value of over 80 percent. The only exception is the museum district in Fort Worth. The Kimbell Museum, which is located there, is definitely a pace setter for the quality of the other museums, which gives this concentration an ostensibly regional character.

Table 7.10 shows the distribution of urban and regional facilities with respect to the weighted accessibility figures. From the table, it is clear that 90 percent of the concentrations of facilities are situated at a location of which the accessibility value is greater than 80 percent.

On the grounds of the outcomes of the analysis of the accessibility and the distribution of employment and facilities, the conclusion may be drawn that a conditional relation exists between accessibility and the functional structure in Dallas – Fort Worth. If the weighted accessibility of a location is greater than 80 percent, the necessary condition for the development of

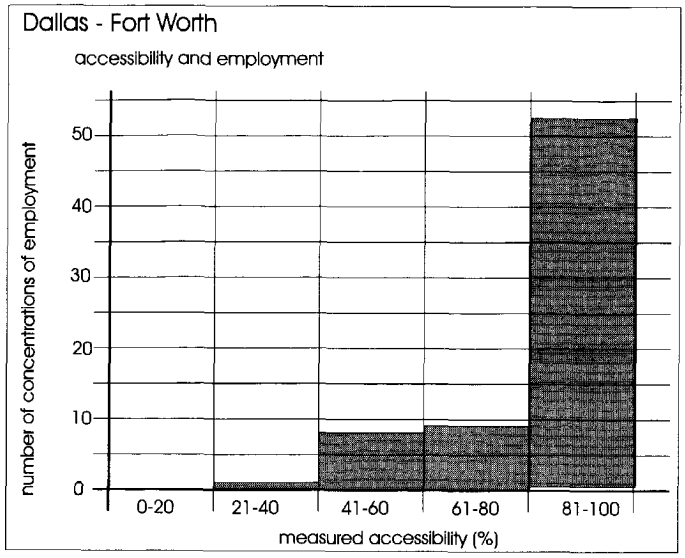


Table 7.9

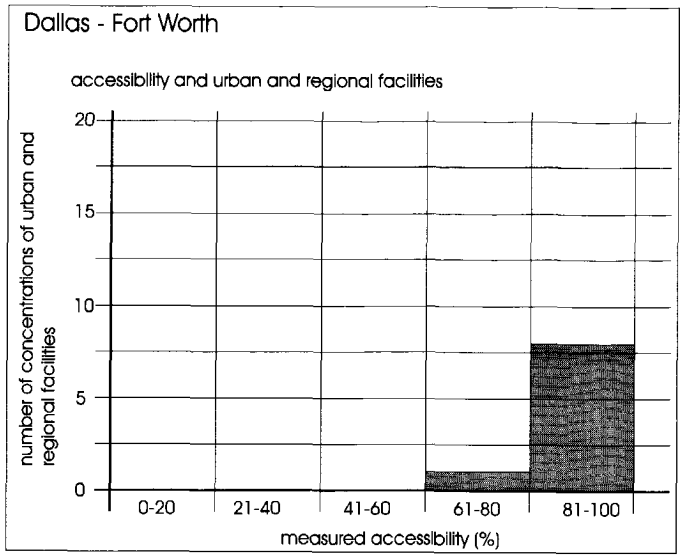


Table 7.10

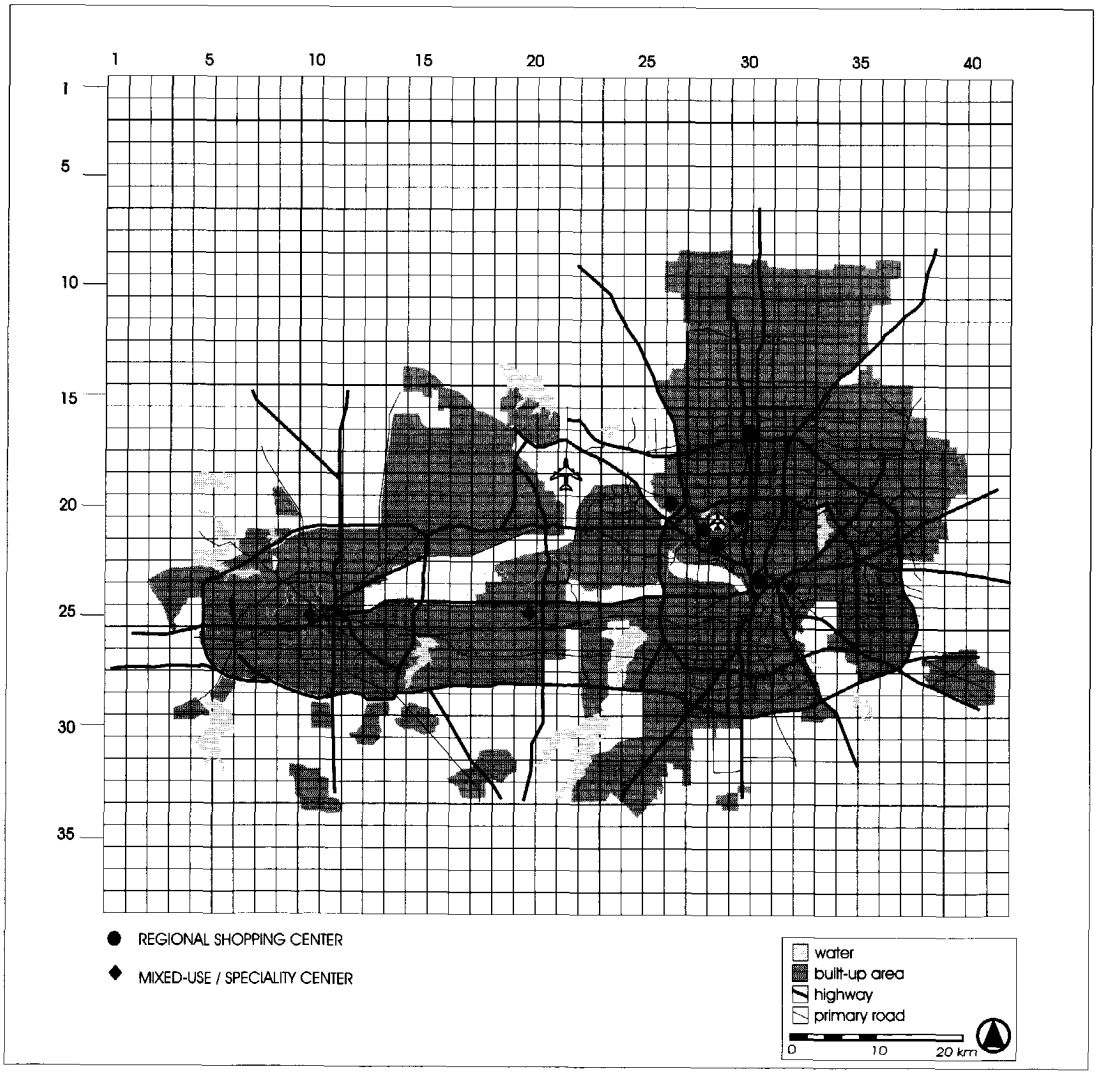


Figure 7.14
Distribution of urban and regional facilities
(source: Department of planning and development, Dallas, 1994)

regional collective activities is present. The results of the measurements are strikingly similar to those for Minneapolis – Saint Paul.

7.5 Frankfurt am Main – Wiesbaden – Mainz

7.5.1 Context

In a publication entitled Randstad Internationaal (Ministerie van VROM, 1991), in which the Randstad Holland is compared with a number of other metropolitan areas in Europe, the region designated as Frankfurt am Main – Wiesbaden – Mainz is not classified as a multinodal region. This is surprising, in view of the spatial similarity with the Randstad, which is considered to be multinodal – specifically because it spans four medium-sized cities. In a functional sense, the classification of the German region would appear to be accurate. Obviously, Frankfurt a.M. is the dominant city in the region, a characteristic that cannot be ascribed to any of the cities in the Randstad. However, another statement made in the same report, that Frankfurt a.M. has a nodal structure, warrants some further elaboration. It is true that the central area of Frankfurt a.M. is highly developed. But it should also be noted that developments have also taken place on the urban fringe that suggest at least some degree of multinodality.

The cities in the region differ greatly from one another. Mainz is the capital of the federal state of Rheinland-Pfalz and is thus administratively separated from Wiesbaden and Frankfurt a.M., both of which lie in the federal state of Hessen. Wiesbaden is the capital of Hessen. The differences among these cities have become more pronounced over the past 50 years, primarily because of the development of Frankfurt a.M. In the period after World War II, Frankfurt a.M. developed its manufacturing base (especially automotive and chemical industries). Over the past two decades, the development took a different direction. Frankfurt a.M. is now one of Europe's main financial centers, with the highly developed service sector associated with that status. Its location at the hub of several major European transport axes – the north-south highway running from Scandinavia to Italy; numerous rail connections; the River Main, which in the meantime has become the link between the River Rhine and the Danube; and the second-largest airport in Europe – are, of course, factors that have made the position of Frankfurt even stronger. Wiesbaden is known as a spa and as the center of the wine-growing region of the Moselle and the Rhine. Neither industrialization nor the emergence of the tertiary or quaternary sectors have had much impact here. The same applies to Mainz, which owes its fame to its historical role: it is the seat of the archbishop, the site of a romanesque cathedral, and (presumably) the place where the printing press was invented. All in all, there seems to be no doubt that Frankfurt a.M. is definitely the central city of the region.

Figure 7.15 Position of Frankfurt am Main in Germany

To recount the history of the cities in this region, it is necessary to look deeper into the past than for the previous cases. Mainz was known as a fortified Roman outpost (Mogontiacum), obviously due to its strategic location on the River Rhine. After the German revolt, Mainz was made the capital of Germania Superior. Far into the middle ages, Mainz remained an important European city. The consolidation of the power of the church in Mainz and the role of the city as a center of art and culture till deep into the 18th century reinforced that status. Changing power relations in Europe in general and in Germany in particular have gradually undermined the position of Mainz. Wiesbaden owes its existence to the mineral springs – and so does Bad Homburg to the north of Frankfurt. The Romans had established baths at a place they called Aquae Mattiacae, which later became a spa for Europe's nobility. The local amenities were also an important reason to designate the city as the capital of the federal state of Hessen, following the fall of Prussia when the Weimar Republic was created.

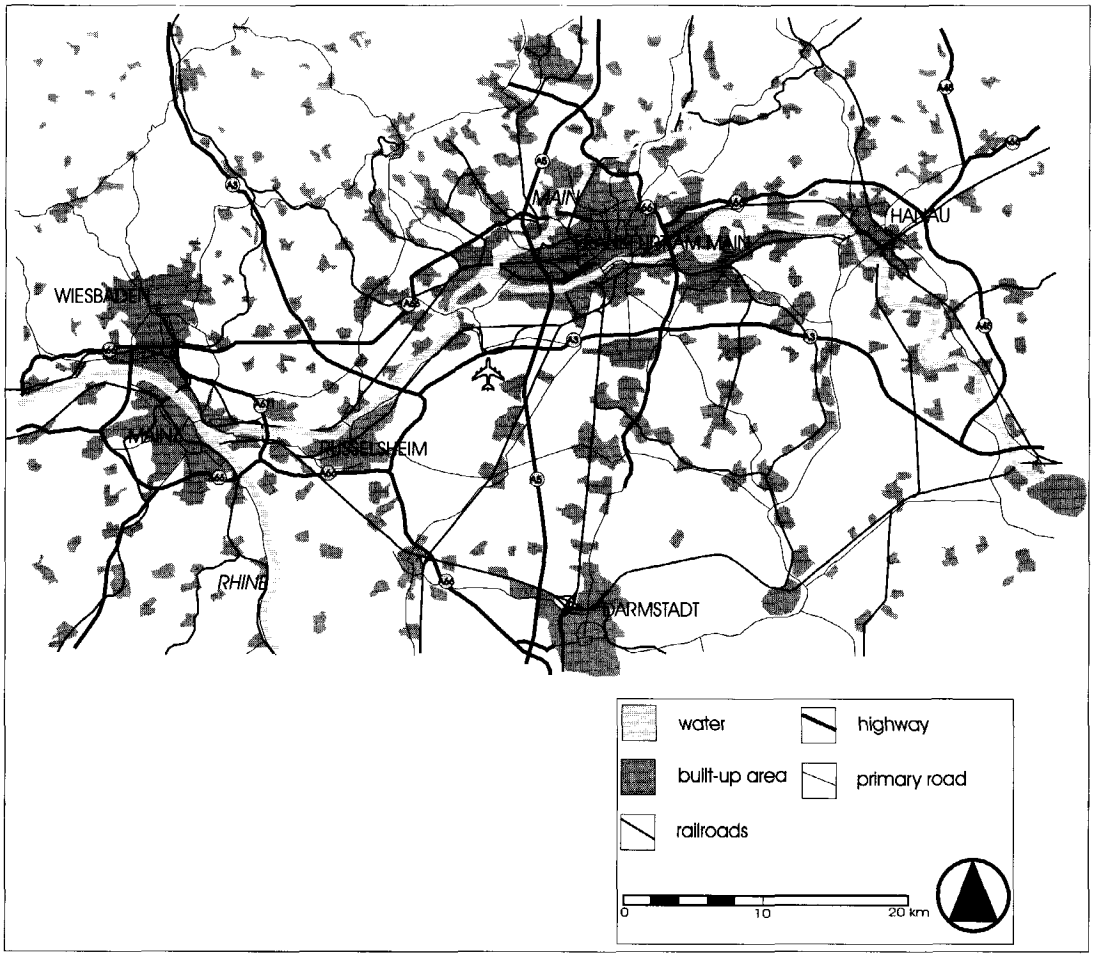
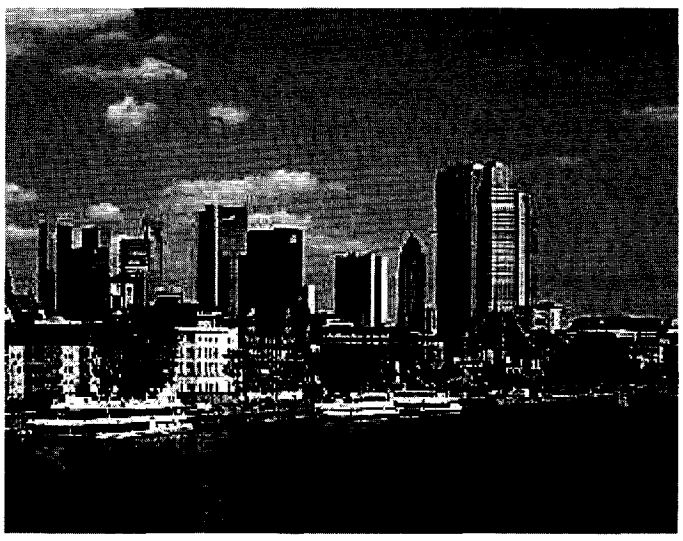


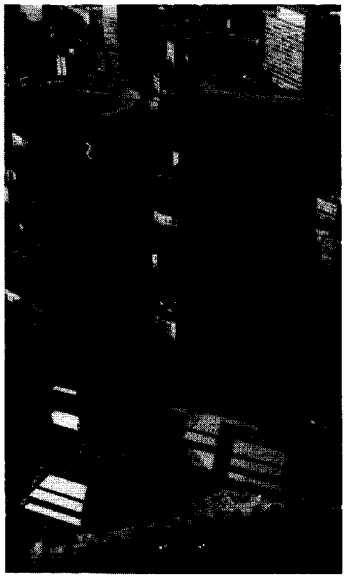
Figure 7.16
Frankfurt am Main – Wiesbaden – Mainz, 1995

Previously, the role of capital city had been performed by Darmstadt, which lies to the south of Frankfurt, when Hessen was separated by Prussian territories. Frankfurt a.M. was also founded as a Roman settlement, albeit a considerably more modest one than Mainz. In fact, the real boundary between the Roman Empire and Germania ran along the River Rhine in this area. Frankfurt was more or less an advance outpost for the army. Actually, the foundations for the position of Frankfurt were only laid around 500 A.D., at the beginnings of the Frankish Empire. When the empire was founded, the settlement called Franconofurt was a place on the border with Alamannia, and it was soon annexed by the Franks. After the Frankish Empire was split up in 843 A.D., Frankfurt occupied a central position in this part of the empire. The good connections by water along the shore of the River Main and in combination with the location on important trade routes, brought rapid growth to the city. Starting in the year 1147, the German kings were crowned in Frankfurt. After the German Empire was declared, Frankfurt was even the imperial capital, from 1372 to 1706. With the end of the Thirty Years War, and the signing of the Treaty of Munster in 1648, the empire gradually broke up into smaller

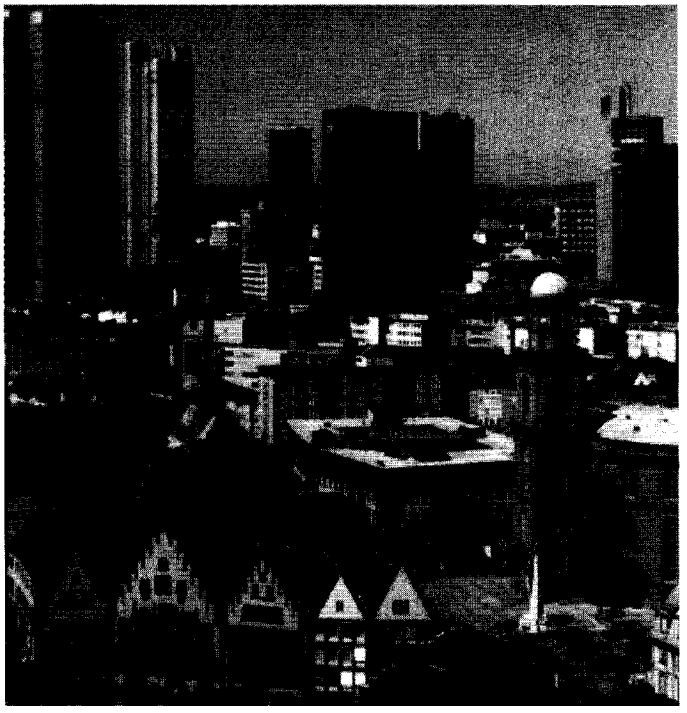


Frankfurt am Main

states. In 1806, the German Alliance was established under Napoleon. Prussia did not join and started the uprising against Napoleon, later together with Russia. When France capitulated in 1815, the first free meeting of the German Alliance was held in Frankfurt, which at that time had 47,000 inhabitants. As the seat of government, and the place where the first 'nationalversammelung' (the former german congress) of the federation was held in 1848, Frankfurt's population grew to more than 90,000 inhabitants (the Northern German city of Hamburg already had 300,000 inhabitants at that time). Dissent among the Prussians about the federation gave rise to the Prussian War (1866-1971) and to the founding of the German Empire under Wilhelm I and Chancellor Bismark. At that point, Frankfurt lost for good its role as seat of government. (This historical sketch was based on Meyers (1911) and Schomann (1996).)
In the disarray of the many boundary adjustments in Germany, Frankfurt had quietly continued to develop into a financial center, particularly due to the presence of the Rothschild family, who had lived there since the 18th century. As bankers of Frankfurt, they provided more and more financing for Germany's trade and industry. In the twentieth century, the large-scale financial sector and the services affiliated with that it have been an important factor in the development of Frankfurt by founding the university (1914) and the Max Planck Institute as well as diverse theaters and museums such as the Schenkenberg Museum of National History and the Jahrhunderthalle, the last thanks to Hoechst A.G. (Maitek, 1980).



German Bank



'Mainhattan'

Frankfurt incurred severe damage from the bombardments that took place at the end of World War II. Virtually the entire historic inner city was destroyed. In contrast to the situation of Rotterdam, as discussed earlier, where a whole new city center was built, the medieval center of Frankfurt has been reconstructed, as much as possible.

The region enjoys a pleasant continental climate. In the winter, the temperature does not usually drop below freezing, while the summers are warm, with temperatures rising to about 35 degrees Celsius. The landscape is dominated by the Taunus Range, to the north of the valley of the Main, and its extension the Hunsrück, to the west of the Rhine valley. These are medium-sized mountains, up to about 800 meters in altitude. The Odenwald and the Spessart, which are dense evergreen and deciduous forests, dominate the landscape to the south and east of Frankfurt. Then, of course, the flat valleys of the River Rhine and the River Main are characteristic features of the landscape.

In the spatial organization of the region, Frankfurt a.M. may be distinguished as the biggest center, followed by Mainz, Wiesbaden, Darmstadt, and Hanau as mid-sized

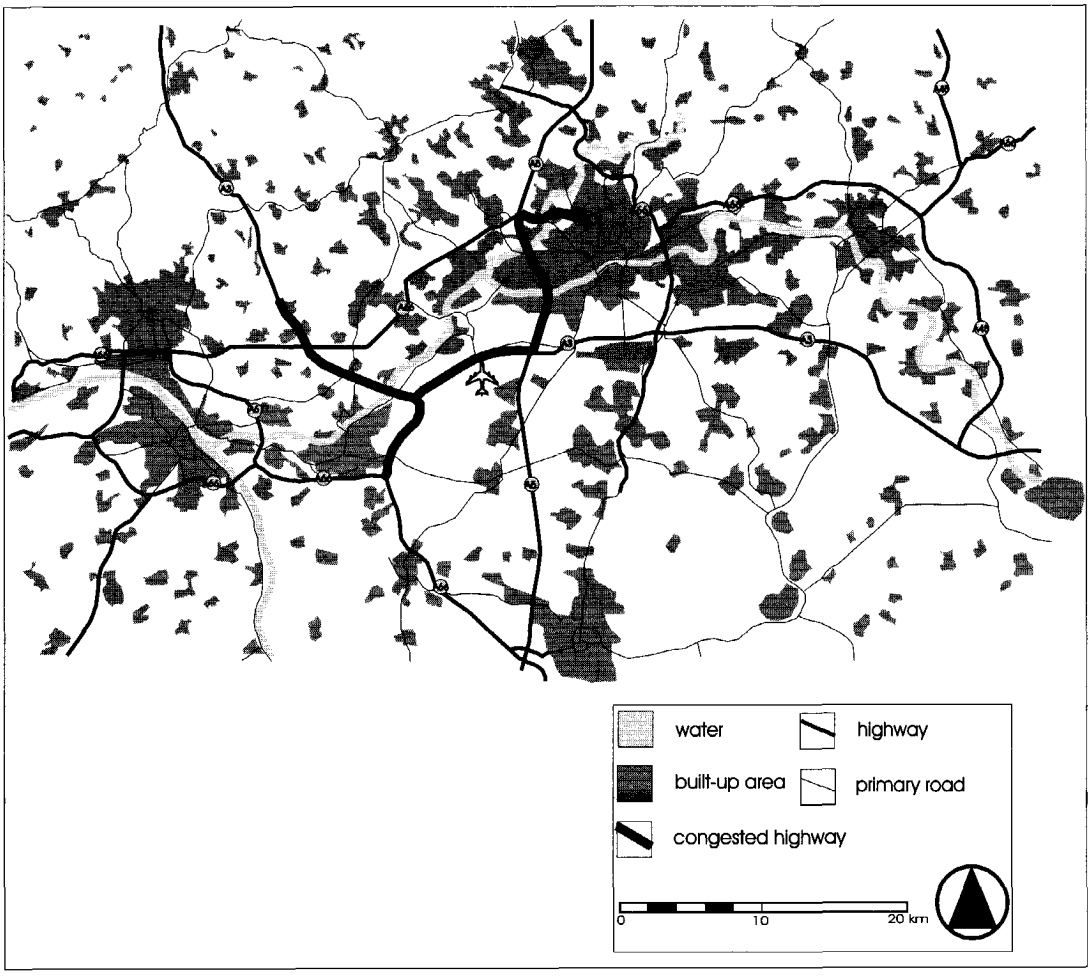


Figure 7.17
Frankfurt am Main – Wiesbaden – Mainz, congested highways

cities. Then there are widely dispersed smaller settlements, both in the river valleys and in the mountainous areas. The image of Mainz and Wiesbaden is strongly determined by their historic inner cities. Frankfurt, in contrast, combines slender towers (thus the nickname 'Mainhattan') with the scale of the medieval inner city, where the city planning of the 1970s has left scars that are still visible. In particular, the region's railway infrastructure is strongly oriented toward Frankfurt. With an extensive network of bus, tram, metro, and regional trains, the entire region has good access to the center of Frankfurt. In fact, it would be more appropriate to see Mainz, Wiesbaden, and all other cities in the region as suburbs of Frankfurt in a nodal region than as equal, competing, or complementary centers in a multinodal region.
Upon further examination of the way the region is organized, it proves that the center of Frankfurt is the leader on all fronts. Along the city's edge, there are some concentrations of offices, which incidentally are no less impressive than developments seen elsewhere, such as in the South Wing of the Randstad or in the American cases.

The center of Frankfurt a.M. is by far the most important concentration of activities in the region. If only in terms of the large number of jobs (475,000) in the municipality and the number of commuters (258,000) this entails, the city clearly deserves that position. But there are also other ways to confirm the importance of the center of Frankfurt: the number of visitors to the city's trade fairs (1,500,000) and to its museums and cultural facilities (1,200,000) (Amt für Statistik, 1995). On the basis of the traffic flows in the Rhine-Main region, it is clear that the inner cities of Mainz, Wiesbaden, and Darmstadt only play a role at the local level (Frankfurter Verkehrs Verein, Statistik 1993). Other concentrations of employment worth mentioning that do play a role at the regional level are the airport, the industrial and office estates near Frankfurt Nordwestkreuz, near Fechenheim/Oberrad,

and near Niederrad as well as the industrial complexes of Hoechst A.G. and Opel A.G. (General Motors) along the River Main. The airport, Nordwestkreuz, and Fechenheim are areas that have started to develop rapidly during the last five years. Niederrad is an office estate dating from the 1970s and 1980s where the growth has come to a standstill. The significance of the industrial complexes should not be underestimated in the region. In Frankfurt itself, the manufacturing sector, after services (25.1 percent), accounts for the largest share in the labor market: 18.8 percent of the jobs. The banking and insurance sector takes third place, at 14.4 percent (Amt für Statistik, 1995). With regard to the accessibility analysis, it should be kept in mind that traditional location factors for industry – in this case, the River Main and the railroads for freight transport – are of decisive importance.

As mentioned above, Frankfurt has many museums and other cultural facilities. The strong concentration of these institutions in the center of Frankfurt is remarkable. The dominant position of the core shopping area is equally striking. With the exception of the center of Frankfurt, the region has no shopping centers that play a role of any significance. Similarly, other places –even the historic inner cities of Wiesbaden and Mainz, and the recently opened TaunusZentrum, which lies to the northwest of the city center near the beltway – prove to serve only a local function (Amt für Statistik, 1995).

	Number of inhabitants:
Frankfurt a.M	652,412
Wiesbaden	222,081
Darmstadt	139,063
Offenbach a.M.	116,482
Landkreise Reg. Bez. Darmstadt (Darmstadt Regional District)	3,669,956
Mainz	189,070
Landkreise Reg. Bez. Mainz	741,314
Total Rhine-Main Region	4,411,270

(Source: Hessischer Statistisches Landesamt, 1994; Statistischer Landesamt Rheinland-Pfalz, 1994)

The above table shows that a large share of the population of the region resides mainly in the 'countryside'. Compared to the South Wing, where the countryside has been deliberately kept 'empty', this region has dozens of settlements, ranging in size from 5,000 to 30,000 inhabitants. Virtually every settlement has a direct rail connection with Frankfurt a.M., Mainz, or Wiesbaden.

Construction started on highways through the region back in 1934. Despite this early initiative – early by European standards – the highway network has remained modest in size. To a large extent, the highways play a role for the traffic between Northern Europe and Southern Europe. The network of secondary roads is essential for access to the rural areas in particular. Even before the automobile became number one in the field of transport, Frankfurt was already a major railway hub, serving both the national rail network as well as the regional lines. In that respect, the train performs yet another important role in daily mobility. The first metro was opened in 1968. Since then, the metro system has been extended greatly, to a total of seven lines and 81 linear kilometers of track (Amt für Statistik, 1995).

In numerous ways, spatial planning in Frankfurt a.M. resembles that of the South Wing of the Randstad both in their role and their significance. Just as in the Netherlands, planning in Germany at the national scale works with a generalized image of the desired outcomes (Bundesministerium, 1993). The long-term policy is couched in such general spatial concepts. At the level of the various federal states (Bundesl‰nder), plans are made to form a spatial framework for bigger projects such as nature development, major infrastructure, or large urban extension areas. Especially in the metropolitan areas, it is common to actively apply urban concepts in order to determine which spatial development will be the most desirable in the long run. It is these integral plans in particular that are fixed in an administrative framework and thus provide guidance for the formulation of land-use plans, which are binding at the local level. These local-level plans clearly specify which kind of activity will be permitted at which location. In this sense, the range of instruments is just as extensive as the tools applied in the Netherlands. The influence of the integral plans and the urban concepts mentioned here upon the development of the city shows up clearly in the plans for Frankfurt drawn up by Ernst May. Appointed in 1925, May designed the urban extension plan for Frankfurt in 1929 along the lines of a satellite model and a greenbelt encompassing the area that was already built up. In making up this plan, May drew inspiration from the

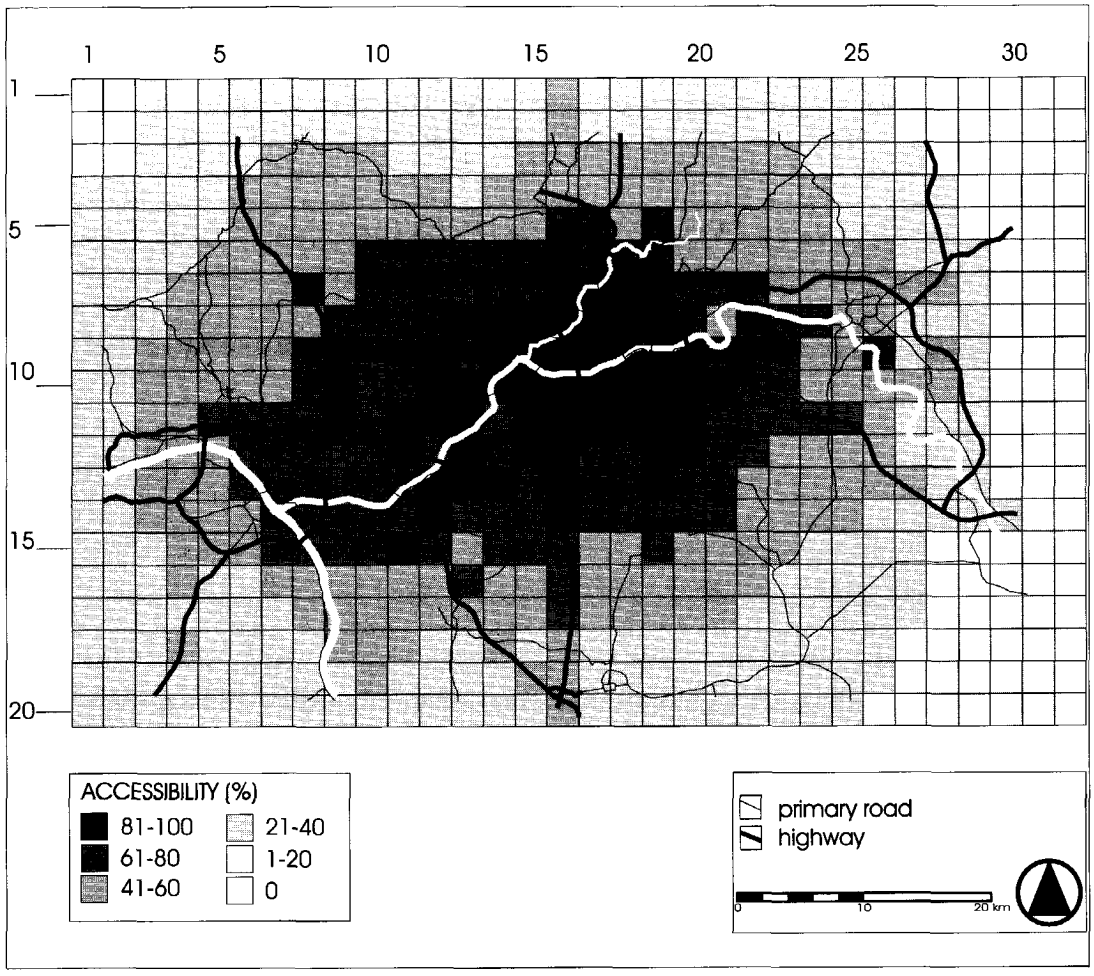


Figure 7.18
Frankfurt am Main – Wiesbaden – Mainz, accessibility analysis

Garden City movement emanating from the work of Howard and Unwin (Hoek, 1995). Even today, work continues on the elaboration of that concept, particularly with regard to the greenbelt (Grungürtel). The plan for Frankfurt is strongly oriented towards the city center, specifically, through the numerous radial connections of the metro lines and the rail connections. In that respect, that plan appears to have made a positive contribution to the development of the city center. One major difference between that plan for Frankfurt and the old plans for both The Hague and Rotterdam concerns the phasing of the development. In Frankfurt, the rail and tram network, and later the metro, were put in at the same time as the urban development took place. In the Netherlands, in contrast, the tram lines (an other urban rail connections) were put in after urbanization was already an established fact.

The intentions with respect to spatial development in the region are modest. Any extensions would be limited by the natural surroundings. The program set forth in the current plans is mainly to reinforce and improve the inner cities and the allow a limited degree of development of areas on the edge of the city, in many instances as a kind of catchment area for businesses that are pushed out of the center (MURL, 1993; Rautenstrauch, 1990). The degree of cooperation among the large cities with respect to concrete plans or proposals is weak, however (Stiens, 1995)

7.5.2 Accessibility Analysis

Public transport plays a considerable role in the region. In Frankfurt, the metro alone carries approximately 92 million people (Stadtwerke Frankfurt, 1997). The number of trains arriving and departing from the main railroad station in Frankfurt also gives an indication of the important role of public transport: there are 1650 trains arriving or leaving per day (Deutsche Bahn A.G., 1996). Nonetheless, the automobile proves to be the most important mode of transport in the region, even

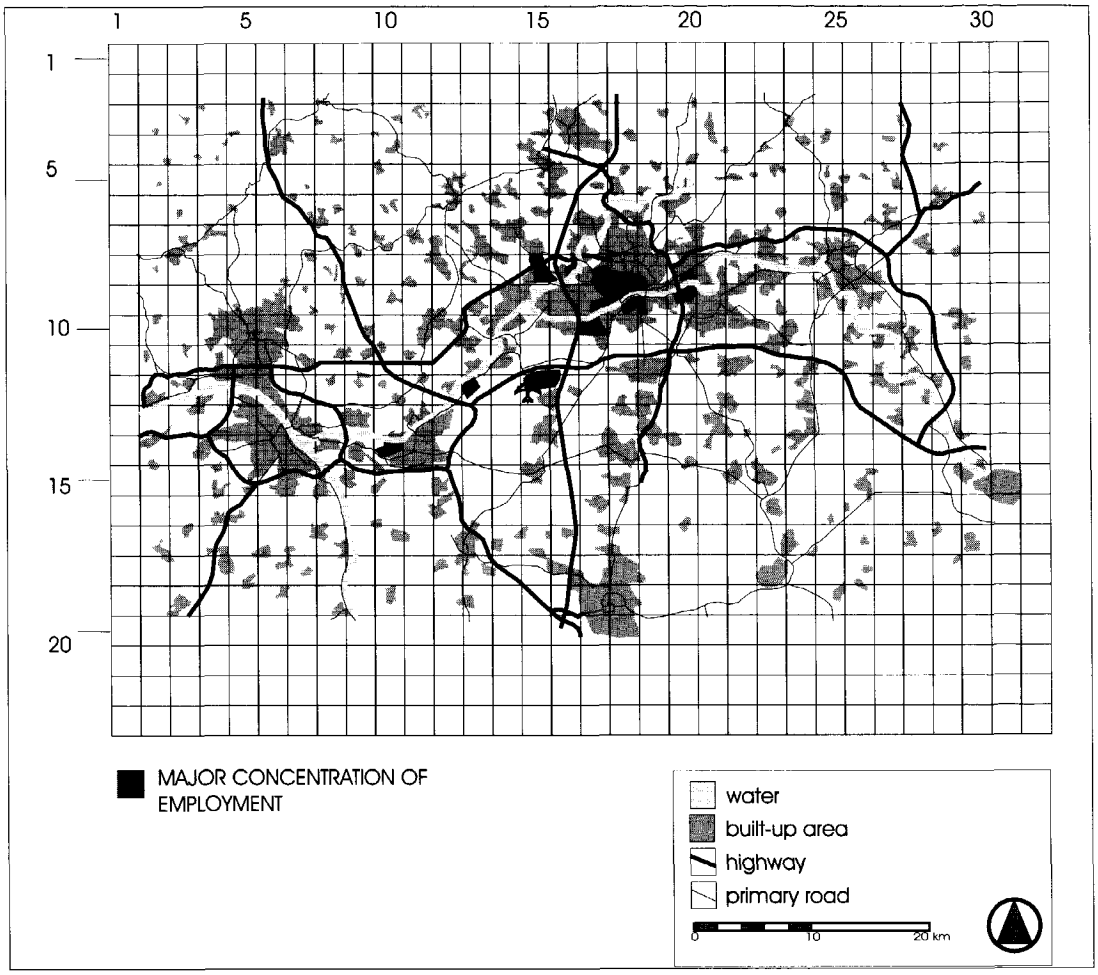


Figure 7.19
Distribution of employment
(source: Ambt fur Statistik, Wahlen und Einwohnerwesen, 1995, Frankfurt am Main)

for trips into the center of Frankfurt (Frankfurter Verkehrsverbund, 1995; Hessischer Statistischer Landesamt: Verkehrsstatistik, 1995). In this study, therefore, the automobile is taken as the basis for the calculation of accessibility values. Here too, a distinction is made between different kinds of roads: highways and main highways; city roads and roads outside the built-up area. Congestion leading to delays of at least 15 minutes occur on the A3 in the direction of Frankfurt, whereby lengthy construction work near the airport is a key factor, and on the A6 to the west of Frankfurt (Frankfurter Verkehrsverbund, 1996).

The calculations for the accessibility value were based an average driving speed of 70 kilometers per hour for the highways and 40 kilometers per hour for the other roads. Figure 7.18 shows the results of the calculations. The areas with an accessibility value higher than 80 percent are mainly found in Frankfurt a.M. and specifically within and along the 'diamond' of highways. The area lying in between the urban concentrations, largely along the highways, also has zones with a value higher than 80 percent. The relatively low values for the cities of Wiesbaden, Mainz, and Darmstadt are striking. The large difference with respect to Frankfurt is determined by the dispersal pattern of the settlements, whereby Frankfurt lies in the middle, as well as by the network of roads, which are oriented more towards Frankfurt than towards the other cities. In view of the measured values for accessibility, it is fair to say that the Frankfurt region might possibly have a multinodal structure, but that the second category of cities in this region have no part in any such structure.

Figure 7.19 shows the distribution of employment, with the following characteristic elements: downtown Frankfurt; the zone near the airport; the highway locations of Niederrad, Nordwestkreuz, and Fechenheim; and two locations on the River Main, namely the sites where Hoechst A.G. and Opel A.G.

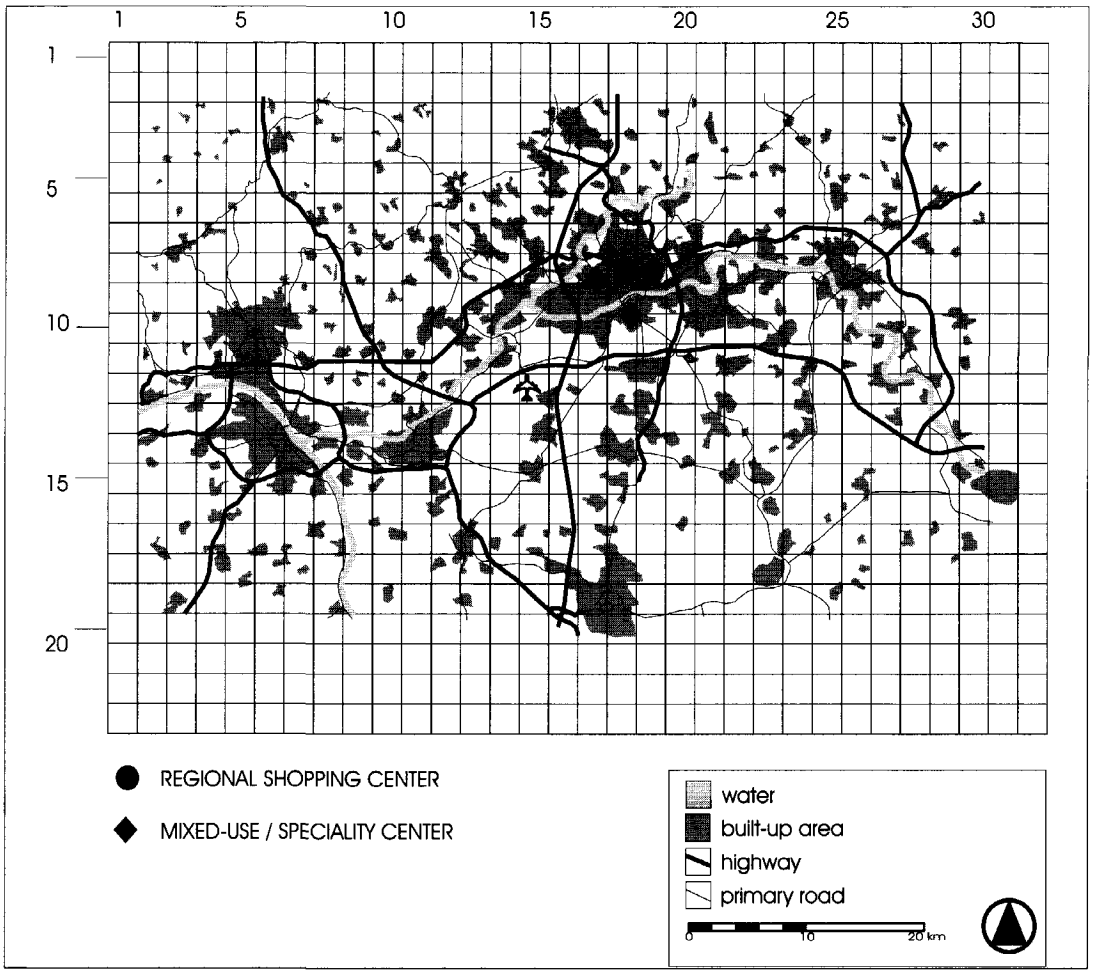


Figure 7.20 Distribution of urban and regional facilities
(source: Ambt fur Statistik, Wahlen und Einwohnerwesen, 1995, Frankfurt am Main)

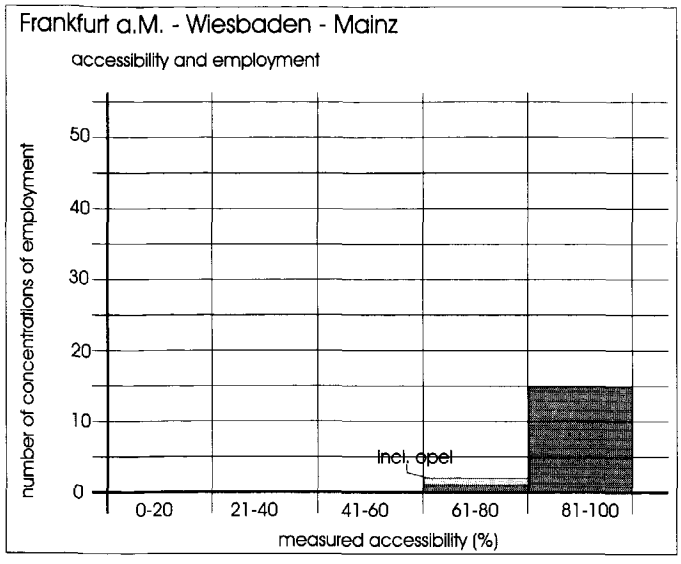
have their plants. These two companies are dependent on traditional location factors to meet their transport needs – specifically, on rail transport, for which extensive marshalling yards are present. For that reason, the analysis should not take these firms into account.

Table 7.11 shows the distribution of the concentrations of employment in the region of Frankfurt a.M. – Wiesbaden – Mainz in terms of the weighted accessibility figures. The table reveals that 94 percent of those employment concentrations are situated at a location for which the accessibility value is higher than 80 percent. In light of this high percentage, it may be concluded that the hypothesis referring to the conditional relation between accessibility and the distribution of employment is not rejected.

Figure 7.20 displays the distribution of urban and regional facilities within the region. The concentration in downtown Frankfurt is clearly visible in this diagram. All these concentrations of facilities lie at locations with an accessibility value of more than 80 percent.

Table 7.12 shows the distribution of the regional concentrations of facilities in terms of the weighted accessibility figures. As the table demonstrates, 100 percent of the concentrations of facilities are situated at a location for which the accessibility value is over 80 percent. Thus, the hypothesis remains unrefuted.

On the basis of the outcomes of the analysis of accessibility and the distribution of employment and facilities, it may be concluded that there is a conditional relation between accessibility and the functional structure in Frankfurt a.M. – Wiesbaden – Mainz. If the weighted accessibility of a location is more than 80 percent, then the necessary condition for the development of regional collective activities is present.



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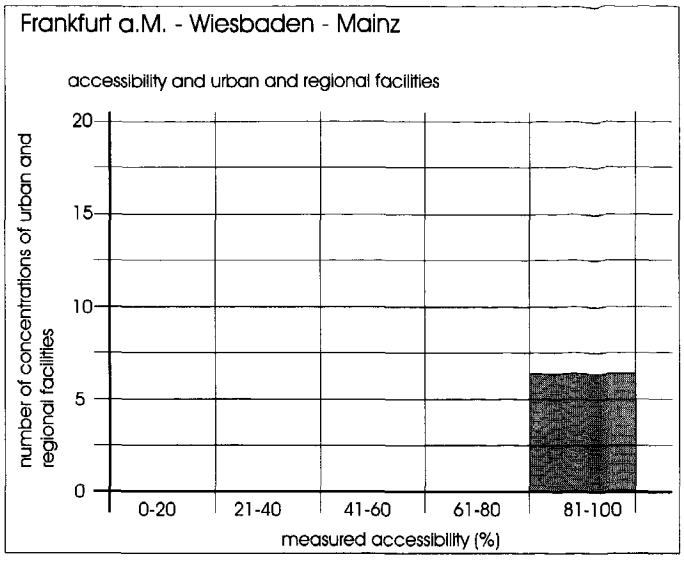


Table 7.12

7.6 Conclusions

The cases discussed above refer to four metropolitan areas. All are areas with a multinodal structure, varying from the strong concentrations of regional activities in Frankfurt to the enormous dispersal in Dallas – Fort Worth. Something that all of these areas have in common is that they are all subject to the process of conurbation formation, yet each one is in a different phase of that process. Minneapolis – Saint Paul has developed into a single urban system. In both Dallas and Frankfurt, on the other hand, the boundaries of the region do not yet appear to be fully part of the urban system. And interference seems to be the prevalent process in the South Wing of the Randstad, where there are no signs of system formation at this point.

A typical characteristic of all these areas is that the chances for each of their inner cities within the area appear to be equal. Both Dallas and Fort Worth are wild-west cities. Frankfurt, Wiesbaden, and Mainz all have an inner city with cultural and historical qualities. Saint Paul and Minneapolis also have a past that is just about the same for each city. Only in the South Wing of the Randstad has some divergence occurred. This is due to the fact that Rotterdam made a fundamental choice to create a new city center after World War II. From the outcome of the analysis, it is clear that such similarities among the old established centers do not guarantee that the cities will develop in the same way. Centers that have better accessibility, including the new centers, overshadow the old centers in the various urban regions. Cities that once were internationally important, such as Mainz, are downgraded to an outlying town in a metropolitan region, either because the accessibility is not as good there or because the accessibility has become better elsewhere.

The differences and similarities between Frankfurt and the South Wing are striking. There is hardly any difference in the extent or method of spatial planning. However, the underlying spatial concepts are very different. Frankfurt accepts the concept of dispersal (with respect to the small settlements in the region). In the South Wing of the Randstad, in contrast, there are secondary settlements of 40,000 to 150,000 inhabitants in addition to the main centers. Furthermore, Frankfurt has a center with high-quality facilities. In terms of the number of jobs, scope of the retail sector, and the size of various other facilities, the South Wing of the Randstad does not come up to the level of Frankfurt's center. Naturally, the size of the population plays a role in this case. In addition, Frankfurt has a much better developed network of roads. Its city center is well accessible by automobile (the accessibility value of the inner city is 100 percent). And all of the settlements in the surrounding area that are small – and thus dependent on the city – are directly connected to Frankfurt, both by road and by public transport. By comparison, the South Wing of the Randstad, with its under-organized network of roads and a few public transport lines to serve the

region, makes a poor showing. The investigation did not consider any possible effects of Frankfurt's public transport system on the functional structure. Nonetheless, in view of the fact that this form of accessibility is also mentioned among the location factors – albeit not as the most important one – it seems evident that public transport does play a role in the development of the functional structure.

	Accessibility and employment	Accessibility and shopping
Minneapolis – St.Paul	91%	92%
South Wing	59% (73%)[1]	67% (89%)[1]
Dallas – Ft. Worth	84%	90%
Frankfurt a.M.	94%	100%

(1) Results if the South Wing is considered to be two seperate urban systems.

When the results of the analysis are seen together, a high correlation shows up between accessibility and the functional structure. Among the cases studied, only the South Wing of the Randstad has low scores. A number of factors contribute to these outcomes for the South Wing. Unlike the other cases, the South Wing does not yet constitute an urban system; instead, it consists of two interfering urban systems. Upon closer examination of each of these urban systems separately, however, the score is still low. The explanation might lie in the extent of planning or perhaps in the cultural and historical qualities of the individual areas. It is evident that the Frankfurt region, in light of its past, can boast of more history than the South Wing. And because accessibility is the decisive factor in Frankfurt, the city's cultural and historical aspects cannot be put forward as a possible explanation. Furthermore, these two areas are about equal with respect to the extent of planning. Two differences should be noted, however. The city region of Frankfurt a.M. (as part of the region) has been developed along the lines of a radial model of urban design. All roads lead to Frankfurt. Furthermore, the landscape offers few alternatives for new infrastructure or large-scale urbanization. In contrast, there was no model for the development of the South Wing. It was not until the 1970s that the development of each of the constituent cities was subjected to the activities of urban design at the regional scale, and then only for a short time. Rather, the development of the South Wing has been guided by spatial concepts such as concentrated deconcentration, which refers the policy of growth centers, and currently the compact city. Concepts such as these have become the basis for national policy and thus should be seen as separate from the spatial reality of the cities. Unlike the situation in Frankfurt, the South Wing might be subject to exogenous concepts – that is, not indigenous to the region – that are imposed on the city and fit like a straitjacket. The result is manifest in the larger settlements surrounding the cities – Zoetermeer, Spijkenisse, Capelle aan de IJssel – in contrast to the small and dispersed settlements around Frankfurt. It is precisely for this reason that sites along the highways have a considerably higher accessibility value, while the policy does not allow that potential to be utilized. The older centers are given priority, whereas the spatial conditions for that development have never been realized. In other words, the planning in the South Wing may be said to create opportunities, only to subsequently prohibit activities that would make use of them, while steering such activities to areas where the necessary conditions are not present.

The theory focuses on a single determining factor, namely accessibility. The literature indicates that this factor is the most important of the spatial conditions, which means that for the most part, other factors do not have to be taken into account. This is true with respect to Dallas, Minneapolis, and Frankfurt. The outcome of the analysis of these areas supports the proposition that a correlation exists between accessibility as a condition and the functional structure. With respect to the South Wing, it must be concluded that spatial planning plays a considerable role. As a consequence of the limitations that apply here, those locations where the accessibility value is high enough (over 89 percent) are not allowed to be utilized in many instances. Further research on the advantages of the policy being pursued, on the effectiveness of spatial planning, but also on how the restrictions affect companies and institutions is recommended, in any event. At the same time, there is also a need to explore the application of spatial concepts that might be more appropriate to the urban areas in question, instead of applying the general concepts that are currently in use at the national level.

Notes

1.
Chapter 5 gives a description of Minneapolis – Saint Paul.

2.
Some examples of professional jobs are teachers, scientists, mathematicians, doctors and registered nurses, lawyers, and writers. Some examples of technical jobs are technicians, drafters, air-traffic controllers, and licensed practical nurses.

3.
As the Design Center for American Urban Landscape, at the College of Architecture and Landscape Architecture of the University of Minnesota, shows in the case study "Building Community Across the Corridor" (Bonsignore, 1992) how landscape elements can be used to achieve a concentration of employment at the local level.

4.
The employment shown here consists of jobs in the tertiary and quaternary sectors.

5.
In 1905, 3M – a small firm close to bankruptcy at the time – was taken over by L.P. Ordway. Afterwards, the company expanded to its current status as a multinational corporation.

6.
The IKEA concern won a court case in 1990 and was thereby granted permission to open up a store at a peripheral location near Delft. As a consequence of that court decision, legislation on large-scale retail trade picked up momentum (Gantvoort and Guyt, 1996).

7.
In an outline plan, the desired spatial development for the whole city is prescribed for the medium term. The legal implications of such a plan are limited. The regional plan, which is drafted by the provincial government, serves as an evaluation framework for the local land-use plans.

8.
The employment referred to here is in the tertiary and quaternary sector.

9.
The term Metroplex is introduces by Meltzer (1984) for overlapping urban structures.

10.
Bureau of Economics Analysis ES-202 files.

11.
Bureau of the Census, Census of Population and Housing, 1990, nine-county CSMA.

12.
This figure does not include taxis or airport transportation (mini vans).

"If you pick up all of the literature on cities, every one of them has the model with one downtown. Where all the tall buildings were. Where people lived close to work and where there was this street life and it's Hudson Street or something. Most of the discussion about cities is still imbued or infected or infested with that kind of thinking. Therefore it's very difficult to come to terms with the reality of a place like Dallas."
(Joel Garreau, 1991)

8.1 Introduction

The foregoing chapters have offered some insight into the relation between accessibility and the functional structure of the urban system. In the course of that discussion, it has been demonstrated that there is indeed a conditional relation whereby a location with an accessibility value that is greater or equal to a specified threshold value is shown to provide the necessary condition for the siting of regional (as well as supra-regional) activities. Furthermore, the previous chapters have examined the process of change that is taking place in multicentered areas. As the study of those areas reveals, this process is driven by the changes in accessibility, particularly by the difference in accessibility from one location to another.

In Chapter 2, it was pointed out that in order to put together a set of instruments that can be applied in the practice of urban design, it is crucial to understand how functional structures – specifically multinodal structures – develop. In that context, it was noted that investigative design lays the foundation for the development of those instruments. In the course of investigative design, theoretical models of structure – that is, models that lead to generalizations on the functional structure in relation to the spatial pattern – are taken as the starting point. The fact that other means and methods exist alongside these models is clearly evident in the numerous books that have been written on the practice of urban design. The choice to focus this study on designing by way of theoretical models of structure was made for two reasons. The first concerns content and is self-evident: this method responds directly to the allocation of a place for specific activities (and thus refers to the functional structure). The second reason is a pragmatic one: if we are destined to stand on the shoulders of giants, we might just as well choose the giant we know best. This does not mean those shoulders are the most reliable ones, however. One's preferred method is not necessarily the best or the most reliable one from a scientific standpoint. An extensive review of the practice of urban design and the various methods used in that field – placed against the backdrop of the scientific underpinnings of the field – is still seen as a limitation in that respect. The work of Klaasen and Witberg (1993) and the studies by De Jong (1992) on the practice of urban design are still seen as pioneering from that perspective. Nonetheless, that literature does not yet offer enough of an overview or adequate grounds on which to judge the various methods. The pragmatic choice in favor of designing on the basis of functional structures does, of course, call for confirmation that the shoulders on which we stand are strong enough to support our efforts. For that reason, this chapter examines that method in greater depth. That discussion leads to a test of various interventions at an abstract level. Afterwards, this chapter analyzes a test in a concrete situation. The result is a series of interventions and possible effects that can be applied in the practice of urban design.

Up to this point, accessibility has been the main ingredient in this investigation. In Chapter 3 in particular, it was pointed out that accessibility has played a critical role in the development of cities for centuries. The present study does not make a hard claim that accessibility will remain an important factor, even though there is a strong suspicion that it will. Specifically, the rise of information technology and the countless new possibilities the IT revolution has engendered – along with the increasing significance of information as an economic factor – has prompted the decision to explore some facets of investigative design.

It should be noted that the core activity of applied scientific research is not to indicate what will probably occur but to visualize various possibilities (Klaasen and Jacobs, 1999; De Jong, 1992). This has no bearing on the analyses and outcomes of the previous chapters. The essence of applied research is to discover which new possibilities may arise and which problems emerge in the process of urban design.

8.2 The Need to Simplify

De Jong (1981) distinguishes a large number of variables at different levels of scale. One could surmise that any change in the distribution of a specific variable at a given scale would affect other variables. The distribution can change because of concentration, deconcentration, and several intermediate forms thereof that De Jong has identified as relevant.[1] It is also possible to separate or combine variables in the dimension of time rather than space; for instance, think of the difference between an intersection with traffic lights (using time) and a traffic circle (using space). For the sake of the argument, let us leave aside the issue of what should really be understood by spatial design or spatial intervention (whereby design refers to the protocol for the intervention and the effect may or may not be specified; Klaasen and Witberg, 1993; Witberg, 1992). Then, to the extend that we endorse De Jong's proposition, the number of possible interventions is too large to develop a practical set of instruments or interventions. In a concrete situation, however, the series of variables can be used to determine whether all possibilities that are relevant at that location have been investigated. That investigation calls for a different approach to the issue, whereby a precondition is the simplification of the issue of design.

Urban design makes use of a simplified view of reality at different levels of scale in order to investigate spatial measures and their effects. This is also done in many instances in the present study. The map of a planning area that an urban designer uses is one example of such a reduction of reality. In that case, the legends indicate which reduction has been made. Any changes in the map can be used to assess interventions, either intuitively or analytically. If the intervention turns out to have the expected effect – and if this effect can be unambiguously ascribed to that intervention – then we may say that a relation exists between the intervention and the effect. Of course, that conclusion would only apply to the local situation.

Also at a higher level of abstraction, the urban designer works with simplified images of reality. Spatial elements may be relieved of their situation-specific context, allowing interventions to be tested for a more general application. One example would be studies on parceling out land. Aside from the question of how to deal with elements specific to a site, such as old trees or differences in relief, a parceling study can provide insight into the effect of building at greater or lesser density and into how the density of the built-up area relates to other spatial elements.
The same possibility is offered at the level of the city and the region by theoretical models of structure. These are models that express the spatial and functional structure. Compared to the parceling study, the theoretical model of structure could allow us to determine the relation between spreading and concentrating buildings at the regional level. For example, it could allow us to examine the possibilities for rapid transit. In this way, separate from the situation-specific context, interventions can be tested to determine their effect, whereby the aim would be to build up a systematic basis of knowledge that has a more general application. Empirical testing of the presumed relations between the intervention and its effects – or, for that matter, using empirical knowledge to test new relations – is an important part of the systematic development of knowledge in the field of urban design.[2]

8.3 Theoretical Models of Structure

The theoretical model of structure is a frequently used instrument in which the situation-specific context is left out in the process of reduction. The origin of this model may be traced in part to the end of the 19th century and the early years of the 20th. In that period, models of this type were commonly applied schematically to give direction to the major urban extension plans that were taking place. Of course, models had also been used before then. Spatial principles for developing a

settlement were used by the ancient Greeks, Romans, and Chinese as well as many other cultures (Lynch, 1981). Principles such as these are extremely interesting from a historical perspective. Yet because they are based on or responsive to daily spatial process such as those that took place in those cultures back then, they are not relevant to the present study. An essay on 'reconsidering the future' ("De toekomst bedacht" by Polman and Scholten, 1990) gives an overview of the development of models of the city and urban concepts.
Lynch (1991) indicates that the main inspiration for the development of structural models comes from the major issues of urbanization, in combination with the introduction of new modes of transport, namely rapid transit (the metro) and later the automobile. "A catalog of models of settlement form" (Lynch, 1991) mentions the star, the satellite, the linear city, and the grid city in consecutive order. It is questionable if the last principle is actually of the same order, however. The first three in the list are clearly relevant to the location of activities in connection with the urbanization pattern. The grid city, in contrast, refers only to relation of the road structure and the parcels of land lying in between. In that sense, the grid should not automatically be included among the structural models. In the Netherlands, Niek de Boer has taken up the task of turning general schematic types into elaborate theoretical models of structure.[3] Niek de Boer demonstrates the practical application of the models of structure in various plans (for Emmen, The Hague, and Deventer, for instance). His work in that area at Delft University of Technology has produced a series of theoretical models of structure that are presumed to be internally consistent (Jacobs, 1990). In other words, from the spatial conditions that may be derived from the structure of the whole, it must be possible to logically infer – based on the neccesary condition- the site of diverse activities. There is some risk in making such inferences, however. A number of principles have been developed on the grounds of a certain desired situation. Originally, the linear city was conceived to make maximum use of linear infrastructure, such as an existing railway or highway. In contrast, a model in the form of a star might indicate a presumed optimal utilization of rapid transit. Furthermore, the use of models may generate some noise, because when normative models are applied in practice, they tend to create their own legitimacy within a scientific framework. Theoretical models of structure, as we know them, can thus provide a framework for testing the effect of spatial interventions but will first have to be tested themselves for consistency.

8.4 Consistency in Models of Structure

Regarding the internally consistent models to which we referred above, the rules used to construct these models require that the model be free of contradictory statements. However, the analysis carried out in Chapters 5, 6, and 7 introduces another rule for these models. Accordingly, the analysis performed in Chapter 7 also has to be performed on the above-mentioned models. The models to be subjected to analysis are the satellite model, the finger-shaped model, the lobate model, and the network model. Essentially, the first three models in that list are the same with respect to their functional structure; they have a single main center and a nodal structure. The difference between the three refers to the spatial pattern as well as to the way in which the supra-regional infrastructure is linked to the urban infrastructure. The urban network is not conceived as a hierarchy of centers; rather, it is presumed to have two or more centers of equal rank, which makes the network model a typical multinodal model.
The most important feature of the nodal (that is, the single nodal) models is that they are firmly based on the characteristics of both rapid transit and slow traffic (i.e., pedestrians and cyclists). A test for internal consistency in terms of accessibility on the basis of public transport as well as slow traffic, for instance, would most likely confirm the consistency of the models in that respect. The basis for the analysis, however, is accessibility in terms of a dominant role of automobile traffic. Furthermore, the infrastructure for automobile traffic that is indicated in the models is an answer that has been worked out and accepted over the years to the question of how to accommodate automobile traffic in the urban area. Confronting these models with the outcomes of the analysis in Chapter 7 is in that respect also a test of how well the proposed infrastructure for automobile traffic ties in with the functional structure. The structural models were constructed to reflect the ways in which the models differ from one another. With

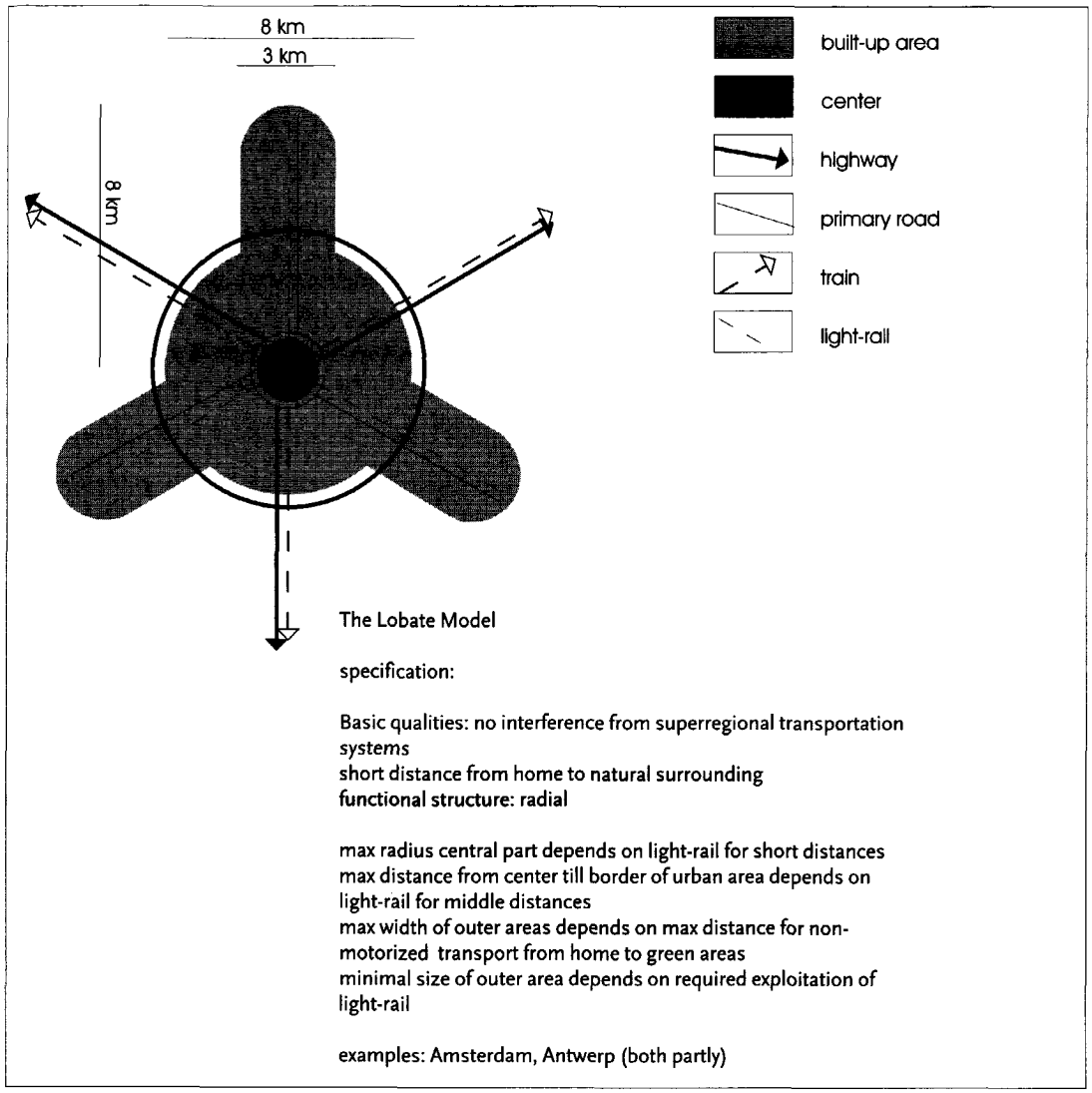


Figure 8.1
Lobate model

respect to the scale that is relevant to the calculations, the standards commonly applied in Northwest Europe were used. For instance, the models were based on the distances typical for public transport service and acceptable cycling distances in those countries. Obviously, use of a different scale would mean that the calculations could lead to different results. Of course, the difference would not be great in view of the fact that the calculation is performed on a grid of 500 by 500 meters.

The first model to be tested, the lobate model, has a radial structure (see Fig. 8.1). That means that there is a hierarchy of centers with only one center for the urban system as a whole. A consistent lobate model thus presumes that the accessibility criterion for the location activities at the urban and regional level will only be met at the site of the suggested center. In other words, only at this location the neccesary conditions will be met. Concretely, this means that the only place where the weighted accessibility value may reach 80 percent or more is the spot designated by the model as the center. However, on the basis of 'empty' surroundings, the analysis reveals that virtually the entire urban area has an accessibility value of 80 percent or more (see Fig. 8.2). Thus, the model cannot be considered consistent. A more differentiated picture emerges from the analysis of the model in an urbanized setting – whereby it is assumed that another urbanized area of roughly the same size can be reached within a distance of 40 kilometers. The intended center, the ring road, and the main radial highways are in that case potential locations for urban and regional activities. Amsterdam is an example of a lobate city where the lobes are comparable

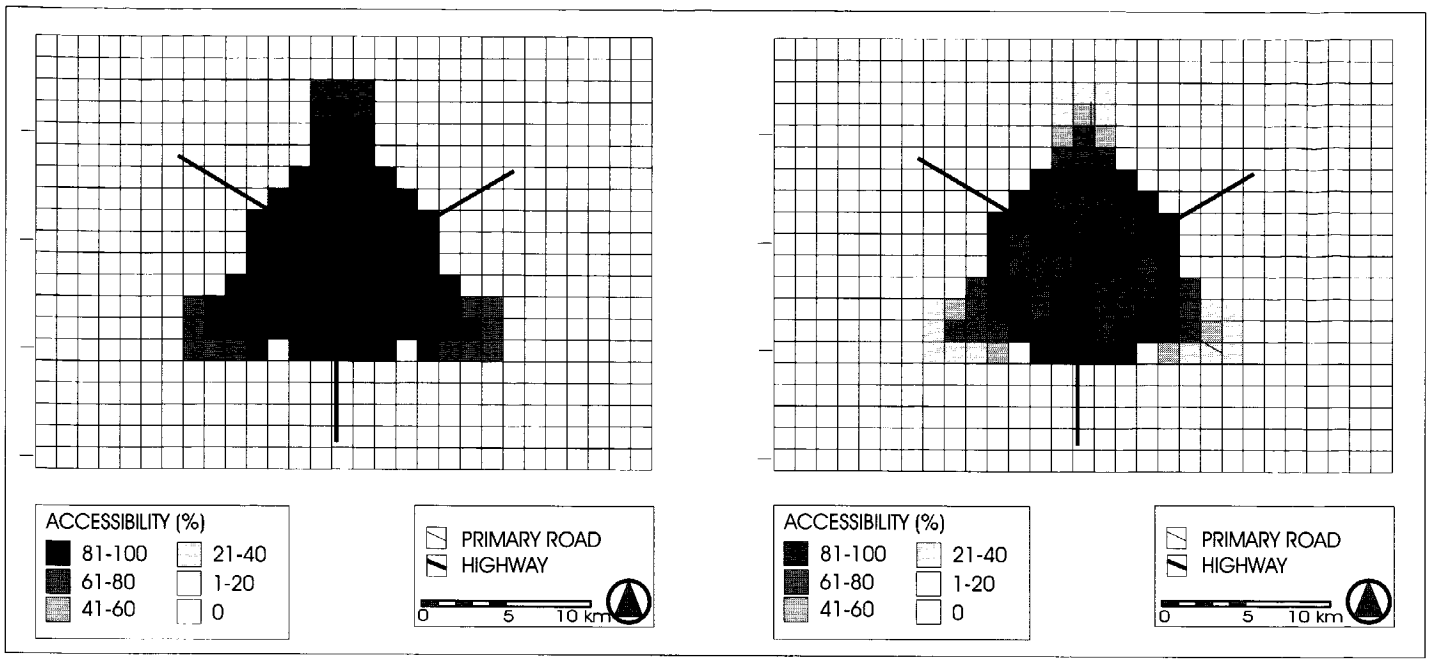


Figure 8.2 Analysis Lobate Model

in size. There, urban and regional activities are established at locations like these in accordance with the conclusions based on the specification of the model.

The finger-shaped model (see Fig. 8.3) is partially based on a prevalent urbanization process, namely urbanization running parallel to the infrastructure. The essence of the model – that is, rapid transit connections on the radial routes and short distances to the natural surroundings – and the radial structure are comparable to the characteristics of the lobate model. Based on the principle of urbanization along existing infrastructure,

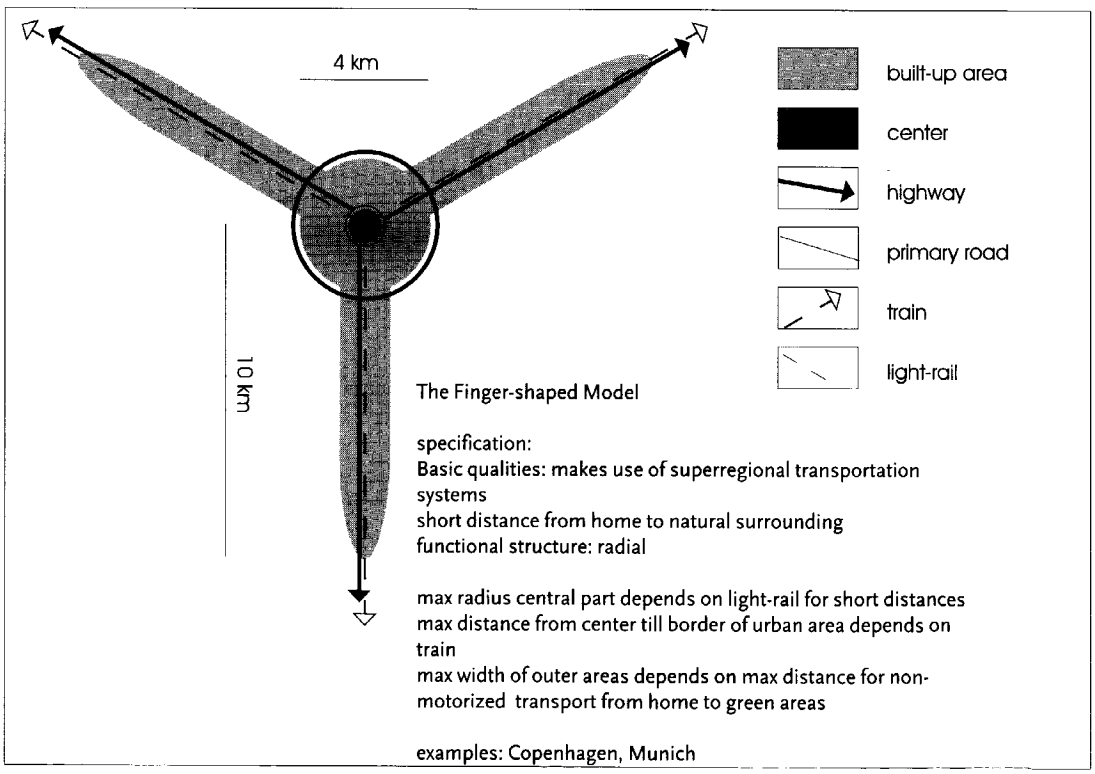


Figure 8.3
Finger-shaped model

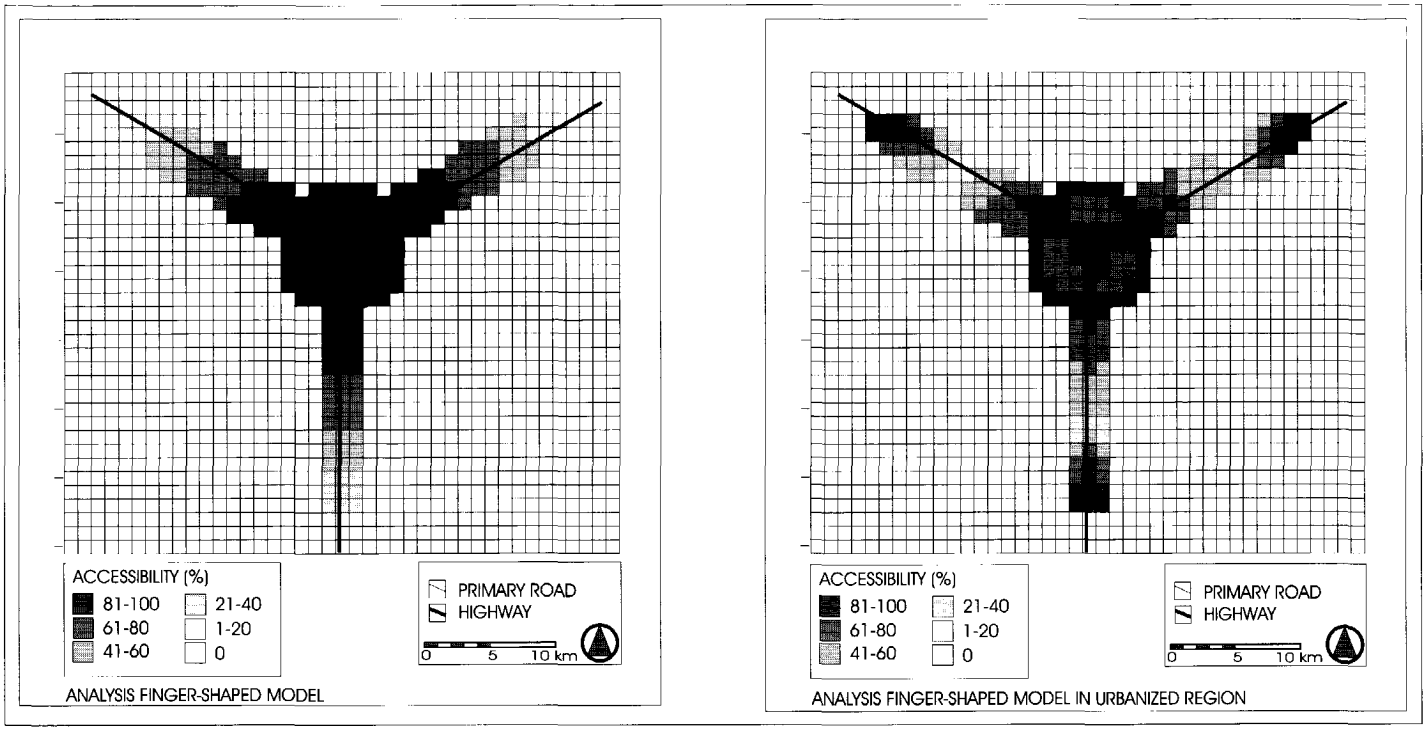


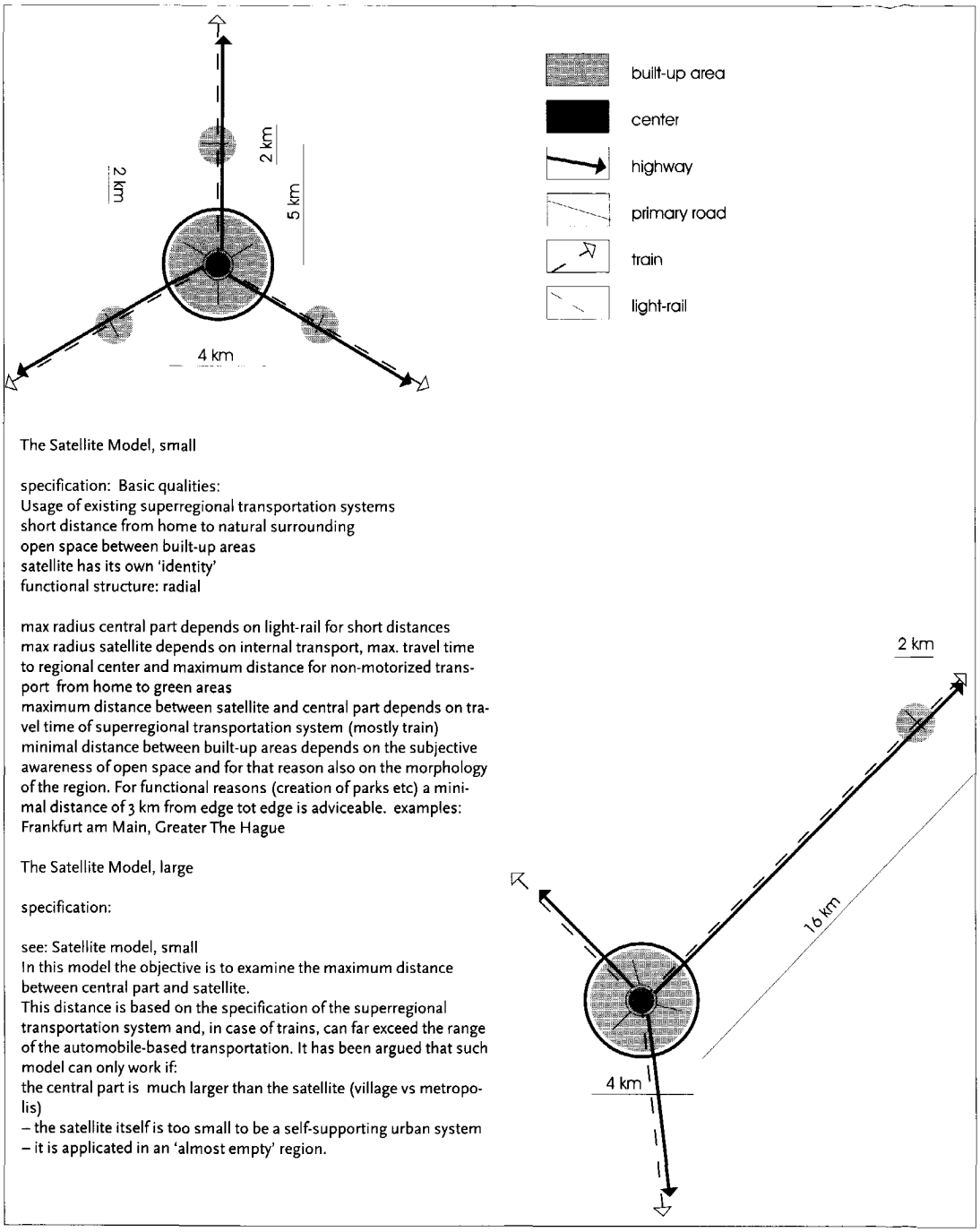
Figure 8.4 Analysis Finger-Shaped Model

this model lends itself to a trunk rail connection as the backbone of development. That is why the urban extension on the finger-shaped model is longer than the lobe-shaped extension according to the lobate model. The analysis of the model reveals that also in this case multiple locations meet the accessibility criterion and are thus suitable sites for urban and regional activities (see Fig. 8.4). Here too, the conclusion must be that the model is inconsistent in that respect. The analysis of the model in an urbanized area demonstrates that just as for the lobate model, the ring road, radial roads, and the intended center will be in principle the most important locations for urban and regional activities. A difference is that in this case the outer ends of the 'fingers' are also suitable sites because of the surroundings. Of course, it must be kept in mind that as the environment becomes increasingly built up, this effect will also become stronger.

The basic principle of the satellite model (see Fig. 8.5) is clear, but the elaboration in the form of a model that specifies distances at a theoretical level can only be sketched in indicative terms. The reason is that the distance between the core city and its satellite depends on public transport. This can be calculated for the tram, metro, train, and so forth, all of which would generate different models. The distance also depends on the degree to which an intervening landscape can be perceived. When the landscape is hilly, for instance, the distance as the crow flies may be short; in a flat open terrain, the distance may be great. It should be clear that an extreme model, such as the large model depicted here, can hardly be applied in a highly urbanized area. The analysis of the model shows that areas along the highway, the radial roads, and the intended center have an accessibility value of over 80 percent (see Fig. 8.6). Accordingly, they are potentially suitable locations for urban and regional activities. Thus, this model is inconsistent. The analysis of the model in an urbanized area even shows that the satellites actually benefit from this fact. Furthermore, it shows that only parts of the areas along the ring road score high, along with the radial highways crossing the area and the intended center area.

A major conclusion that may be drawn from the analysis of the three models is that more locations offer the neccesary condition for the situation of urban and regional activities than the respective models would suggest. Aside from the question whether or not it is

Figure 8.5
Satellite model



desirable to try to have just one main center, the models will have to be adapted if they are to play a role in the design of metropolitan areas.

The fourth model is a multinodal model. The underlying philosophy is that by making two or more centers complementary to each other, the problems that characterize large metropolitan areas can be avoided. This also offers an alternative to large-scale urbanization. There is no longer a single large urban area but a system of smaller cities with centers that complement one another. In the Netherlands, this is the underlying principle for the development of the Randstad Holland. In Chapter 6, paragraph 1, however, we indicate that the scale at which this is possible is smaller than that of the Randstad.

At a theoretical level, when building models of this sort, it is assumed that none of the individual urban areas may have a certain spatial advantage. In a topological analysis of models (Jacobs, 1990), it has already been

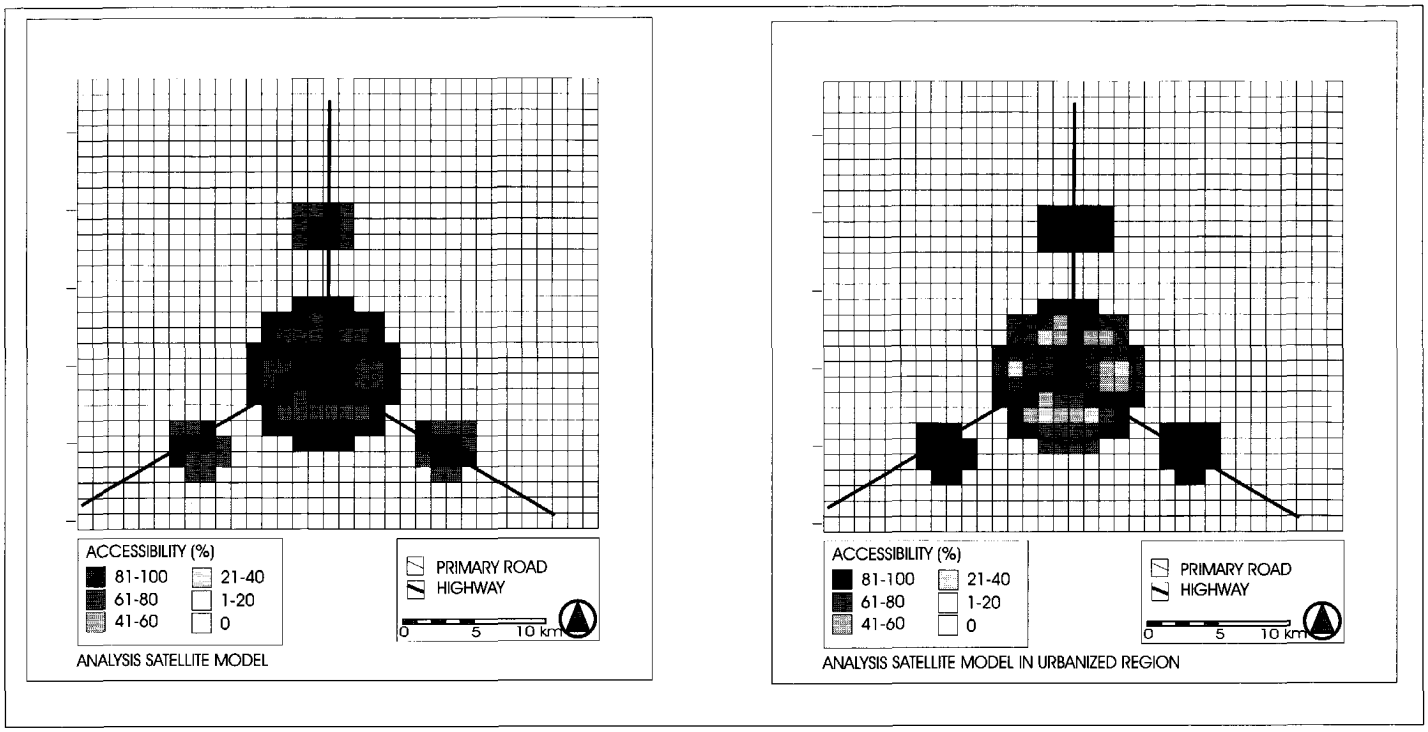
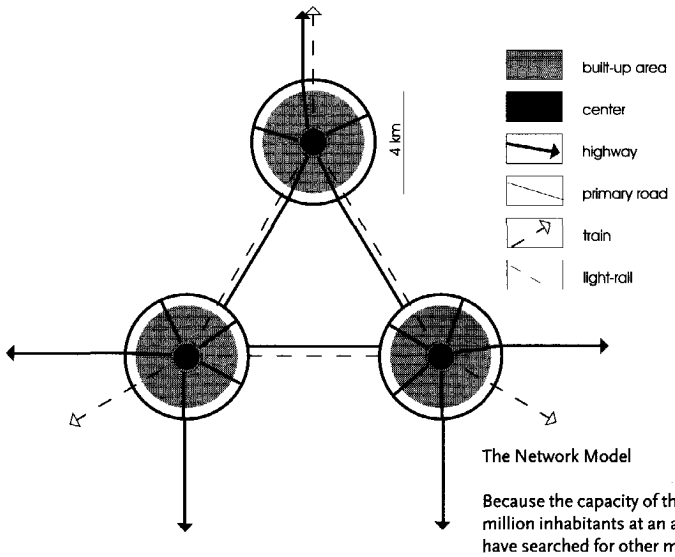


Figure 8.6 Analysis Satellite model



The Network Model

Because the capacity of the traditional radial models is limited, usually till 2 million inhabitants at an average density of 80 persons per hectare, people have searched for other models, sometimes reacting to an existing situation. The network model is an example of such a model.

specification:
Basic qualities:
Large capacity combined with possibility to maintain openness of landscape
Equal centers (on a regional level)
functional structure: circular (multinodal)

max radius central part depends on light-rail for short distances
maximum distance between separate centers depends on travel time of superregional transportation system (mostly train) from any part of the whole area to any center.

examples: besides used as a basic model for Randstad-Holland, never really used in regional planning and design

Figure 8.7 Network model

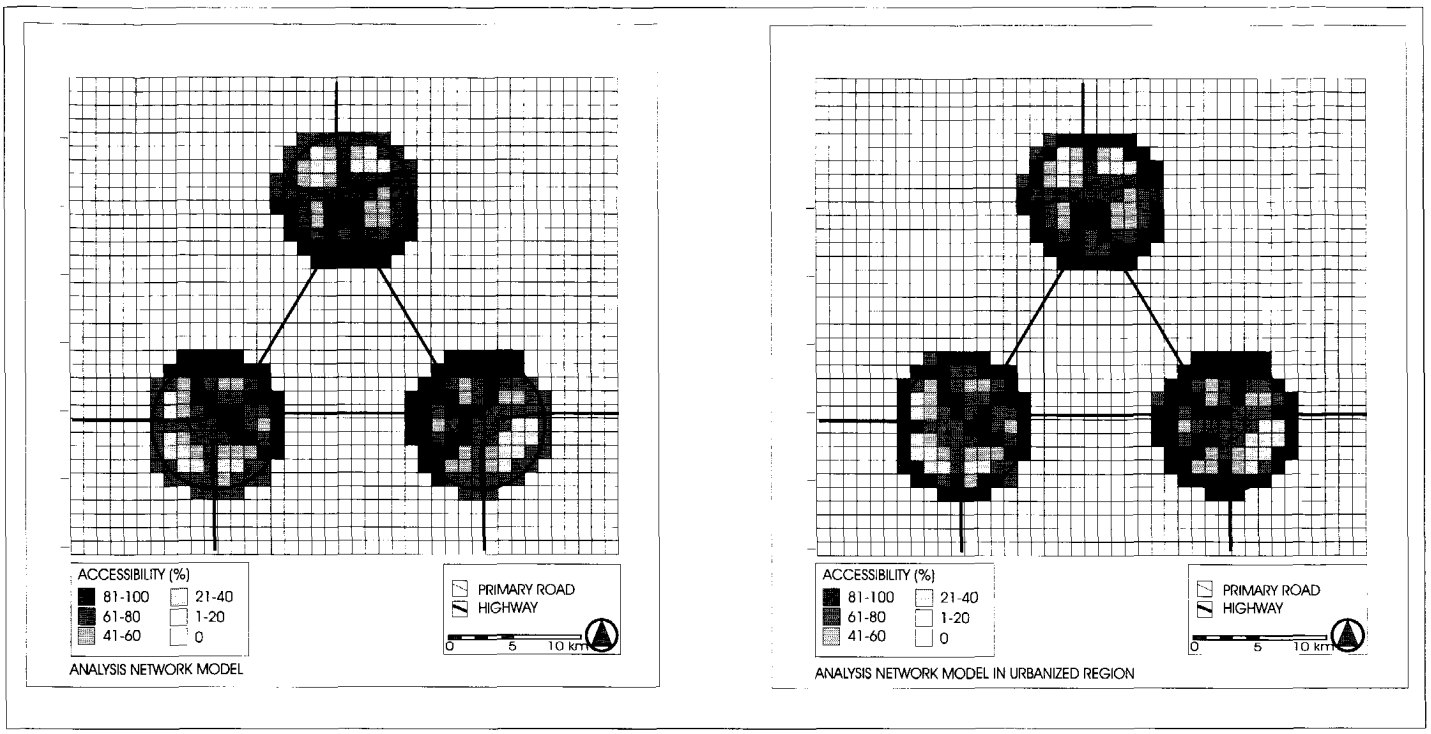


Figure 8.8 Analysis network model

revealed that as the number of urban areas and centers increases, spatial equality can only be realized in the form of a ring. A model such as the one depicted here (see Fig. 8.7), showing three urban areas, is in fact the basic model for a ring.

The analysis of the model demonstrates that the accessibility value at the location of the intended centers is only partially sufficient (see Fig. 8.8). It is the urban fringe in particular that scores high here. This interpretation is strengthened when the model is placed in an urbanized setting. Furthermore, just as for the other models, more locations are suitable for urban and regional activities. Thus, the chosen constellation cannot be considered consistent.

8.5 Adaptation of the Models: Interventions and Effects

The question that arises at this point is whether the models discussed above can be adapted to make them consistent. By answering this question, we take the first step toward developing design interventions that determine the opportunities for the spatial structure. With regard to the adaptation of the models, it seems useful to build upon the observations made in earlier chapters. Chapter 5 in particular clearly describes how the ring road has affected the development of Minneapolis – Saint Paul. The role and significance of other highways in the urban area are clearly seen in Frankfurt am Main. There, the highway plays a more limited role in the regional and urban traffic than highways in the Netherlands or the United States. Another observation regarding Frankfurt am Main is the way the urbanized area has spread out through the region. The urban sprawl is combined with a functional structure that is primarily nodal. The opposite situation is found in the South Wing of the Randstad. There, the urban area is more concentrated, whereas the functional structure is more multi-nodal in character.

The first test is to redesign the lobate model. Step 1 deals with the infrastructure. Instead of putting the ring road directly around the central urban area, it could be placed far away from the city (see Fig. 8.9). However, that option is complicated by the fact that the diameter of the ring, and thus the circumference too, would become too large. Then the ring is no longer an alternative transit route; instead, the road through the urban area – in many cases the original route – becomes

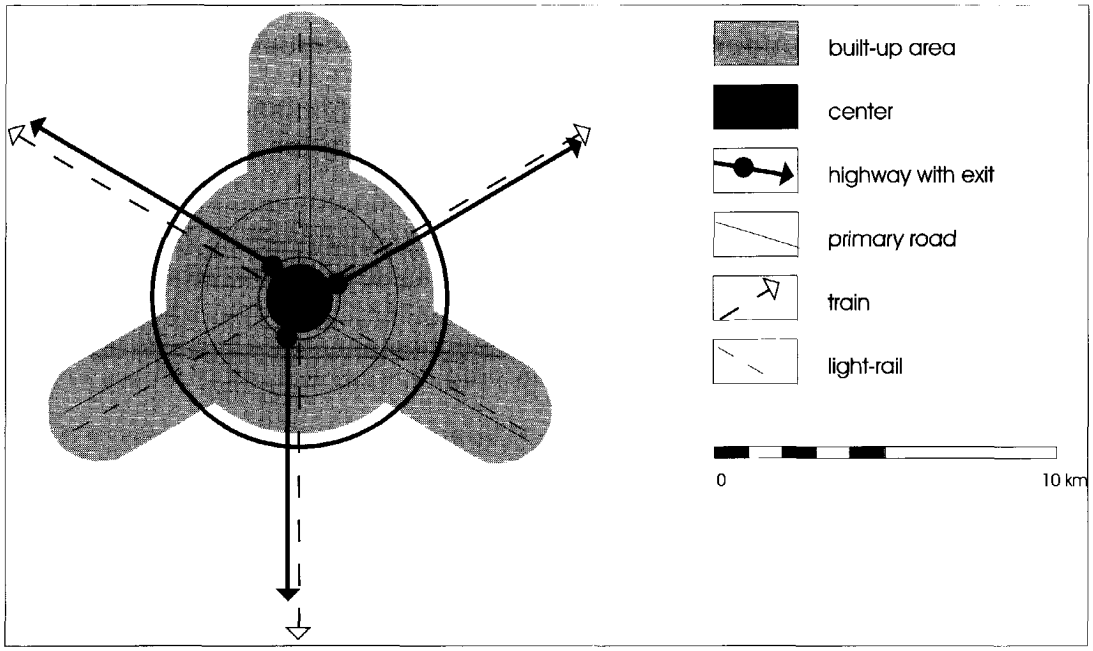


Figure 8.9
Spatial intervention lobate model

more attractive. A second complicating factor is that this option only seems possible in a non-urbanized area (see for example Klaasen and Jacobs, 1999). Of course, the construction costs and the deterioration of the landscape also play a significant role. As an alternative, it may be suggested that the network of highways in the urban area should not play any role in intra-urban traffic flows. The number of on and off ramps should thus remain limited, similar to the situation in Frankfurt am Main. In the lobate model, the assumption that the highway would exclusively tie into the small ring around the center (the black dots in the figure) and that main roads[4] (to be newly built) would take care of the intra-urban traffic flows.The outcome of the analysis of the adapted lobate model is very different from the previous analysis. Assuming that the highway ties exclusively into the small

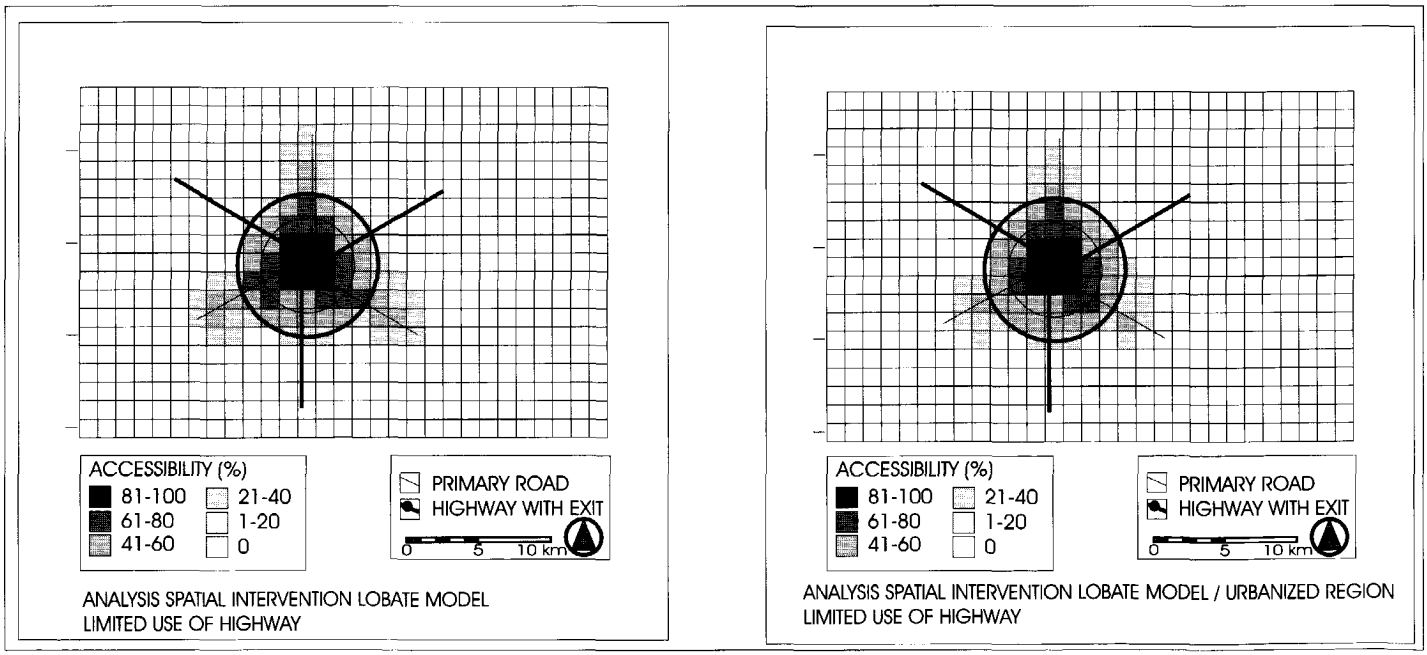


Figure 8.10 Analysis spatial intervention (limited use of highway)

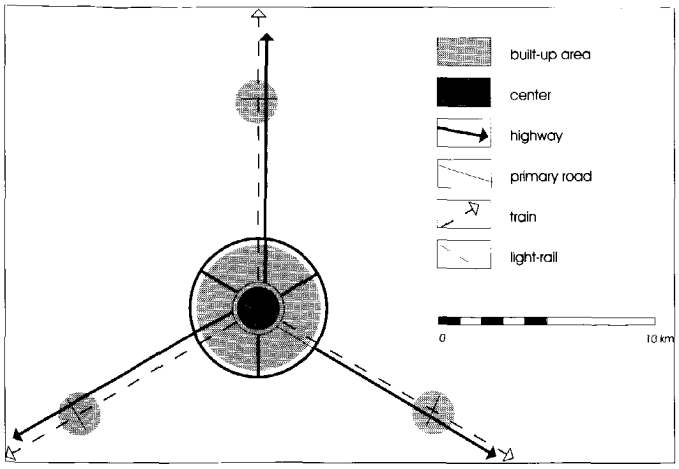


Figure 8.11 Spatial intervention satellite model (concentration)

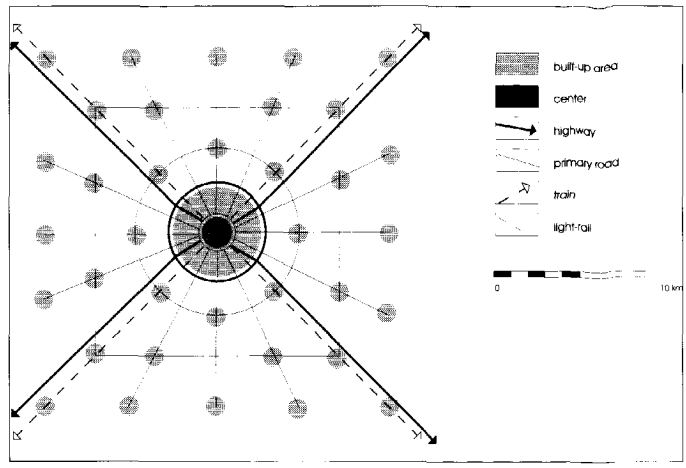


Figure 8.12 Spatial intervention satellite model (sprawl

ring around the center, the effect is that an accessibility value of 80 percent or more is found exclusively in the area surrounding or within the small ring (see Fig. 8.10). Thus, only these areas would be suitable locations for urban and regional activities. The effect is even stronger if the surrounding area is urbanized. Thus, we may conclude that placing restrictions on the use of the highway for urban traffic movements has a strong effect on the change in the accessibility values for the area. We may also conclude that the adapted lobate model is in fact consistent. Of course, it should be kept in mind that measures to restrict the use of the highways are not usually popular. At the same time, it must be realized that there is a spiral of more roads leading to more dispersal of functions which leads in turn to more movements calling for more roads and so on. Finally it should be mentioned that the interventions also require solutions for the demand for parking-space which is inevitabely an important issue for this model.

The second step is to manipulate the accessibility by way of dispersal and concentration of the urban area. However, any manipulation of the urban area in this theoretical exercise will not go unpunished if the infrastructure is not adapted accordingly (see De Jong, Dieters, and Boelen, 1996). The basis for this exercise is the satellite model. In applying that model, two variants are used: strong concentration and strong dispersal (see Fig. 8.11 and Fig. 8.12). In principle, an highway will have on and off ramps in the urban area.
The first analysis reveals concentration of the urban area in the satellite model and, as a result of that concentration, an increase in the population density (see Fig. 8.13). It shows that as an effect of concentration, almost the entire urban area gets a weighted accessibility value of more than 80 percent. Thus, the entire urban area would be suitable for urban and regional activities. In principle, the satellite model is based on the assumption of a nodal structure. Therefore, concentration does not seem to be applicable in this model. The problem is that concentration provides the conditions for a multinodal structure. If further concentration were allowed, it would lead to a model in which the center overlaps with the urban area. A situation like this is found in an extremely compact city such as Hong Kong. In that case, however, there is in fact a nodal structure.
The second analysis is based on the assumption of dispersal. Instead of a limited number of large satellite cities and a relatively large core city, the model includes a large number of small satellites – small towns and villages – and a relatively small core city. An increase in the regional road network is inherent to this exercise. The analysis demonstrates that as a consequence of the dispersal, the central part of the core city is the only place where the accessibility value is over 80 percent (see Fig. 8.14). In the model, this area is also the location of the urban and regional center, which makes the model consistent. Furthermore, the analysis shows that when the surrounding area is urbanized, locations near the highway, and especially the ring road, are also suitable for urban and regional activities. If it is not

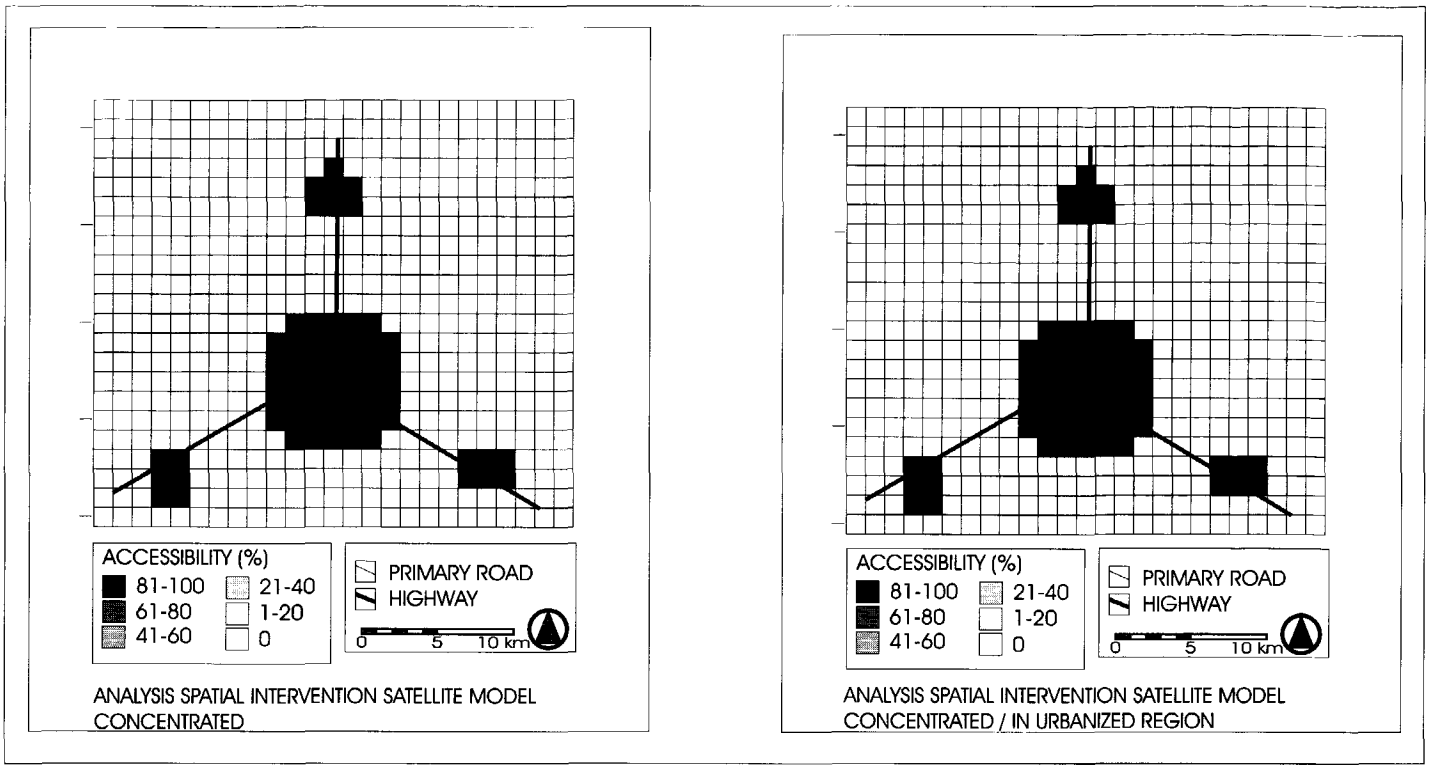


Figure 8.13 Analysis spatial intervention (concentration)

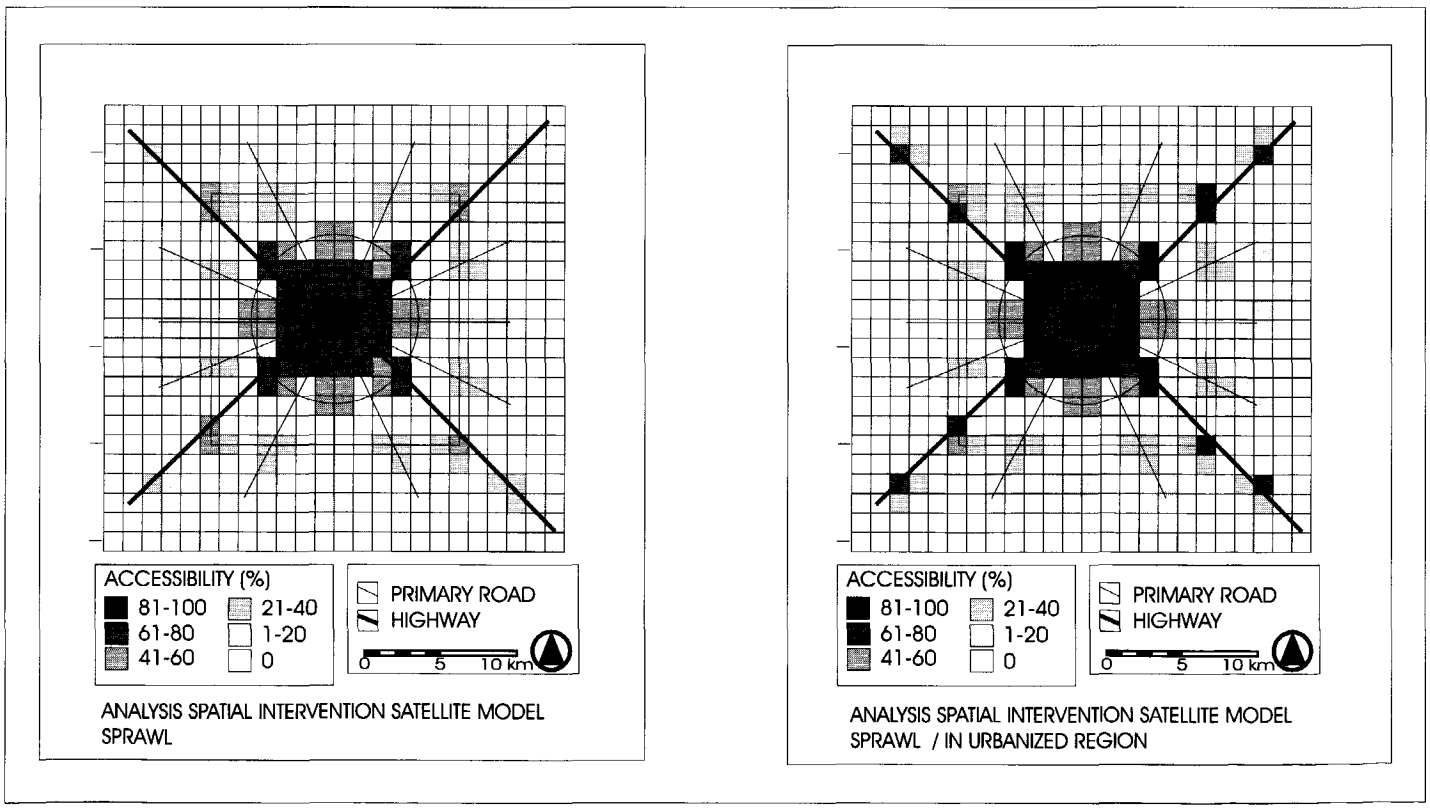


Figure 8.14 Analysis spatial intervention (sprawl)

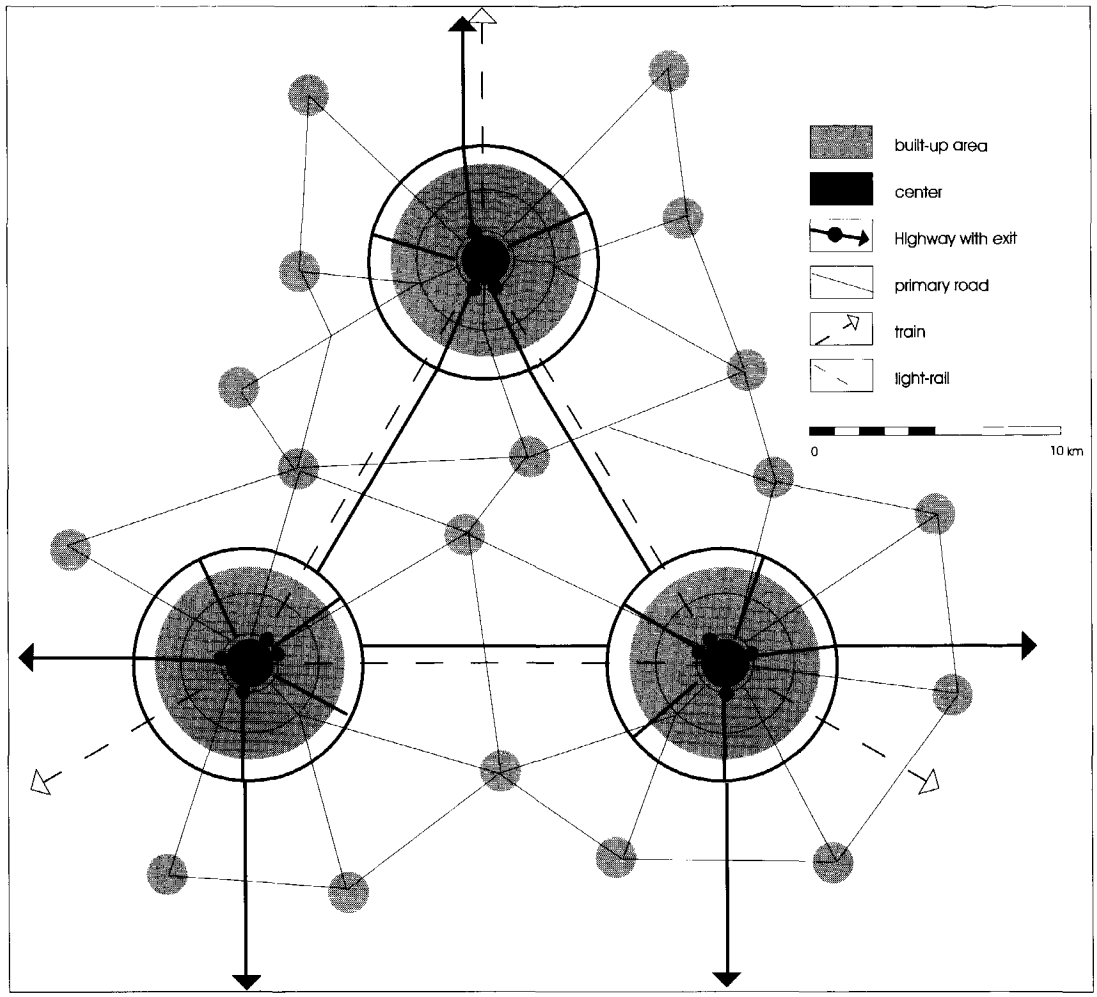


Figure 8.15
Spatial.intervention network model (sprawl and limited use of highway)

desirable to use these sites for that purpose, it is possible to restrict the number of on and off ramps, just as in the revised lobate model.

The point of departure for the network model is a multinodal structure, and in this sense it differs from the previous models. According to the network model, however, that structure consists of a limited number of centers. For the sake of the analysis, an attempt is made – in light of the analyses of the other models – to build a model that would provide the optimal conditions for a multinodal structure by way of dispersal on the one hand and adaptation of the infrastructure on the other. Therefore, the model depicted here consists of three large settlements, among which the urban and regional centers are assumed to be included (see Fig. 8.15). Subsequently, the model consists of a series of small settlements. With respect to automobile traffic, they are not linked to the network of highways. Rather, they are connected to the primary roads, with level intersections and a low maximum driving speed. Furthermore, the two infrastructure networks in this model are only connected close to the intended centers.

The analysis of the model demonstrates that as a result of the dispersal and the far-reaching adaptation of the infrastructure, the three centers envisioned by the model actually do reach the required accessibility value (see Fig. 8.16). In addition, with the exception of two small settlements, no other location has an accessibility value higher than 80 percent. The central location of the two small settlements within the region explains their high accessibility value. However, the picture is different with an urbanized surrounding area. Then the highways have a greater effect. Moreover, as the analysis shows, only the centers of the large settlements have an accessibility value that is sufficiently high to allow urban and regional activities to be situated there.

Having elaborated and analyzed the models, we may

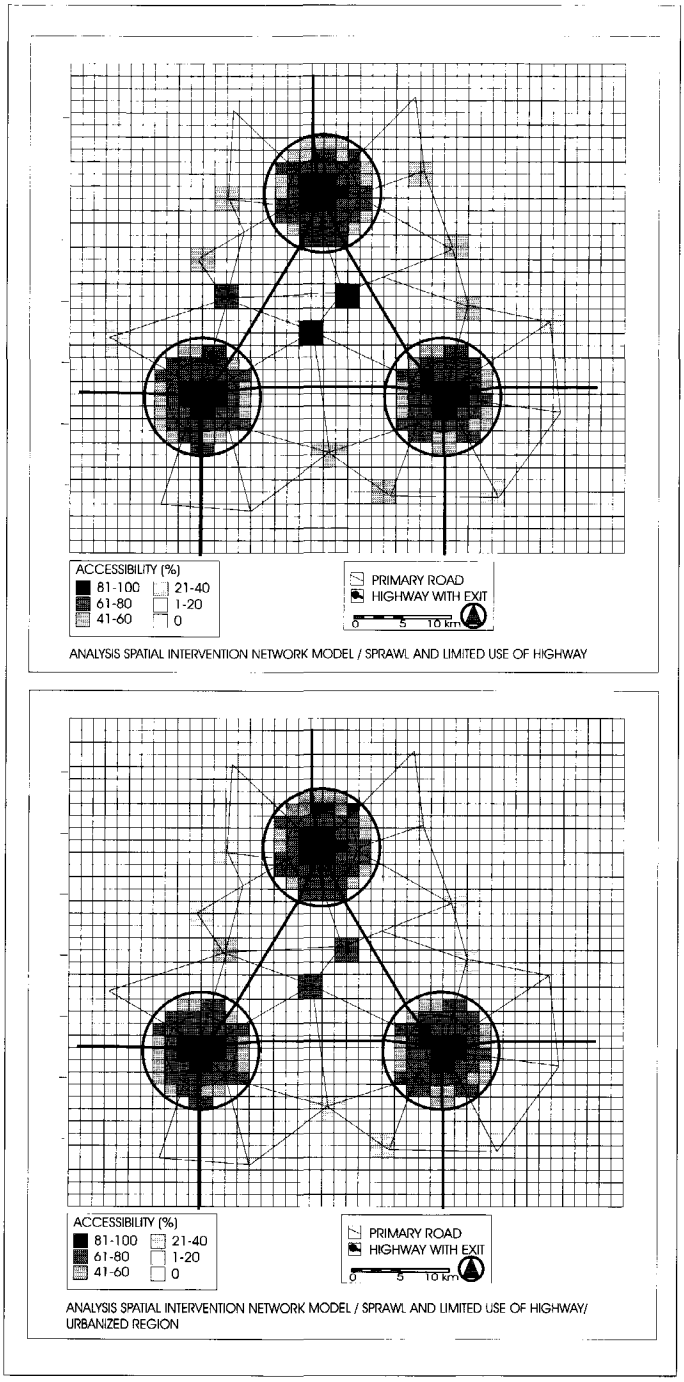


Figure 8.16
Analysis spatial intervention sprawl and limited use of highway

conclude that dispersal – and thereby a road network of a lower order to provide access to the area – has a positive effect on restricting the number of locations where urban and regional activities can be established. It also proves that adapting the network of highways – and specifically limiting the number of exits – has a strongly differentiating effect. Concentration of the urban area, on the other hand, leads to an increase in the number of locations with a high accessibility value.

If the aim is to produce a nodal functional structure, with the overarching goal of developing a single high-ranking multifunctional center, then the appropriate means to reach that aim would appear to be the adaptation of the network of highways – or influencing the use, which might involve lowering the maximum speed on the road. At the same time, it is then advisable to strive toward a dispersal of the urban area instead of trying the make it more concentrated.

If a multinodal functional structure is the aim, then the picture is different. According to the network model, there would have to be two or more large settlements that, in view of their equal rank and their more or less equal status in the connections at the supra-regional level, could obtain the same accessibility value. Combined with a selective use of the network of highways and a dispersal of the rest of the urban area, a structure can be achieved in which urban and regional activities are only established at locations designated for those purposes. In theory, there may be two or more equal-ranking multifunctional centers or a number of specialized complementary centers.

If, however, the goal were to allow urban and regional activities to locate in as many urban areas as possible, then concentration of the urban area would seem to have a positive effect. The effect is even much stronger when the region is opened up by putting in highways. A highly dispersed area, as indicated in the last network model, one that is entirely accessible by highways, shows hardly any differentiation in the weighted accessibility values.

With respect to the models investigated here, it is important to take note of the purpose of the exercise. Here, the focus is exclusively on the relation between the model and the functional structure. That choice was deliberately made in order to determine the consistency of the models and to investigate the effect of certain interventions. The exercise did not consider the intention to ensure that a center can be reached by public transport from each and every location within an acceptable amount of travel time. Nor did it consider what the minimum size of smaller settlements should be in order to ensure a sufficient economic base to

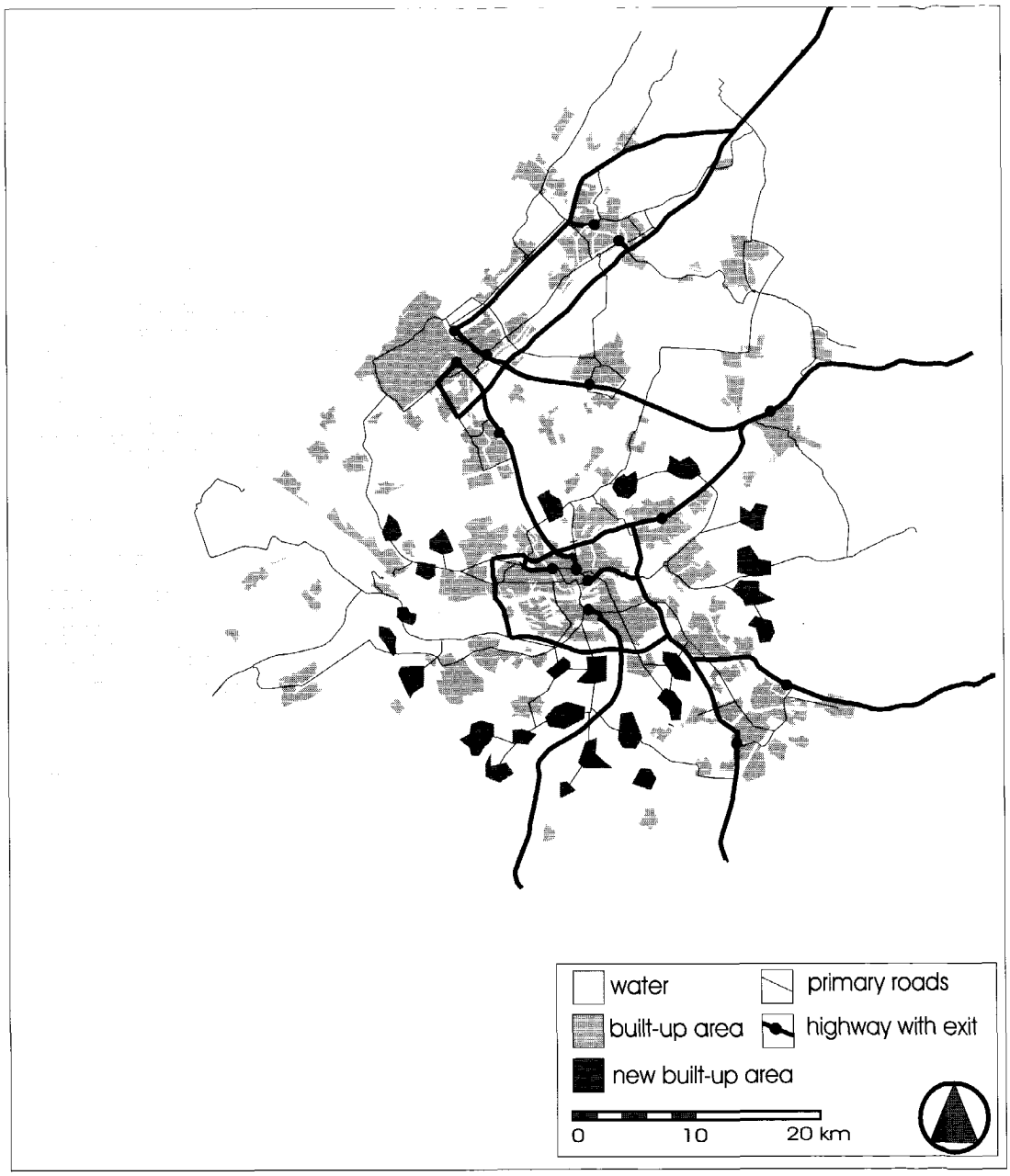


Figure 8.17
The South Wing, design 1: Sprawl around Rotterdam and limited use of highway

support the services there. Furthermore, it should be noted that the models are based on a nomothetic approach, as described in Chapters 2 and 3. To apply the models in a concrete situation would require insight in the specific functional, geographical, and morphological characteristics of that situation.

8.6 Applying Design Interventions

The analyses of these theoretical models of structure demonstrate that a functional structure can be influenced by changing the roads and by spreading out or concentrating the built-up area. On that basis, it is now possible to take the next step, which is to examine how that functional structure can be manipulated in an existing situation by way of design interventions. This analysis refers to two cases: the South Wing of the Randstad and Minneapolis – Saint Paul. Both areas are multinodal in character, though the South Wing is still developing in that respect (see Chapter 6). Furthermore, there are a number of differences that make the analysis of the design interventions particularly interesting. For instance, the highway network in Minneapolis – Saint Paul is much more extensive and the urban area is more

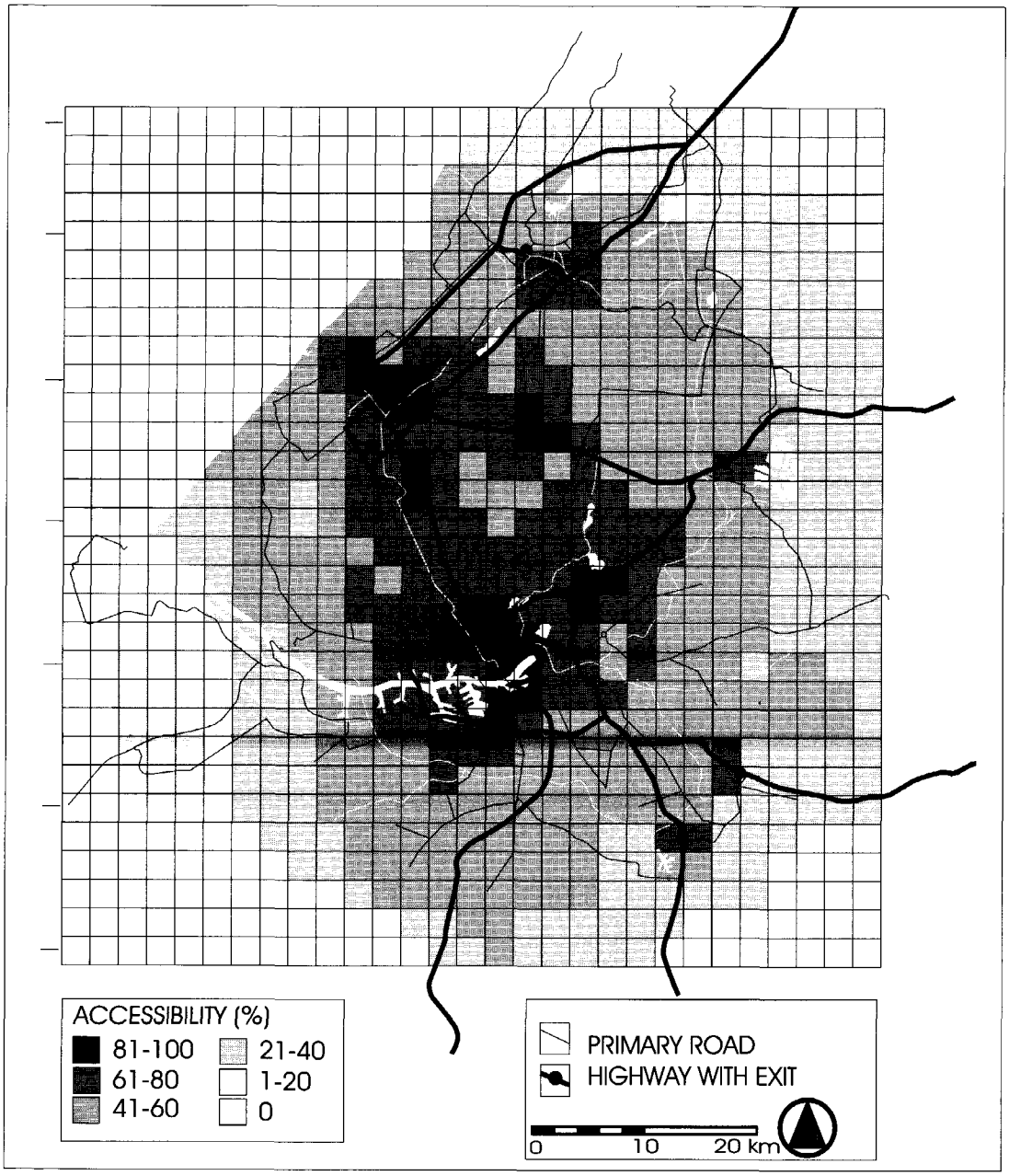


Figure 8.18
Analysis South Wing, design 1

widely dispersed in comparison to the South Wing of the Randstad Holland. On the other hand, the South Wing consists of a number of highly concentrated urban areas. The deeper objective of applying design interventions in these areas is to see if it is possible to generate a single-nodal or a multinodal structure through spatial interventions. With respect to the latter type of structure, the question arises whether it is possible to give a selective advantage to just a few areas.

The first intervention in the South Wing is intended to develop a single center for the entire area. Thus, the goal is to achieve a single-nodal structure. In this example, it was decided to give an advantage to the existing inner-city center of Rotterdam. To that end, a highly dispersed extension of the urban area is undertaken. In addition, the use of the highways for city traffic is restricted as much as possible (see Fig. 8.17). In total, more than 20 on and off ramps are closed. In order to do this, the regional network of roads is expanded. In theory, it is also possible to test the effect of separate interventions. For instance, we could only test the effect of adapting the infrastructure. Because changing the urban area also involves an adaptation of the infrastructure, the

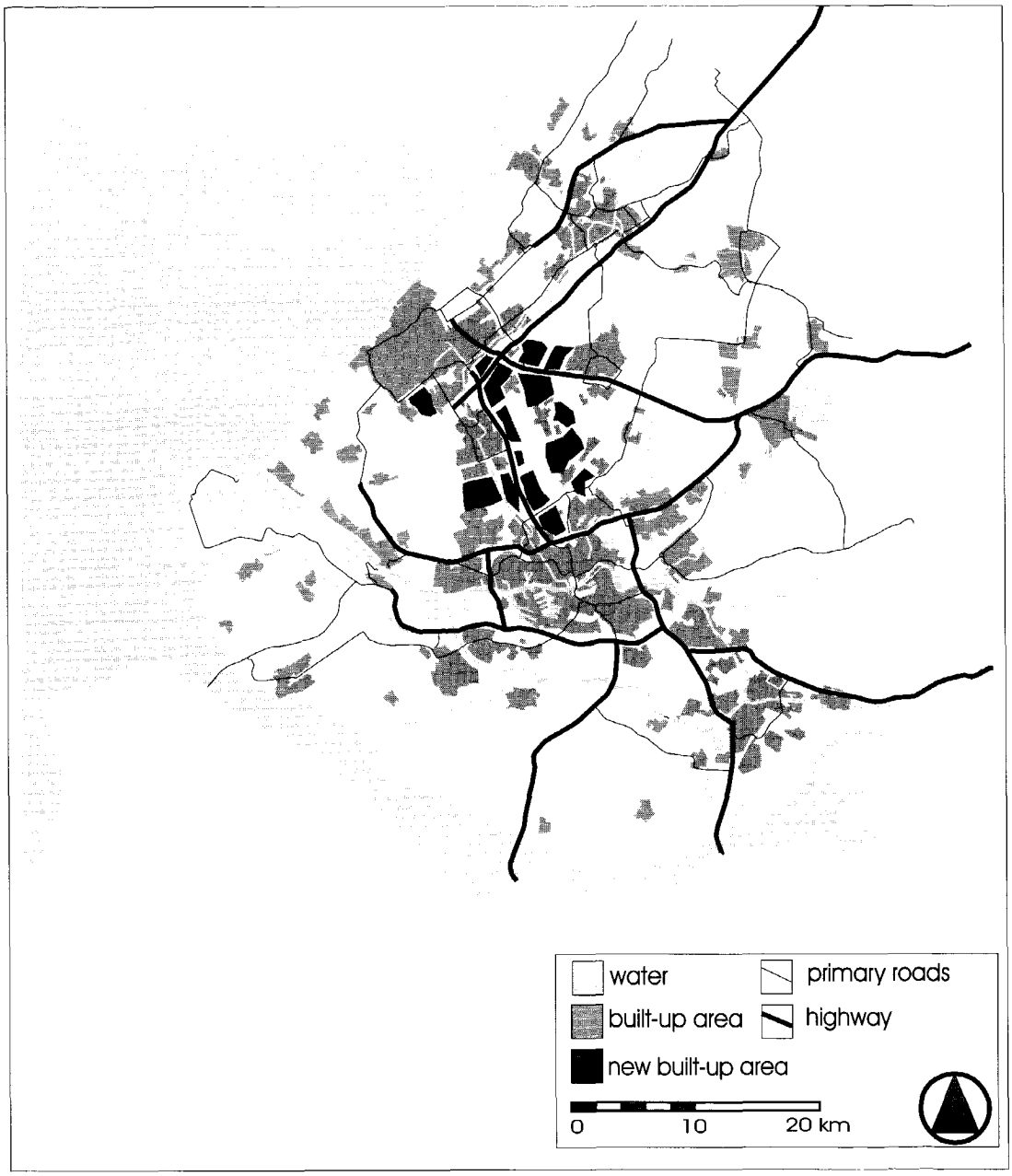


Figure 8.19
The South Wing, design 2: Concentrated urbanization between The Hague and Rotterdam (corridor and limited use of highway)

interventions are judged here in combination. In that way it is also possible to determine whether or not a desired functional structure, be it single-nodal or multinodal, can be generated.

Figure 8.18 depicts the effect of the interventions. In comparison with the analysis of the current situation, as covered in Chapter 7, there are far fewer locations with an accessibility value of 80 percent or higher. This means that the possibilities for dispersal of urban and regional activities are also considerably restricted. In that respect, design interventions provide a manageable means to stop the spread of activities. It should be mentioned that urban sprawl could be detrimental to the development of rapid transit. The aim to position the inner city of Rotterdam as the only center in the area, and thereby to create a single-nodal structure, was not reached. Even though we may conclude that the dispersed expansion of the urban area, in this case with a capacity for about 250,000 dwellings, helps limit the spread of urban and regional activities, the role of the highway in the entire effort remains evident. For all the remaining on and off ramps, the accessibility value is still high enough to allow the establishment of urban

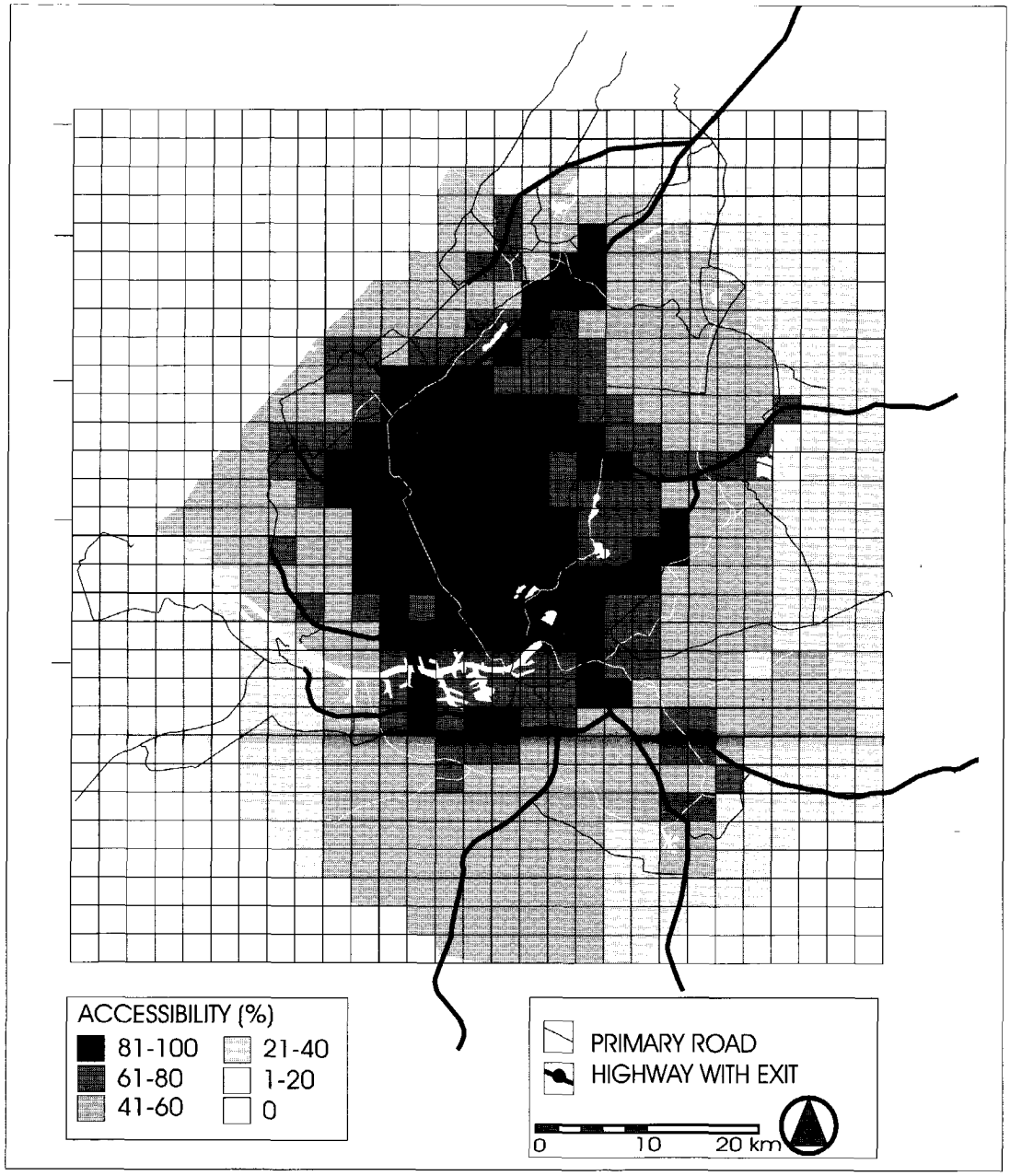


Figure 8.20
Analysis South Wing, design 2

and regional activities. The overall result of these interventions in this specific situation is that the conditions are created for a multinodal structure in which the number of centers is limited.

The second intervention in the area, in accordance with the earlier theoretical exercise, aimed at creating the greatest possible amount of space where urban and regional activities can be located. The points of departure are an expansion of the network of highways and a concentration of the urban area (see Fig. 8.19). It is interesting to observe that these two interventions are largely in line with the current spatial policy of the national (i.e., the Netherlands) as well as the provincial (i.e., the province of South Holland) governments. Since the 1980s, the national government has promoted compact urbanization. In the course of time, it has developed a policy that is directed to the urbanization of corridors (Ministry of VROM, 1988, 1991, and 1999).

The development of urban corridors may be described in various ways. For instance, one could think of a development like the Megalopolis of Gottman, or an urban strip running for more than 200 kilometers. Or

one could think of linear urbanized regions along main transport axes, whereby the urban band might comprise a sequence of urbanized areas with a total length of 100 kilometers. In addition, the corridor may denote an urbanization at the regional scale, or an urban band between two big cities, whereby the distance between the two might be anywhere between about 15 and 40 kilometers. The urban corridor policy proposed in the Netherlands aims at this last model (Ministry of VROM, 1999). It should be noted, however, that the policy does not envision unbridled urbanization along the infrastructure routes. Rather, the government aims at creating points of urban concentration (urban areas up to approximately 100,000 inhabitants and a maximum of about 150 hectares in industrial areas). Those points would be interspersed with open green space devoted to nature and recreational use. In that sense, the corridor may be seen as a string of beads linking two or more cities.

The provincial government has already expressed its standpoint on the future of the Randstad Holland and on further development of the area lying between Rotterdam and The Hague. That standpoint calls for development in the space between the cities (Provincie Zuid-Holland, 1989; Randstad Overleg Ruimtelijke Ordening, 1990). The idea of extending the road network has been on the agenda for some time already (Provinciale Staten van Zuid-Holland, 1965 and 1987). Both national and provincial governments take a clear stance against dispersal of urban and regional activities; instead, they call for efforts to reinforce the existing centers. In order to be able to test current policy at the same time, the design for the area stayed as close as possible to that policy.

Figure 8.20 shows the effect of the interventions. The number of locations with an accessibility value of 80 percent or more has increased with respect to the current situation. This is a consequence of changes on two fronts: expansion of the urban area according to the principle of concentration; and the extension of the road network. In other words, urban and regional activities can be located in a sizeable part of this conurbation. The conclusion that a far-reaching dispersal of urban and regional activities is achieved by the designated intervention is instructive, though academic. In relation to the spatial policy of the various governments, however, the conclusion is extremely disconcerting. The choice to move toward a concentrated urban area runs counter to the goal of reducing the spread of urban and regional activities. That choice actually facilitates the spread of those activities in every respect. It is imperative to deploy other means to combat dispersal; one way is to introduce prohibitory clauses in the land-use regulations. It remains to be seen how long such regulatory measures could be upheld. The truth of the matter is that economic interests, thinking in the short-term, and local opportunism have often prevailed in the past.

The design interventions that have been carried out in the South Wing can also be applied to Minneapolis – Saint Paul. These areas have different spatial patterns, of course. Therefore, the effect of intervention should also be expected to differ. Nonetheless, for Minneapolis – Saint Paul, the intervention aimed at the dispersal of the urban area and a limited use of the highways is expected to produce a wider differentiation in accessibility. At the same time, it is expected that concentrated urbanization in Minneapolis – Saint Paul will make a larger area suitable for the location of urban and regional activities.

The first intervention in Minneapolis – Saint Paul is directed in principle to achieve a selective improvement in the position of the central area. That center consists of downtown Minneapolis, Midway (halfway between the two downtowns), and downtown Saint Paul. In the provisional plan, it was decided to change the highway into an urban road in places where that would be possible (see Fig. 8.21). The only place where access to the network of highways would be provided is in the central urban area. In order to do this, urban roads were added and the network of highways was made as closed a system as possible. The extension of the urban area takes place by establishing small new towns ranging in size from 100 to 300 hectares on sites within a radius of 40 kilometers from Midway. The interventions in the road network are enormous, especially in this American example. The reason is that the highway and particularly the ring road have taken on an important role in the urban traffic pattern (Gordon and Richardson, 1996). Figure 8.22 shows the effect of the proposed

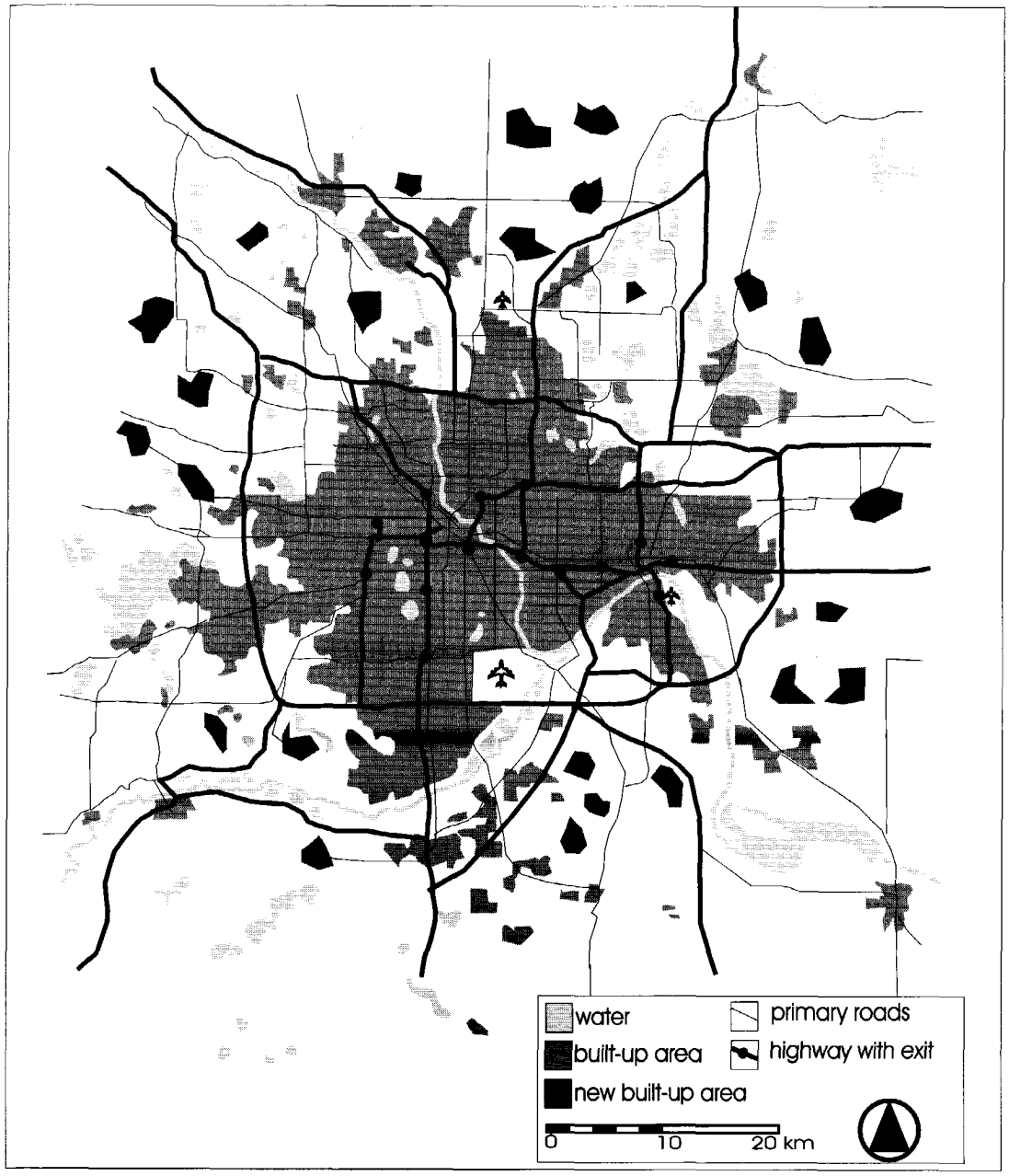


Figure 8.21
Minneapolis – Saint Paul, design 1: Sprawl within 40-km radius and limited use of highway

intervention. In order to assess the outcome, it is necessary to make a comparison with the analysis results for Minneapolis – Saint Paul given in Chapter 7. There, it proved that almost the entire area within the beltway (I-494) and the adjacent zones provide sufficient conditions for the establishment of urban and regional activities. The analysis of the intervention demonstrates that the area has been reduced considerably. The only place where urban and regional activities can still be located in the two downtowns or their immediate surroundings and near the airport. The effect of the dispersed urbanization on the accessibility values in the area must be estimated to be weaker than the effect of the adaptation of the road network. The reason is that the increase is a mere 15 percent, more or less. Nonetheless, the significance of the smaller new settlements is still related to placing greater emphasis on urban roads instead of on highways, as argued earlier in this chapter.

The Metropolitan Council of Minneapolis – Saint Paul presented a plan entitled "From Here to Mobility" in 1992. The aim of that plan was to curtail unbridled sprawl, particularly of urban and regional functions, by indicating that five centers could be developed within

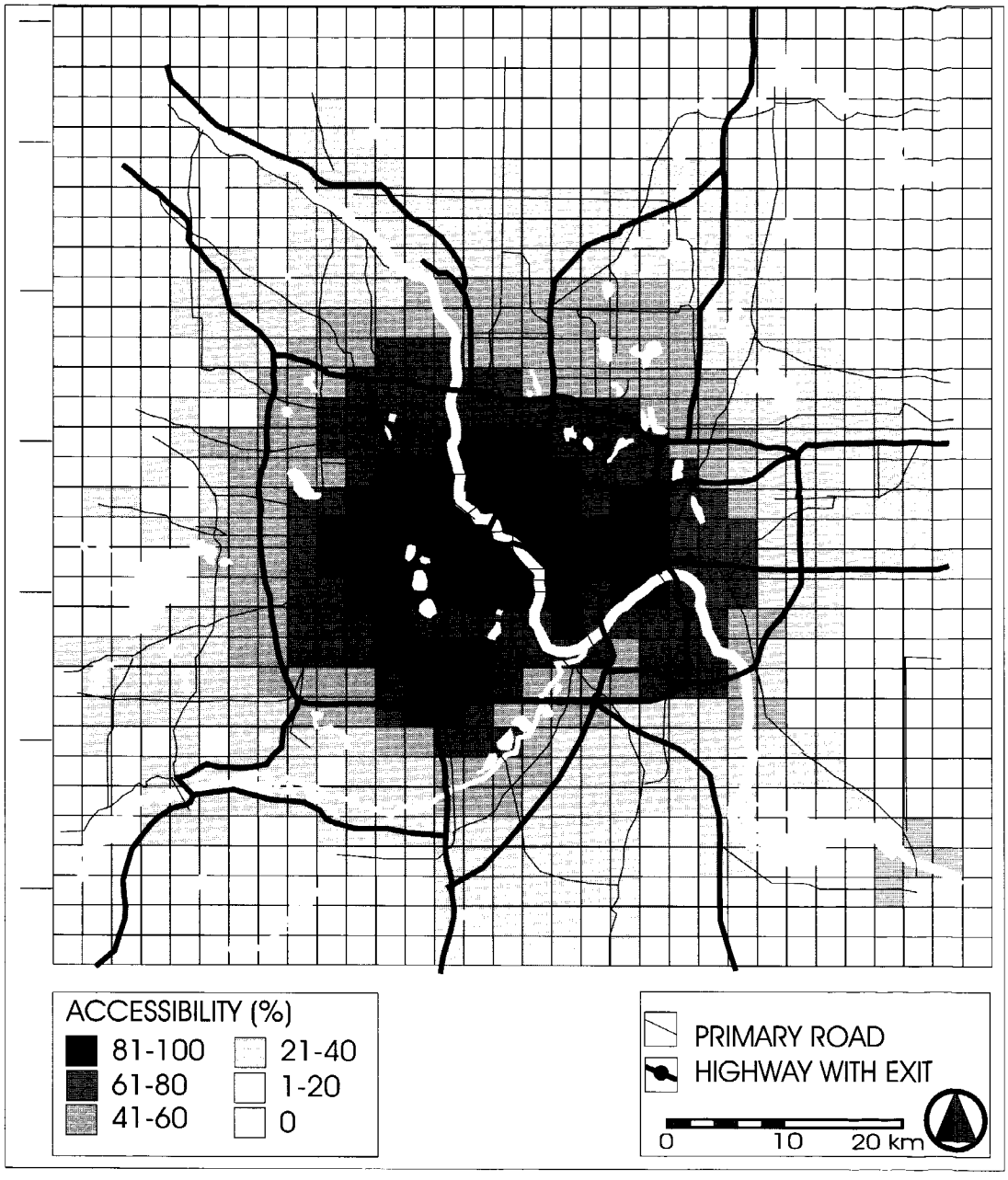


Figure 8.22
Analysis Minneapolis - Saint Paul, design 1

the multinodal structure. Interestingly, four of the five centers named by the Council are located in places where the accessibility value is 80 percent or more and, as a result of the intervention, these are places where urban and regional activities (i.e., center functions) can be established. In light of these observations, it may be concluded that the proposed intervention supports the aims of the Council. Whether or not the intervention is politically and socially feasible is another question, which rightly falls outside the scope of the present analysis. The point is to explore the possibilities and to find relations between the intervention and the effect.

The second design (see Fig. 8.23) connects at a number of points with daily practices in Minneapolis – Saint Paul. Urbanization is occurring in areas known for their natural beauty and along the main roads leading out of town. At the same time, the network of highways is being expanded. The proposed design is primarily intended to see whether a multinodal structure can be developed in this manner. But the design also serves as the spatial prognosis for Minneapolis – Saint Paul in 2020.
As a consequence of the intervention, the area suitable for urban and regional activities is expanded. This is just like the situation in the South Wing and is also largely in

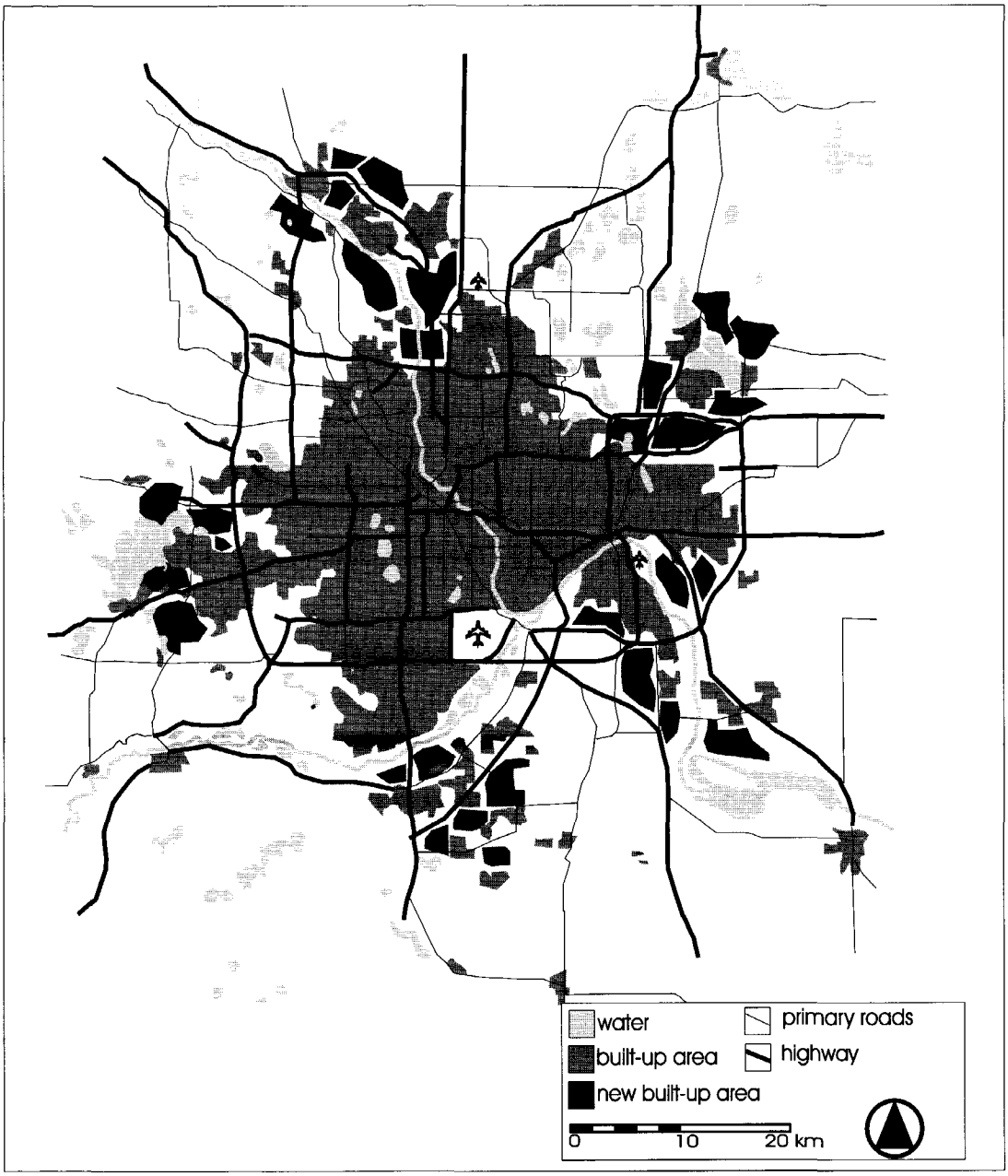


Figure 8.23
Minneapolis – Saint Paul, design 2: Concentrated urbanization

line with the analysis of the theoretical models of structure. Figure 8.24 shows that the area with an accessibility value of at least 80 percent now has a radius of nearly 20 kilometers. Thus, there is plenty of room for a strong dispersal of all kinds of activities. With those activities, people's demand for mobility will probably increase sharply too. It is very questionable whether there will still be any multifunctional center areas with the qualities usually associated with them.
The analyses lead to the conclusion that within these two urban areas, it is not possible to develop a single-nodal structure by way of the proposed interventions.

Nonetheless, it proves that as a result of adaptations in the road network and dispersed urbanization, the further spread of urban and regional activities can be kept under control. One could almost say that this intervention is required in order to develop a multinodal structure that consists of a limited number of concentrated centers, as proposed in Minneapolis – Saint Paul.

The idea that urban sprawl should be considered a good development is almost diametrically opposed to the principles of spatial policy in the Netherlands. The main priority for the coming decades is to promote compact

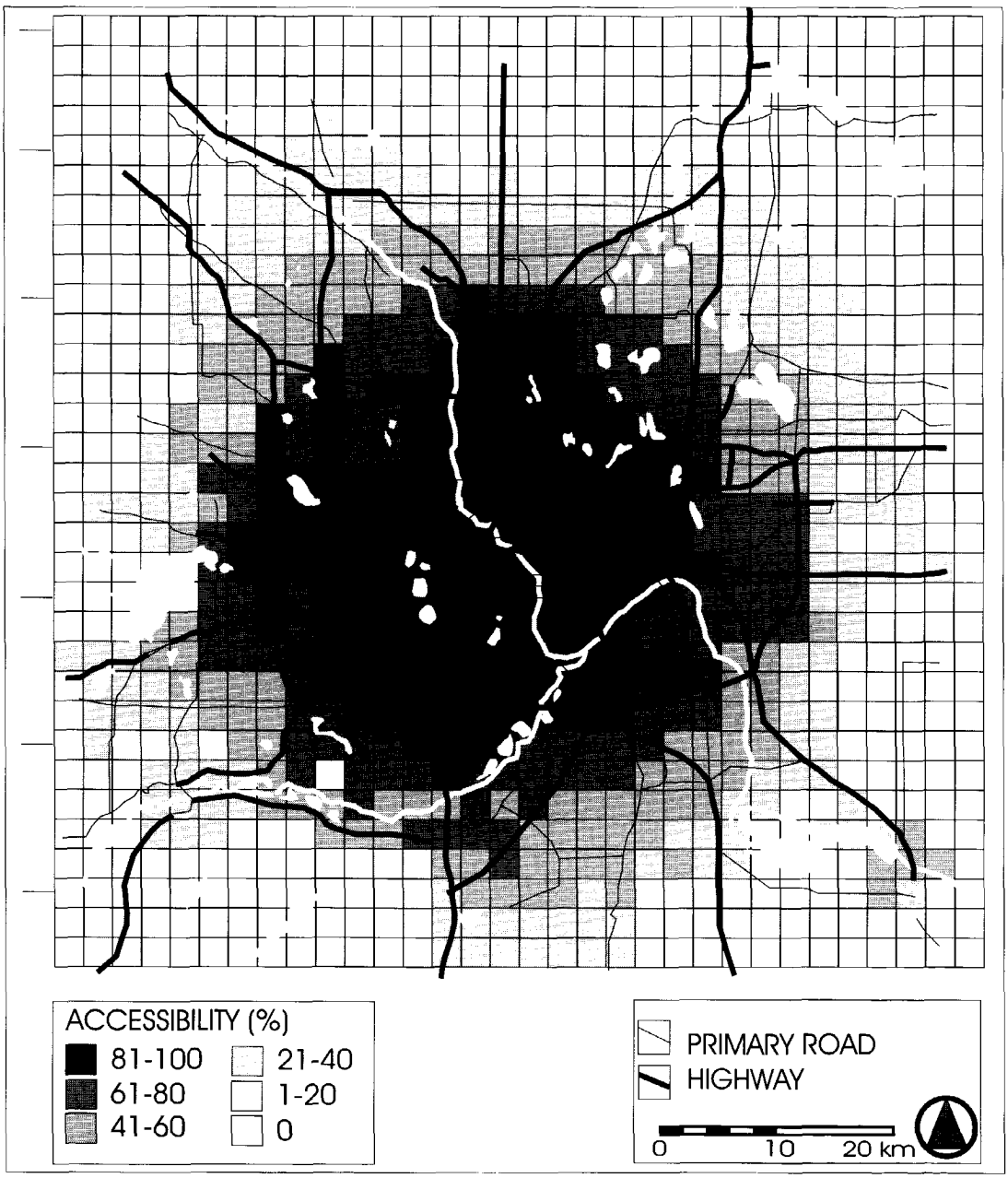


Figure 8.24
Analysis Minneapolis - Saint Paul, design 2

development and urbanized corridors. At the same time, it is assumed that multinodal structures will develop and thereby reinforce the existing cities that comprise those structures. However, the analysis shows that the urbanization principle just opens the floodgates by stimulating an almost unrestricted dispersal of urban and regional activities. The national government in the Netherlands, incidentally, has already expressed some doubt about the compact city policy. The main concern is whether the extensions immediately adjacent to the built-up area really do provide direct support for the urban facilities. Yet the government is also concerned about the possibility that urban extensions of that kind might make the urban area too large and thereby make it unattractive (Ministry of VROM, 1997, p. 49). Furthermore, it should be noted that envisioning the compact city and urban corridors is related to other qualities as well. For instance, these visions are associated with efforts to stimulate rapid transit and slow traffic as well as to reduce the use of space for urban activities. In that respect, the analysis carried out here sheds light on the weak points in the concepts. Of course, that does not exclude the possibility that those concepts contain other valuable qualities.

8.7 Information and Communication Technology

The focus in this study of multinodal structures is physical accessibility. It proves that the functional structure is largely determined by the degree of accessibility – and, by extension, the difference in accessibility between various places. If we now cast a glance toward the future, then it is only logical to ask whether or not accessibility will remain the most decisive factor. We have to ask how significant will the new information technology be in the development of the urban functional structure. In order to answer that question, we can first refer to the various investigations that Pred has conducted on urban development in the United States. In those studies, Pred observes that the information always precedes the development of economic and, later, urban networks (Pred, 1977 and 1980). In Pred's opinion, the proliferation of means of communication such as telephone and television is a precondition for the development of larger spatial systems. In the same vein, we must acknowledge that these means of communication play a role in the exchange of information and ideas. But at the same time we must realize that at the time the American economy was mainly based on manufacturing and was moreover strongly geared to mass production. In the meantime, the economic base has shifted in the direction of business services and automated production (post-fordism). The range of applications for information technology (IT) has since moved beyond the telephone and television. Rather than providing a tool for communication, the IT field offers all kinds of new alternatives for the daily routines of individuals, companies, and organizations (Occelli, 1998; Graham and Marvin, 1996). Teleworking and teleshopping are two examples. Some say that the factor of physical distance – and thus also the question of accessibility – has been reduced to negligible proportions by these activities. The discussion on this topic has generally revolved around the question of whether information technology will replace physical accessibility. In fact, the question of the physical movement of people – not of goods – might well become redundant. Personally, I see no reason to make it a black and white question; couched in these terms, it ignores a number of the city's fundamental qualities, and those of the city center in particular. Niek de Boer (1982) describes the qualities of the phenomenon of the city center not so much as a concentration of activities but as the place where people are confronted with new ideas, opinions, products, and other people. In that sense, by their presence in the center, beggars and buskers form part of our society; nobody has come across a beggar on the Internet yet. Meanwhile, the myth of urban dissolution, whereby telecommunication is said to be a substitute for the city and for face-to-face interaction in particular, has also been dispelled (Gaspar and Glaser, 1988).
To some degree, information technology can take over those aspects of the city center to the extent that they concern ideas, products, and opinions. Another interesting point is that the new media operate worldwide and thus amount to global communication. In practice, however, this technology has only been available to a select group: so far, the only ones on the information highway are higher-income persons in Western countries (Drewe, 1998). Whereas the old center exuded a vivid sense of being the place where you can meet the world, information technology at least makes it possible to communicate at that level. The difference remains that the medium is more anonymous than public spaces in the city. Without a search engine, a person runs the risk of being excluded from the circuits of new ideas and opinions. When comparing information technology with the quality of the city, the center, and public space, perhaps it is better to use an 'and-and' construction instead of phrasing the options in terms of 'either-or'. The new technology does not replace a situation but adds a dimension to it. In this regard, one might wonder if information technology will squeeze out other means of communication such as the telephone (with E-mail and E-phone instead of the traditional phone call) and the television.

Occelli takes the standpoint in her research that physical accessibility and information technology are not in competition with each other but definitely do have a mutual influence. She proposes using the concept of temporal dimension as a collective term embracing both physical accessibility and the new information technology. In this way, both phenomena can be integrated in urban planning (Occelli, 1998).

In proposing this solution, she assumes that new information technology has an influence on the temporal processes that, in turn, are related to physical movements and thereby to physical accessibility. As Drewe (1998) points out, the issue is certainly not the substitution of physical moves by virtual ones. Information technology does in fact create opportunities to avoid making a number of moves (teleworking and teleshopping, for instance). At the same time, however, it induces other moves– especially new kinds. Moreover, as a result of a changing pattern of daily activities, in which the journey to work no longer predominates, a mobility budget is spent in a different way (Van Reisen, 1997).

The main question that arises at this point is whether the functional structure of the urban system is actually influenced by information technology. First, it should be noted that the urban system consists of activities of individuals, companies, and organizations. Changes in the temporal dimension of those activities also imply a change in the spatial expression of those activities in the functional structure. Physical accessibility within that structure has not lost any of its significance as a critical factor.

A shift can also take place in the direction of a global accessibility; this is seen among banks and other financial institutions. Alternatively, a shift may occur toward accessibility at the level of the neighborhood or the district; for instance, a library may have a central depot and a number of small branches where the public can browse on the computer and reserve books online. In that respect, the change in the functional structure will also be determined by the shifts that occur within various activities. Regionalization and concomitant deregionalization will play a role in that process. With regard to the functional structure, it may be said that the location chosen for those functions that will operate at the regional level in the event of a far-reaching deployment of information technology might be determined primarily by physical accessibility. For instance, the concert hall is a good example. Alternatively, the location might be determined by a combination of physical accessibility and access by way of the information network. Regarding the former group, the theory discussed in this book is valid, with the caveat that the threshold value of 45 minutes can change if the activity pattern of individuals shows evidence of radical change as well. Regarding the latter group, it proves that besides a good physical accessibility, possibly in connection with distribution (a library's stacks, a publishing house), a good and reliable connection to the IT network for local, regional, national, and global exchange of information is an important condition for establishing premises at a particular site. Precisely with regard to that network, a phenomenon specific to the big city comes to the fore: the phenomenon that Pred refers to as long-term rank stability (Pred, 1977). Unlike the history of the telephone, for instance, implementation of information technology widens the gap between metropolitan areas and the countryside with its smaller towns. One reason is that investment in information technology goes to the city first. But an even more important consideration is the opportunity to switch back and forth between physical mobility and the transfer of information via the computer. This strategy could play a major role when commuting time between big cities declines, for instance by introducing fast train connections. According to Sanuki Toshio, the information revolution is reducing time-distance between specific major cities at a rapid rate. Therefore, one of the problems of the information society is that only a limited number of cities are becoming centers of information, with many other cities lagging behind. This creates the possibility of difference in the level of information sophistication. (Sanuki Toshio, 1970)

In the present situation, as analyzed in Chapter 7, the influence of the surroundings of the metropolitan area plays an unmistakable role. The key question is, which urban areas are (physically) accessible? In that respect, as in the temporal processes in the urban system, a reduction of the travel time between large metropolitan areas, and the growth in the IT sector put the functional structure of the region in a different light. In view of the theory advanced in this thesis, which accentuates physical accessibility, the interaction between three factors – namely, physical accessibility, the connection to the IT network, and the possibility to cover large distances quickly – may be expected to play a role in the coming period. The new 'hot spots' in the urban area

will then be those locations that have not only a high accessibility value but also a good and reliable connection to the information network. The consequences are clear: alongside the criterion of physical accessibility, the regional IT network, and particularly that part of the network with a large capacity and high degree of reliability, could play a leading role in the further development of the functional structure. That possibility prompts an important question to be addressed in further research. Notably, one of the key assumptions on which this research is based states that physical accessibility is the most important location factor. Research on the extent to which companies and organizations but also individuals have meanwhile been profiling themselves in terms of the information age and research on how they let themselves be led in their choice of a location by the reliability and availability of information is imperative. Only by understanding such behavior can we gain insight into the future development of the functional structure.

The European Commission (1993) has studied the significance of information and communication infrastructure as a location factor. In light of the questions asked, we can see the research results as a first indication of the scope of the development. In view of the speed with which the sectors of information and telecommunication have developed, the research results almost seem out of date. Nonetheless, the study shows that for office functions in particular (including head offices), the presence of quick and reliable information infrastructure is a critical location factor. It ranks third in importance, after accessibility and parking facilities. For financial institutions, business services, and activities associated with software, this factor is almost equally as important as physical accessibility, according to the study by the European Commission. Based on the fact that this infrastructure constitutes a key location factor, then the next question to be considered is to what extent there is a differentiation – at the national, the regional, and perhaps even at the local level – in speed, capacity, and reliability.

In his research on the Netherlands, Drewe (1999) raises the question whether current ideas about spatial planning are still in line with recent developments in the field of information technology. In that study, he observes that IT is becoming increasingly important as a location factor and that it is gradually becoming a necessary condition. At the same time, however, he observes that several economic sectors are almost entirely directed toward IT. In addition, his study shows that the reliability of the data communication within the Netherlands and for connections abroad leaves much to be desired. The chance of errors is still great because so many networks are linked and so much switching is done across those networks. If data communication is critical to a firm's business, then the closer the company lies to a (major) interconnection point[5] the smaller the chance of error and the greater the speed and capacity (Drewe, 1999). The Netherlands currently has 19 KPN interconnection points of this sort, and these are found in several of the larger cities. Only a few of these points actually provide a direct international connection and sufficient capacity, however, which does not improve the reliability. How important is this? And to whom? At the national level, the main issue is where the economic concentration of this new industry can and will take place. As Drewe rightly points out, the concern is whether this concentration will comply with spatial policy and how that development can be influenced by infrastructure. By extension, the second question is whether there is still any differentiation at the regional level.

The current trends in IT infrastructure allow us to speculate on the further development of the South Wing. The KPN has two interconnection points there: one in Rotterdam, the other in The Hague. Urban telecommunication rings are linked directly to those points. Most of the surrounding towns and villages fall outside those rings. If the IT infrastructure, in conjunction with physical accessibility, is to play a significant role as a location factor, then the development will probably have to take place along the following lines. Taking present infrastructure as the point of departure, companies and organizations associated with the IT sector will locate primarily around The Hague and Rotterdam. This will relieve some of the pressure on areas lying in between the cities or at some distance. From this perspective, it seems that selective investment in IT infrastructure would help curtail the spread of urban and regional activities. However, an

unrestricted expansion of the IT infrastructure would lead to further leveling out, just as we have seen for the automobile infrastructure.

As Roberts (1999) argues, in order to achieve an 'integrated metropolis' B that is, a multinodal metropolis with diverse centers B it is essential to integrate physical accessibility with the information infrastructure. Naturally, this condition applies to the creation of a nodal structure as well. Roberts takes the same position as Ocelli, stating that both physical and the digital accessibility must be brought under the same heading in the conceptual framework of the metropolis. Thus, by serving as a platform for the interaction between the various parts of the city, communication networks form the basis for the design of the city of today. From that standpoint, Robert's ideas tie in with the core of the structural models described earlier. ìConsidering the connections between the traditional urban centers and new sub-centers leads to the notion that it is the communications network which forms the essential building block for a model of the city's structure, rather than either the urban block or the neighborhoodî (Roberts et al., 1999). The integration of new communication networks in those structural models would seem to be a logical step in light of current developments. But it is also a necessary step if the field of urban design is to contribute to the development of the modern city.

8.8 Conclusion

This chapter considered the applicability of the theory and the method to urban design at the regional level. The question raised here is whether the instrument of weighted accessibility is a practical means to understand how the functional structure develops. Several models of structure were taken as the basis on which to elaborate the instrument. The analysis of those models and the adaptations to make them more consistent shows that the insight that was gained in Chapters 5, 6, and 7 can be applied. This leads to the elaboration of a method to guide the development of the functional structure. The notions of dispersal or concentration, as worked out in the models of structure, are taken as the point of departure. On these grounds, we investigated whether the presumed effect on the functional structure –specifically, the change in the accessibility value – is achieved in existing situations. Two proposed designs – one for the South Wing of the Randstad Holland and the other for Minneapolis – Saint Paul – demonstrate that further spread of regional activities can be curtailed. This can be accomplished by pursuing a policy of more dispersed urban land use and by emphasizing the urban infrastructure while regulating the use of highways. Conversely, a policy of compact urbanization gives greater impetus to the spread of those activities. In this regard, we must reiterate that a number of qualities that helped form the basis for the notion of the compact city – including better utilization of mass transit, shorter distances for slow traffic, restrictions on land use – have played no role in the analysis whatsoever. In that sense, we would not be doing justice to the notion if we were to discard it solely on the grounds of the analysis performed in this thesis. Still, the analysis does reveal some weak points, all the more reason to examine the concept of the compact city more closely.
This chapter ends by raising a critical question:
To what extent will physical accessibility keep playing a role in the development of the functional structure of the urban system? It is argued that the integration of the various networks – and thereby integrating physical and virtual accessibility – could play an increasing role in the development of the functional structure. We also observed that as the IT sector develops further, it could provide a basis for growing differentiation in the functional structure. In principle, the IT sector can thereby help combat the current tendency toward an ever-wider dispersal of urban and regional activities.

Notes

1.
By introducing gradients (radial gradient, tangential gradient, bimodal and trimodal gradient), De Jong develops a whole spectrum of distributions. In principle, this method generates 18 basic forms for the distribution of one variable; the number of possibilities becomes much greater when multiple variables are taken into account.

2.
Besides that, knowledge about the relation between the situation-specific context and the spatial pattern is another important object of research. Unlike the method whereby the situation-specific context is removed through reduction, knowledge obtained by the last-mentioned method is not necessarily generally applicable. In that case, the investigator must construct a typology that is tailored to the various situations and use that model as a basis for research.

3.
The grid is generally used with reference to the division of lots in the urban area (as in Manhattan). In that sense, a grid is unlike the other types. On the other hand, a grid can denote a structure devoid of differentiation and hierarchy. In that respect, the network model is an example of the grid principle.

4.
The municipality of Amsterdam studied the feasibility of building over the A10 highway (Dienst RO, 1997). As a way to adapt the A10 West, the report suggested using part of the highway for that purpose, which would mean lowering the maximum driving speed.

5.
In the Netherlands, this refers to an interconnection point operated by KPN, the company that provides the country's postal and telephone service.

9.1 Introduction

This research project grew out of a fascination for the city. I was particularly fascinated by the kind of change now going on in many metropolitan areas: the shift from a city with a single main center to multinodal urban areas. That new structure is also known as a polynuclear city or an urban network. In any case, the distinguishing characteristic is the fact that there is no longer just one main center. A multinodal structure is generally characterized by multiple centers, regardless their degree of specialization.
The objective of this thesis was to gain insight into this process of change. The idea was to apply that insight to the practice of urban design in general and to design at the urban and regional level in particular. To that end, the main thrust of this thesis has been on the relation between the changes in accessibility and the change in the functional structure. That perspective was chosen to be able to pass on a number of viable instruments to practitioners working in the field of urban design.

When Joel Garreau's book *Edge City* appeared in 1991, it sparked a discussion on the idea of the multinodal city that has since stirred up a torrent of debate. In the scientific arena, scholars for and against the principle – especially in the United States – have discussed it extensively during the rest of the decade. Elsewhere – in the Netherlands, for example –interest in this urban phenomenon has grown mainly as a result of the increasing complexity of the design task. For myself, that design task has also been a source of inspiration for this thesis. In that sense, the bulk of the conclusions – the models and interventions presented in Chapter 8 – are related to that task. The point is that it is fundamental for a technical science like urban design to make knowledge applicable to practice.
From the perspective of design research, incidentally, it seems self-evident that research should start with a series of designs. Then the research could build upon the existing body of knowledge – in this case, on the relation between diverse spatial factors and the distribution of functions – to put these designs to the test, as would be it an experiment in one of the natural sciences. As it turns out, more knowledge would be required to perform such a test. Even though the phenomenon of the multinodal city had already been described early in the twentieth century, hardly any research had been done on this topic until the 1990s – at least hardly any studies had produced results that could be applied to urban design. Design research, which is gradually taking shape within the field of urban design, is still in its infancy in that respect. But so is the field of research that is required for meticulous testing of design interventions. As far as the present thesis is concerned, the immature state of the art has had several implications for the research design. First of all, a theory building phase and a review of the literature formed the point of departure for a case study. That case study, in turn, laid the groundwork for the design research. Not surprisingly, virtually no research protocols were available for a study along these lines. In that sense, this thesis is the outcome of an exploratory study.
That entailed searching within the discipline of urban design for a research framework that would yield research results that are applicable in the practice of urban design.

The core of the present thesis is the search for those factors that lead to change in the functional structure of the city – or perhaps we should say, in the urban system. That search initially emphasized the processes of change that lead to the emergence of a multinodal structure. Subsequently, the study took another direction. The focus was then on how, by means of design interventions, the structure of an urban system could be changed so that the desired structure would be achieved. The intention was for this research to explain the diverse characteristics of urban structures as well. However, that explanation had to be limited to a theoretical discussion. As it turned out, that aspect of the research design did not fit into the case-study approach, at least as far as the methodology is concerned. The case studies were specifically intended to reveal the relationships at the scale of the entire region. In contrast, an investigation of the qualitative aspects would require a detailed inventory at the scale of the locality or neighborhood. Moreover, the intended explanation would require comparability among the different cases. At the scale of the urban region, there is still some degree of comparability, given the fact that the urban economy is embedded in a context of liberal

capitalism. At the local level, however, there are various factors – climate and people's lunch habits, for instance – that influence the qualitative aspects.

9.2 A Turning Point in Urban Development

As mentioned above, researchers devoted relatively little attention to the multinodal urban structure until the nineties. This can be explained in part by developments that have taken place over the past 150 years. For a long period of time, infrastructure development – canals and waterways, railroads and tramways – but also industrialization determined the way in which Western cities in particular were organized in both a spatial and a functional sense. These developments had something in common. They all contributed – to a greater or lesser degree – to the strong position of a nodal urban structure. At a general level, we might say there was a far-reaching optimization of the nineteenth-century metropolis, whereby the strong concentration and centralization of functions came to distinguish it from its previous form.
In principle, this process of optimization has had wider repercussions. It has also resulted in a highly normative approach to urban design. A prime objective was the development of a single center; the epitome of this trend was the city forming that took place in the seventies. However, for some time, regional economic and geographical theories of the city were also couched in the same belief that a city must have one and only one center. It was not until multinodal urban areas had appeared that people realized how deeply imbued their thinking was in the classic image of the city. Only then did they see the need for new insights in order to better understand the phenomenon of the city in general and its functional structure in particular.

Uncovering the hidden assumption that a city must by definition have just one center brings a new question to bear. What are the determining factors – specifically spatial factors – behind the development of the urban structure? Here, urban structure refers primarily to the pattern of distribution for urban and regional activities and the relations associated with them. This question leads to one of the most important propositions to come out of this investigation. As shown in this thesis, differences in spatial conditions play a key role in the development of and locational choices for urban and regional activities. By extension, they influence the functional structure of the city. Research into the choice of a business location is generally concerned with finding a direct relation between spatial factors and the site selected for one specific activity. Here, however, the emphasis is placed on the difference in spatial factors at various locations. This shift in emphasis opens up an interesting perspective in the study.
As pointed out earlier, a number of theories about the dispersal of urban activities are based on the assumption that a major shift has taken place in the location preferences of companies and organizations. Thus far, however, only a few aspects of that assumption have been proven. Let us assume that the locational preferences have remained more or less unchanged through time. In that case, we may conclude the following: because of a strong shift in the difference in spatial conditions (that is, a leveling of the differences), each and every urban activity would seem to be liable to being located anywhere in a region. Besides numerous other motives for a particular locational choice, accessibility still seems to be the most important one. It also seems that any place is almost as good as any other, as long as these places are equally accessible. This perspective was explicitly drawn into the research design with respect to the phasing of the objectives.
In order to investigate the research problem, as well as the hypotheses derived from the statement of the problem, the first task was to study the process of change. Subsequently, the relation between spatial differences and the distribution of urban and regional activities was examined. As elaborated in Chapter 5, 6, and 7, those two parts of the study then set the stage for developing a set of instruments with which the design process can be supported at the level of the city and its region.

In brief, this thesis had four objectives:

Objective 1:
To determine the correlation between the functional structure and the differentials in location value within an urban area;

Objective 2:
To clarify the relation between change in the functional structure and change in the differentials in location value;

Objective 3:
To identify the characteristics of various functional structures on the basis of how those structures affect symbiotic activities and transport flows;

Objective 4:
To develop a series of spatial interventions on the basis of factors affecting the functional structure at the scale of the system of cities, whereby the interventions would be designed to influence this process of change, and to develop an instrument to analyze sectoral and integral spatial proposals.

9.3 Definition of the Research Problem

In most cases, the multinodal city is perceived as the result of the change from a nodal city caused by the dispersal and deconcentration of urban functions.
The point of departure for this standpoint, which is propounded in many theories, is that multinodality is always a result of a process of change. That process is referred to here as *transformation*. It is also conceivable – certainly in the field of urban design – that an urban system could have a multinodal structure from the very start. In that event, the structure would be predetermined. From that perspective, we could refer to that structure as *design*. There is another way in which a multinodal structure can come into being. That happens when two or more urban systems (regardless of whether they are nodal or multinodal) are merged to form one new urban system. This last process is what I call the *emergence of a conurbation*.

This research is primarily concerned with two processes: transformation and the emergence of conurbations. The present study revolves around the relation between the change in the differentials in spatial factors, on the one hand, and the change in the functional structure, on the other. By transformation, we mean the change in the functional structure of a single urban system. In most cases, the change is from a nodal system to a multinodal one.

By the emergence of conurbations, we mean the development of a new urban system as the result of the increase in relations between two or more (smaller) urban systems. To understand this process, it is useful to break it down into a number of steps.
The first step in the process is in fact the initial phase, which I have called *interaction*. Various relations are maintained with other urban and rural systems in this phase. Those relations have no significant effect on the functional structure.
I call the second phase *interference*. External relations become intensified during this phase, whereby they have a greater impact on the functional structure. The level of the urban and regional activities is still connected to that of the individual urban systems. One example of interference within an urbanized area with multiple urban systems is the relocation of activities to the city's edge; shopping centers form the classic example.
The last phase in this process is called *system formation*. This term denotes the existence of a new urban system. In fact, there is no more distinction between internal and external relations at this point.
The defining characteristic of system formation is the fact that the new urban activities that come into being are appropriate to the size of the new urban system.

9.4 A Theory of Multinodal Structures

Countless decisions might have to be made with respect to the choice of a location for one single urban activity – a museum, for instance – for which a large number of factors must be weighed by both private and public parties. In view of the scope of the decision-making process, it would be futile to try to explain a change in structure – which takes place in the course of several decades or more – in terms of the location conditions for activities. Therefore, it is necessary to have a theoretical framework that can be used to observe and describe the mechanisms that are at play in the process. An important step in that direction is not to ask why the process took place; the question should be how. From this angle, the theory, as described in Chapter 3, states that any change in accessibility should be taken as a determining factor in the development of a multinodal structure. With respect to the spatial factors, the theory emphasizes the fact that it is not so much the absolute

accessibility that matters but more a question of weighted accessibility. In other words, the difference in accessibility between given locations determines the location of urban and regional activities. On the other hand, it proves that accessibility is still the most important location factor for numerous activities. Another factor that is important to this thesis is that the amount of time that people spend on travel for their daily activities has remained the same over the centuries. Because that factor could be held constant, we were able to study the spatial factor of accessibility and the effect on the functional structure.

At this point, one might ask if there is a causal relationship between accessibility and the functional structure. The answer is no. As mentioned earlier, accessibility is merely one of the location criteria for an activity. Therefore, it is obvious that good accessibility in itself is not sufficient reason to locate a cinema or an office estate, for instance, in a particular place. The good accessibility only provides one of the necessary conditions that the location decision will take into account. Of course, this standpoint has implications for the research methodology.
It is clear that the relation itself cannot be falsified. Only the counterfactual – for instance, if activities were to be sited in an inaccessible place – can be used to falsify the hypothesis.
Another problem arises when we take a conditional relation as the point of departure. In this case, the relation is between weighted accessibility and the pattern of distribution of urban and regional activities. The problem is that this relation cannot be expressed in an absolute sense.

Accessibility differentials of more than 49 percent, for instance, cannot be related to numbers of jobs or square meters of sales floor space. However, if we do not include a number of values in the thesis, it is virtually impossible to test the hypothesis. Moreover, the research results would have little meaning for the development of a design instrument. For that reason, the following threshold was set: if the relative accessibility is less than 80 percent, the accessibility criterion for the location of urban and regional activities will be insufficient. In that sense, 80 percent is a threshold value that indicates the difference between sufficient and insufficient accessibility.

9.5 Structure of the Cases

Assuming a relationship between the difference in weighted accessibility and the functional structure, and assuming that change in accessibility has a decisive influence on change in the functional structure, a number of hypotheses may be investigated. The method chosen for this investigation is the case study. First of all, that method is appropriate to the relation to be studied, which rules out a number of other research methods. Secondly, the case study was selected because neither the relation to be studied nor its context – an arbitrarily chosen urban area – is always clearly circumscribed.

Among the questions that arise with regard to the relation to be studied, one of the most important is the issue of causality. To what extent did a change in accessibility lead to a change in the structure? Or did the location of a number of new activities, mediated by a concomitant demand for new infrastructure, lead to a change in accessibility? In light of this question, we decided to first give attention to the relation between the change in accessibility and the change in the functional structure. Only when that relation had been clarified would we investigate the relation between weighted accessibility and the functional structure.
At the same time, in view of the exploratory character of this thesis, we conducted two consecutive studies of single cases to investigate how change in accessibility is related to change in the functional structure. That made it possible to apply the insights gained from the first case – insights that could have repercussions for the theory – to the research design for the second case.

One of the single cases refers to Minneapolis – Saint Paul (Minnesota, USA). The other refers to the South Wing of the Randstad Holland (the Netherlands). Both research areas were known to be subject to the emergence of conurbation. The single case consists of a series of snapshots taken at intervals of 20 years, starting around 1850. The series starts at a time when the tram and the train had not yet made their mark on

the urban area and it runs up to the present.
The results of these single cases laid the foundation for a multiple-case study. There, four metropolitan areas were compared. On that basis, we investigated the relation between the weighted accessibility and the functional structure. The following four metropolitan areas were covered in that multiple-case study: Minneapolis – Saint Paul (Minnesota, USA); the South Wing of the Randstad Holland (the Netherlands); Dallas – Fort Worth (Texas, USA); and Frankfurt am Main – Wiesbaden – Mainz (Germany). The multiple case covers several issues. The core of that study is the precise calculation of the weighted accessibility and the analysis of the relation to the distribution of a number of urban and regional activities. But it also contains a description of the context of the cases, accentuating the significance of spatial planning while examining other aspects as well.
The weighted accessibility is calculated by establishing a value for potential accessibility. The latter value is the total size of the built-up area from which a given point can be reached within a given amount of travel time. In the calculation, the absolute (potential) accessibility is worked out for raster units of 2.5 by 2.5 kilometers. The outcome is then divided by the highest value measured. These steps lead to a value for weighted accessibility, expressed as a percentage for each of the cells in the grid. The value is determined for urban and regional activities, including employment. Specifically, values are calculated for jobs provided by companies and institutions in the tertiary and quaternary sector; services, particularly urban and regional shopping facilities (mainly non-food); cultural amenities (museums and theaters); educational institutions (universities); and large sports facilities that have an important public function. The main thrust of this exercise was to gain insight into the relation between weighted accessibility and the functional structure.

9.6 Properties of Structure

One of the objectives of this research project was to shed light on the characteristics specific to various types of functional structures. As mentioned earlier in this chapter, that topic was not covered in the case studies. Nonetheless, the theory has some implications that would certainly warrant attention in a follow-up study. Our initial argument was concerned with characteristics that may be directly ascribed to the functional structure. In that context, we are most interested in the opportunities for mass transit and in the possibility that symbiosis would take place. These options are dependent upon how the mutual relationships are organized among activities in an urban area. In other words, the options depend on the structure.

With respect to mass transit, as we noted in Chapter 3, multinodal structures appear to be more favorable for public transport in urban areas with approximately three million inhabitants. The reason is that during the various peak times, the lines are busy in both directions, unlike the situation in nodal structures. However, in addition to being classified as multinodal, the diverse centers have to be sufficiently multifunctional in character. Moreover, it is important that the relative position of the various centers, the concentration of destinations in those centers, and an adequate frequency of service would permit chains of moves to take place without too much loss of time.
Symbiosis is a characteristic that is highly dependent upon a continuous flow of people in a public area. A nodal structure guarantees that this condition will be met, as all urban and regional activities are found in one single center. In multinodal structures, symbiosis is only conceivable when the centers are multifunctional or, in the case of monofunctional centers, when these are shopping centers. Only at such locations is there a sufficient flow of people throughout the entire day.

9.7 Hypotheses and Research Results

On the basis of theory about the factors that determine the development of the multinodal structure, we formulated a number of hypotheses. Subsequently, these were investigated by conducting case studies. The following five hypotheses have been studied here:

1. Change in relative accessibility within an urban system is a necessary condition for a change in the distribution of collective activities.

2. Change in the relative accessibility in an urban area

whereby at least two locations get an accessibility score that is greater than the threshold value is a necessary condition for transformation.

3. Change in the relative accessibility in an area where multiple urban systems are found, with the result that one or more locations get an accessibility score that is greater than the maximum score applicable to each of the systems separately yet lower than the threshold value for two systems jointly, is a necessary condition for interference.

4. Change in the relative accessibility in an area where multiple urban systems are found, with the result that one or more locations get an accessibility score that is greater than the threshold value applicable to each of the systems separately, is a necessary condition for system formation.

5. A location's accessibility score that is greater or equal to the threshold value is a necessary condition for the presence of urban and/or regional collective activities at that location. The threshold value is 80 percent of the maximum accessibility score for the area of the urban system.

The first four hypotheses were the subject of research in the two single cases. In the first single case, we examined the development of Minneapolis – Saint Paul. This urban area is known as the Twin Cities. That name would suggest that the case study is about a classic double city. In reality, as the analysis reveals, the situation is more complex. Besides the two downtowns, there are a number of other important centers in the urban region. In that light, it is definitely better to classify Minneapolis – Saint Paul as a multinodal system.

The Twin Cities are located in the southwestern part of the state of Minnesota at the point where the Minnesota River flows into the Mississippi. The population of the metropolitan area of Minneapolis – Saint Paul is roughly 2.5 million. The region is host to a number of major international firms such as 3M, Dayton Hudson, and Cargill. Saint Paul is the state capital of Minnesota. Furthermore, Minneapolis – Saint Paul is known as the home of the Mall of America, which is currently one of the biggest shopping malls in the world. The case of Minneapolis – Saint Paul is described in Chapter 5.

For much of its history, Minneapolis – Saint Paul had developed as two cities operating as separate systems. Starting in 1850, which we take as our vantage point, that development continued until about 1940. The course of development in that period may be characterized by interaction. From 1940 onwards, a number of developments took place that led to a change in accessibility.

The first development is the greater importance attached to the automobile around 1940 and the emergence of new shopping areas. The next is the increase in the number of roads around 1960, when the first shopping malls were built and a number of regional facilities were established. The last development was the deconcentration and decentralization of employment, which started in the 1970s.

The construction of highways in the period around 1960 allowed the development of locations that could be reached within 45 minutes from anywhere in the entire urban area. Because of that development, the condition for system formation was present. The locations of the shopping malls that were built in the period around 1960 satisfy this criterion for accessibility. The strong orientation toward the new suburban areas, as well as the level of these malls, suggests that these are subregional facilities. For that reason, these observations do not lend support to our hypothesis. However, a number of unique facilities were also created, such as the sports stadiums, Orchestra Hall, the Walker Arts Center, and the Guthrie Theater, all of which clearly perform a regional function. The hypothesis that system formation will occur if there are locations with an accessibility score greater than the threshold value of 80 percent is thereby not falsified. For this research, it is important to emphasize that no regional functions have been established at locations that do not meet the accessibility criterion. Thus, the hypotheses are not refuted.

The late timing at which system formation could take place with respect to employment is noteworthy. Around 1960, a large share of the employment appeared to have a regional function already. Nonetheless, that function only became clearly visible in the 1980s, when new

employment areas were developed and the volume of traffic increased. Only then was there firm evidence that Minneapolis – Saint Paul had developed into a single urban system. The difference between the development of the locations for employment and those for services might be explained on the basis of a large differential in spatial conditions. At any rate, public facilities (stores, stadiums) are directly dependent on their accessibility to visitors (their economic base). Many companies, and particularly manufacturing industries, had been dependent on transport possibilities and transport costs till well into the 1970s. At the same time, they also had to be allowed to create some degree of nuisance in the surrounding area. Only when the production processes changed, which started to occur in the 1970s (Alonso, 1975a), could companies become less dependent on traditional location factors. From then on, they seemed to become freer in their choice of a location.

The first case, that of Minneapolis – Saint Paul, reveals a sequence of events that tend to occur as a result of changes in accessibility. First, there is interaction between two urban systems. This is followed by interference and then by system formation. Subsequently, the urban system undergoes a process of transformation, which is manifest in the emergence of new cities in the area.

The second case was initially intended to cover the entire Randstad Holland. This is the urbanized area of Amsterdam, The Hague, Rotterdam, and Utrecht. Upon further analysis, it proved that this area does not fall into the category of an urban system. Nor is there any indication of an emergence of conurbation going on here. With respect to the distances between the cities and the amount of time it takes to travel from one to another, that process should be possible, however. Nonetheless, the volume of traffic between those cities is significantly lower than the volume of traffic in the individual urban regions. This observation was critical to the decision to conduct the investigation at a smaller scale, namely at the level of the South Wing of the Randstad. That case is described in Chapter 6.

The South Wing consists primarily of the following cities: The Hague, Rotterdam, Leiden, Zoetermeer, Gouda, and Dordrecht. The urbanized area making up the South Wing has roughly three million inhabitants and is thus comparable in population size to Minneapolis – Saint Paul. Given the current spatial configuration of the South Wing, one would expect it to be a double city. Thus, one would expect this part of the Randstad to be undergoing a process of change through interference and possibly system formation. However, the findings from this case study led us to draw some unforeseen conclusions. In any event, it is clear that the development in the South Wing of the Randstad got started later than development in Minneapolis – Saint Paul.

The South Wing is located in the southwestern part of the Netherlands. The biggest cities in this region are Rotterdam and The Hague. Since The Hague is the nation's seat of government, this city hosts a large number of embassies and international bodies, including the International Court of Justice. Rotterdam is renowned for its port facility, where various international oil companies have installations.

Up till the 1960s, when the automobile began to play a major role, there were no signs of interference in the South Wing. Already in 1900, train connections in this area – with an approximate travel time of half an hour between The Hague and Rotterdam – provided the conditions for the establishment of collective activities with a regional significance.
In the period from 1900 to 1960, the modal split was dominated by the tram and the bicycle.
There is no evidence of a clear relationship between laying the tramlines and establishing new activities. First of all, the tramlines were put in after the new urban areas were developed (in that case, the tramline did not constitute a condition). Secondly, the role allotted to spatial planning itself makes such a relationship unlikely. Particularly in the period 1940-1970, in light of ideas on the desirable functional structure of the city, the plans designated locations for residential and employment areas as well as concentrations of services. After 1960, the functional structure of the agglomerations changed. An increasing volume of automobile traffic and the construction of highways affected the accessibility of diverse locations.

The functional structures of the agglomerations were subject to the process of transformation in that period. Given the ongoing growth of automobile traffic and improvements in the road system, as well as the construction of a beltway around Rotterdam, further changes in the functional structure were inevitable. Around 1980, various collective activities with a function at the regional level were established at locations that met the accessibility criterion for interference.

In 1990, the South Wing did not constitute an urban system, in that the number of daily trips between the major poles was limited. Therefore, we must conclude that there is no system formation in the South Wing. Several explanations of this counterintuitive observation may be offered. First of all, it is possible that the mobility was still insufficient for the development of a single urban system in an area of this size. Consider, for instance, the fact that the average distance that people travel to and from work is just 12.2 kilometers. Secondly, it has been observed that great similarities exist between The Hague and Rotterdam with regard to the level of employment as well as the range of amenities. It is plausible that if the mutual differences were greater – for instance, one city that is obviously larger, or two or more cities whereby there are clear differences in employment base and range of amenities – the number of trips in the entire area would by many times be greater, allowing an urban system to develop. The third explanation might lie in the influence of spatial planning. Spatial developments between The Hague and Rotterdam are deliberately prevented by designating buffer zones. In this regard, it should be noted that until recently, regional plans and structure plans in particular have taken the individual agglomerations, and not the South Wing, as the object of spatial planning. In fact, the planning level that operated between that of the agglomeration and that of the Randstad as a whole has been grossly underexposed.

The difference between Minneapolis – Saint Paul and the South Wing of the Randstad may be ascribed largely to the different timing of the ascendancy of the automobile: the time when it became the most important mode of transport and the time when the highways were built and expanded. In Minneapolis – Saint Paul, the car has been predominant since 1940. In the period 1940-1960, a number of shopping centers were built in response to the interference in the area. In 1960, the highway system in the region of Minneapolis – Saint Paul was over 500 kilometers long, as compared to a total length of 140 kilometers in the South Wing. In fact, interference was not observed in the South Wing till after 1970, when a change in employment was seen at a number of existing locations and new locations for large-scale retail stores were established. The difference in distance between the two main cities in each pair –Minneapolis and Saint Paul are 15 kilometers apart, while The Hague is 20 kilometers from Rotterdam – partly determined the later development, at least in the South Wing. Incidentally, there is a striking similarity in the average distance traveled to and from work: 13.0 kilometers in Saint Paul and 12.2 kilometers in the South Wing.
Also, the majority of the locations of shopping facilities in the South Wing are planned. Furthermore, legislation is in place to ensure that only certain retail branches will be allowed to open outside of the planned shopping centers. But even more important is the timing of the processes of deconcentration and decentralization. In both cases, these processes started to take place in the 1970s, the point at which companies in particular became less dependent on traditional location factors (Alonso, 1975a). Specifically, the ideas on the ëfunctional city' and the 'hierarchy of centers' have had a determining influence on the location of district centers in The Hague and Rotterdam.

The spatial distribution of employment at the regional level shows large similarities. In both urban areas, the city centers – that is, the central business districts – contain the most important concentrations of employment. The other main concentrations lie at employment locations at the city's edge. There are two differences, however. First of all, in the South Wing, the locations of employment outside the main centers are sharply delineated. This is a clear example of the effect of spatial plans. Secondly, in Minneapolis – Saint Paul, the employment is more strongly concentrated in the central business districts. On the one hand, this may be ascribed to the system of skyways. The possibility to walk to one's office from the parking lot through these

skyways, in a comfortable climate, has led to a clustering of dozens of buildings. On the other hand, this difference may be described as a side-effect of the very fact that the South Wing is subject to planning. The process of city forming, which has made the concentration of skilled jobs possible in Minneapolis – Saint Paul, did not take place in The Hague, partly as a result of the vehement protests against cutting traffic arteries through the center and against the construction of office towers in that period.

In both cases it becomes clear that with the emergence of automobile traffic, the changed accessibility of diverse locations provided the condition for the development of urban and regional functions at those locations.

Developments in Minneapolis – Saint Paul laid the foundation for the theory on system formation. Reducing travel time by building highways – initially leading into the city center – helped make diverse locations accessible within 45 minutes from anywhere in the whole area. The first collective activities that are included in the level of the newly formed urban system are found in the existing centers. Because of the construction of the beltway, even more locations could be reached within 45 minutes, and these locations were mainly used for purposes of employment. Neither in Minneapolis – Saint Paul nor in the South Wing of the Randstad were any collective activities with a function for the entire area found at locations that did not meet the accessibility criterion.

In conclusion, it may be stated that the development of mobility –and in these cases, the emergence of the automobile and the construction of radial and tangential roads– has provided the necessary condition for locating collective activities outside existing centers. The fact that the accessibility value of locations has continuously changed in Minneapolis – Saint Paul has led to transformation, interference, system formation, and subsequently transformation again. In contrast, the South Wing has been subject to transformation and interference.

9.8 Accessibility and Functional Structure

Thus, there is a conditional relation between accessibility and the location of functions. The conclusion that changes in accessibility drive the development of the functional structure of the urban system, opens up an opportunity to investigate the correlation between the structure and the sum of the differences in accessibility, as formulated in hypothesis 5. That hypothesis is tested in Chapter 7 on the grounds of a multiple case. This case consists of an analysis of Minneapolis – Saint Paul, the South Wing of the Randstad, Dallas – Fort Worth, and Frankfurt am Main – Wiesbaden – Mainz.

Minneapolis – Saint Paul (see a summary of this case earlier in this chapter) is a complete urban system. It is also important to observe that the role of spatial planning is limited there. The analysis of Minneapolis – Saint Paul shows that a conditional relation exists between accessibility and the functional structure. If the weighted accessibility figure for a location is higher than 80 percent, the necessary condition for the development of regional collective activities may be considered to be present.

Spatial planning is given a great deal of attention in the South Wing of the Randstad (for a summary of this case, see earlier in this chapter), in contrast to the situation in Minneapolis – Saint Paul. The results of the analysis show that the significance of that planning has also been great: 67 percent of the concentrations of services are situated at a location for which the accessibility value is over 80 percent. If, incidentally, the inner cities are not taken into account, then the score is even higher: 89 percent. On the basis of the outcomes of the analysis of accessibility and the distribution of employment and services, it is still too early to draw an unambiguous conclusion with regard to the existence of a conditional relation between accessibility and the functional structure of the South Wing.

The third component of the multiple case is Dallas – Fort Worth, an urban region in the northern part of the state of Texas. This region has a population of approximately 3.9 million. The most characteristic

feature of the region is the enormous growth of Dallas during the eighties. In that period, countless oil companies established premises there, creating the image of Dallas that became known worldwide through the TV series of the same name. Besides these oil companies, the region is also home to an electronics industry, the best known firm being Texas Instruments. Dallas – Fort Worth is commonly referred to as a metroplex. In comparison with Minneapolis – Saint Paul, it is a developing urban system, whereby Dallas is the most important city in the area. Fort Worth keeps lagging behind. In that light, the multinodality of the metroplex would appear to be influenced less by the traditional twin- city principle and much more by the dispersal around Dallas. Just as in Minneapolis – Saint Paul, planning in Dallas – Fort Worth does not play a leading role.

On the grounds of the analysis of accessibility and the distribution of employment and services in Dallas – Fort Worth, we may conclude that a conditional relation exists between accessibility and the functional structure. If the weighted accessibility of a location is greater than 80 percent, the necessary condition for the development of regional collective activities is present. The results of the measurements are strikingly similar to those for Minneapolis – Saint Paul.

The fourth component of the multiple case is Frankfurt am Main – Wiesbaden – Mainz. This urban region is situated in central Germany. Mainz is the state capital of the federal state (Bundesland) of Rheinland Pfalz. The other two big cities lie in the federal state of Hessen. The region has played a prominent role in European history. Frankfurt a.M. was the capital of the Frankish Kingdom and later a court city. Mainz was the main bishop's seat, while Wiesbaden was a major spa resort. At present, Frankfurt a.M. is most famous as the site of the German stock exchange and various financial head offices. But it is also known as the home of big industries, including the automotive plants of Opel (General Motors).

Like Dallas, Frankfurt a.M. is the most important city in the region referred to here as Frankfurt a.M. – Wiesbaden – Mainz. In fact, it would be more appropriate to see Mainz, Wiesbaden, and all other cities in the region as suburbs of Frankfurt a.M. in a nodal region, rather than as equal, competing, or complementary centers in a multinodal region. Upon further examination of the way the region is organized, it proves that the central business district of Frankfurt a.M. is the leader on all fronts. Along the city's edge, there are some concentrations of offices, which incidentally are no less impressive than developments seen elsewhere, such as in the South Wing of the Randstad or in the American cases. Also, with the exception of the center of Frankfurt am Main, the region has no shopping centers that play a role of any significance.
An interesting observation in the Frankfurt a.M. region is that a large share of the population of the region resides in the 'countryside'. Also, the train performs an important service in facilitating the daily mobility of the population.
Compared with the two American cases, planning plays a leading role in this region. Furthermore, in contrast with the South Wing, the regional plan appears to have made a positive contribution to the development of the city center. One major difference between that plan for Frankfurt a.M. and the old plans for both The Hague and Rotterdam concerns the phasing of the development. In Frankfurt a.M., the rail and tram network, and later the metro, were put in when urban development took place. In the Netherlands, in contrast, the tramlines (an other urban rail connections) were put in after urbanization was already an established fact.

The accessibility analysis of the Frankfurt a.M. region shows relatively low values for the cities of Wiesbaden, Mainz, and Darmstadt. The large difference with respect to Frankfurt a.M. is due to the dispersed settlement pattern, whereby Frankfurt a.M. lies in the middle. But the difference is also caused by the network of roads, which are oriented more towards Frankfurt a.M. than towards the other cities.

On the basis of the outcomes of the analysis of accessibility and the distribution of employment and facilities, it may be concluded that there is a conditional relation between accessibility and the functional structure in Frankfurt a.M. – Wiesbaden – Mainz. If the weighted accessibility of a location is more than 80

percent, then the necessary condition for the development of regional collective activities is present.

Reviewing the results of the analysis, we see a high correlation between accessibility and the functional structure. Among the cases studied, only the South Wing of the Randstad has low scores. A number of factors contribute to these outcomes for the South Wing. Unlike the other cases, the South Wing does not yet constitute an urban system; instead, it consists of two interfering urban systems. Upon closer examination of each of these urban systems separately, however, the score is still low. The inner cities of The Hague and Rotterdam are exceptions to the rule. The weighted accessibility of these specific locations apparently does not have to amount to 80 percent. Although it was pointed out in Chapter 4 that the norm of 80 percent is provisionally assumed to be correct, it is still noticeable that the South Wing deviates from this norm, whereas the other cases do have good scores. Concerning the scores, it should be clear that the norm of 80 percent is not a thin, hard line. We probably will have to take a bandwidth of approximately ten percent into account. This means nevertheless that the norm could be 84 percent or more, whereby the cities in the South Wing would appear to be exceptions. The norm could also be anywhere between 70 and 80 percent, whereby the urban systems of The Hague and Rotterdam would not be exceptions at all. Either way, it is obvious that as the number of cases grows through future research, we will know more about the exact norm.

In an effort to explain the anomalous outcome of the analysis of the South Wing, the question is raised whether or not other factors are in play here. For the South Wing, there is a far-reaching form of spatial planning. Throughout the postwar period, Rotterdam has continuously worked on the reconstruction of its city center, where there was room for large-scale development. Furthermore, the influence of the automobile on spatial development has only been visible since the 1980s (see Chapter 6), which means that the effects of the automobile are only starting to manifest themselves now. There are also signs of a national policy to stimulate people to use public transport. The spatial policy has thereby had an effect on the relationship between accessibility and the functional structure. It might possibly act as a limiting factor in that relation.
Incidentally, the historic inner city of The Hague – including the Binnenhof, which is the seat of government – should be considered as one of the location factors. This cultural and historical quality would in a sense compensate for the lower degree of accessibility. Spatial policy that is geared to the promotion of the existing inner-city centers and public transport appear to have an influence in that respect also. Thus, the explanation of the anomaly might lie in the extent of planning or perhaps in the cultural and historical qualities of the individual areas. A further inquiry into the influence of spatial policy and cultural and historical qualities on the development of the functional structure would seem to be warranted.

	Accessibility and employment	Accessibility and shopping
Minneapolis – St.Paul	91%	92%
South Wing	59% (73%)[1]	67% (89%)[1]
Dallas – Ft. Worth	84%	90%
Frankfurt a.M.	94%	100%

(1) Results if the South Wing is considered to be two separate urban systems.

The differences and similarities between Frankfurt a.M. and the South Wing are striking. There is hardly any difference in the extent or method of spatial planning. However, the underlying spatial concepts are very different. Frankfurt a.M. is amenable to the concept of dispersal (with respect to the small settlements in the region). In the South Wing of the Randstad, in contrast, there are secondary settlements of 40,000 to 150,000 inhabitants in addition to the main centers. Furthermore, Frankfurt a.M. has a center with high-quality facilities and a much better network of roads. Its city center is easily accessible by car (the accessibility value of the inner city is 100 percent). By comparison, the South Wing of the Randstad makes a poor showing, with its underdeveloped network of roads and the limited number of public transport lines that serve the region.
There is another difference between these two regions. The Frankfurt a.M. region has a model for the development of the region, while no such model exists for the development of the South Wing. Instead, the

planning of the South Wing as a whole is directed by national concepts such as the compact city policy. Concepts such as these should be seen as separate from the spatial reality of the cities. Unlike the situation in Frankfurt a.M., the South Wing might be subject to top-down planning instead of bottom-up initiatives. Planning concepts that are imposed on the city might turn out to fit like a straitjacket. The result is manifest in the fact that the cities are surrounded by relatively large settlements: Zoetermeer, Spijkenisse, Capelle aan de IJssel. That picture is in stark contrast to the pattern of small and dispersed settlements around Frankfurt a.M. It is precisely for this reason that sites along the highways have a considerably higher accessibility value, although the policy does not allow that potential to be utilized. The older centers are given priority, whereas the spatial conditions for that development have never been realized. In other words, the planning in the South Wing may be said to create opportunities, only to subsequently prohibit activities that would make use of them, while steering such activities to areas where the necessary conditions are not present.

9.9 Applying the Results

The method chosen for the analysis of the relation between the weighted accessibility and the functional structure, as developed for this investigation, was applied in Chapter 7. That method provides an opportunity to analyze the present situation in any randomly selected area. In that way, it is possible to depict a range of potential developments. The method also offers an opportunity to test the effects of proposed spatial interventions. That is, the method indicates how the spatial conditions change. By elaborating that method, one of the objectives of the present research has been met, to some degree.
Applying that method and the results of the analyses, it was possible to develop a set of instruments for use in designing the urban region. Theoretical models of structure were taken as the point of departure.
The first step in developing a set of design instruments was to ensure that the models of stucture would be consistent with the results of this investigation. An analysis of the models of structure using the method developed in this thesis has brought several theoretical problems to light. For instance, a number of well-known constructs – such as the finger-shaped model and the satellite model – has proven to be inconsistent with the outcome of the analysis in chapter 7. The fact that most models originally are based on the assumption that public transport plays a structuring role -or should do so – explains this inconsistency. This inconsistency means that, with respect to the conditional relation between accessibility and the functional structure, the functional structure they depict was not logically derived from the spatial pattern described by these models, nor was it derived from the infrastructure network, given the dominant position of the automobile. By changing the spatial pattern and the infrastructure, the models were made consistent with the findings of the case studies presented here. In doing so, it proved that far-reaching adjustments were required to achieve the necessary degree of coherence.

The elaboration of the models and the analyses performed with them suggest a number of conclusions. First of all, we conclude that distribution, and by extension a road structure of a lower order to provide access, has a positive effect on the effort to limit the number of locations where urban and regional activities can be established. Secondly, it proves that adapting the network of highways, and in particular limiting the number of exits, has a highly differentiating effect. Conversely, measures to concentrate the urban area lead to an increase in the number of locations with a high accessibility value.
If the aim is to develop a single high-value multifunctional center, it will be necessary to create a nodal functional structure. It seems that the best way to achieve this is by adapting the network of highways. Alternatively, the use of those highways could be adapted, for instance by lowering the maximum speed limit. At the same time, it would be advisable to try to spread the urban area out instead of pursuing a policy of strong concentration. It is also evident that the development of a single high-value multifunctional center requires adequate solutions for the concominant parking problems.
On the other hand, if the aim is to develop a multinodal functional structure, in accordance with the network model, then there must be two or more large centers.

Moreover, it must be possible to assign those centers the same accessibility value. That value should reflect their more or less equal position in the connections at the supraregional level. In combination with a selective use of the network of highways and the dispersal of activities across the rest of the urban area, it would be possible to create a structure in which urban and regional activities would only take place at locations so designated. In theory, there may be two or more multifunctional centers of equal value or a number of specialized complementary centers.
However, if the aim is to allow urban and regional activities to be situated in as many urban areas as possible, then a different approach is needed. In that event, concentration of the urban area would appear to have a positive effect. An even greater effect is achieved when the area is made accessible by highways.
As indicated in the last network model, an area with highly dispersed activities that is fully accessible by highways has hardly any differentiation with respect to the weighted accessibility value.

We then tested the instruments described above to check how appropriate they would be for practical application. They were tested on two cases, namely Minneapolis – Saint Paul and the South Wing of the Randstad. However, as the analyses demonstrate, it is not possible to develop a nodal structure within these two urban areas on the basis of the proposed interventions. Yet it is possible to curb the current sprawling development of urban and regional activities. That would call for adaptation of the road network and a dispersed pattern of urbanization. Such measures would be almost imperative if the aim is to develop a multinodal structure that consists of a limited number of concentrated centers, as envisioned for Minneapolis – Saint Paul.
The idea that urban sprawl should be considered a good thing is almost diametrically opposed to Dutch spatial policy. In the Netherlands, compact development and urbanized corridors are the planning priorities for the coming decades. Furthermore, multinodal structures are expected to develop, and the centers that already exist within those structures are expected to become stronger. However, the analysis demonstrates that the urbanization principle opens the floodgates to development. That policy facilitates the almost uncontrolled sprawl of urban and regional activities. Incidentally, the central government of the Netherlands has expressed some doubt about the policy of compact urbanization. The government wonders whether the urban extension areas that are built immediately adjacent to the existing built-up area will actually provide direct support for the city's services. The government also has reservations about the scale of the urban extension areas, since an urban area that is too big may lose its appeal (Ministerie van VROM, 1997, p. 49).
It should also be noted that the policy of compact urbanization and urban corridors is also related to the promotion of other qualities. For instance, the urbanization principle calls for efforts to stimulate the use of mass transit and slow traffic (i.e., walking and cycling) as well as measures to curtail the consumption of space. In that regard, the analysis performed in this investigation sheds light on the weak points of the notions. That does not rule out the possibility that those notions might have other valuable qualities, however.

Physical accessibility is central in this thesis on multinodal structures. The degree of accessibility – and by extension, differences in accessibility between various locations – was found to have a determining influence on the functional structure. Looking toward the future, it is not at all certain that accessibility will remain the most influential factor, however. The question that must be asked now is what significance should be attached to the new information technology. How will it affect the development of the functional structure of the city? Changing temporal processes in the urban system, shorter travel time between large urban areas, and the ascendancy of information technology – all of these developments put the functional structure of the region in a different light. With respect to the theory presented in this thesis, whereby the accent is placed on physical accessibility, we should expect to see a new development in the coming period. In the future, the interaction between physical accessibility, the connection to the network for information technology, and the opportunity to travel quickly over long distances will play a more prominent role. The new hot spots in the urban area will then be those locations that have not

only a high score for accessibility but also a good and reliable connection to the information network. The consequence is that besides physical accessibility, the regional network for information technology could also play a role in the further development of the functional structure. This seems even more likely in light of recent findings of the European Commission. That research gives a first indication of the increasing importance of information infrastructure as a criterion in location decisions. In view of the importance of information technology, it is fair to say that selective investment in IT infrastructure, by extension, helps limit the dispersal of urban and regional activities. Nonetheless, a restricted growth of IT infrastructure may lead to further leveling, as we have seen in the automobile infrastructure. In my opinion, an empirical study to underpin that hypothesis would be an important topic for further research in this area.

9.10 Further Research

In the previous section, we observed that information and communication infrastructure plays a role in location decisions. We also noted the need to investigate the significance of IT infrastructure in that regard and its possible impact on the functional structure. But in addition to these points, some other questions have been raised in the course of this investigation. And these too should be topics of research. First of all, in the analysis of the South Wing of the Randstad, it became clear that the interaction between The Hague and Rotterdam is limited. In the ensuing discussion, a possible explanation emerged. It lies in the fact that for both cities, the employment base is dominated by the tertiary and quaternary sectors, while the level of the shopping facilities and cultural amenities such as concert halls and museums is very similar in these same cities. It is only natural to wonder if there could be more reciprocal relations than there currently appear to be. That question would certainly arise if the two parts of the South Wing were to differ even more with respect to the employment base and the range of facilities. In asking that question, one wonders if in addition to the primary condition, namely accessibility, there might be a secondary condition for interference and system formation. That other condition might be a difference in the nature of the employment base and the level of amenity, or rather the degree to which these elements are unique.

An important area for further research is the scientific discipline of urban design itself. The question is how design research should be elaborated. Is it better to refine the traditional method of trial and error? Or can modeling play a bigger role in research, in one way or another? Research along these lines is a necessary step in hammering out a scientific method for urban design research.

In the present investigation, we devoted attention to symbiosis and mass transit in Chapter 3. There, these issues were treated as characteristics that are related to the functional structure. However, these issues did not come up in the cases. Research into these aspects in relation to the type of structure can provide a definitive answer to questions about the quality of the structure. Therefore, further research is recommended. With respect to the quality of the structure, another point of interest is the relation between the type of structure, on the one hand, and the political, economic, and cultural power relations within a region, on the other. For instance, the Frankfurt am Main model is strongly hierarchical, whereas the South Wing model is much more egalitarian. The thought that comes to mind in this regard is that deliberate choices have been or are being made. These choices may pertain to the entire structure or to its constituent parts – for instance, as when the government has to decide where to locate museums.

One last research topic should be mentioned here. The significance of spatial planning to the development of an area should also be investigated. In my opinion, the observation with respect to the South Wing, whereby the effect of the national policy for spatial planning seems to be the opposite of what it was intended to be, calls for a review of the theory. The accuracy of the concepts that have been applied should be examined carefully, as these theoretical constructs provide the grounds on which far-reaching spatial planning has been justified

9.11 Final Remarks

In this thesis, we have attempted to shed light on the relationship between accessibility and the functional structure from the perspective of urban design. The purpose was to provide a basis that lies firmly within the scope of urban design, a basis on which to work out some new responses to the design challenges posed by the multinodal city. In my opinion, by making a deliberate choice to work from that perspective, we were able to provide a scientifically sound answer to a number of questions that seem to have been glossed over in the past. But at the same time, we have also broken new ground. Not least among our discoveries is the observation that the South Wing, both in its development as a conurbation and in its relation between accessibility and functional structure, deviates from the other areas covered in this investigation. By bringing that anomaly to light, we have raised some probing questions about spatial planning practice in the Netherlands, leading to some critical remarks on the subject.

At the beginning of this chapter, we stated that urban design, as a technical scientific discipline, is still in its infancy. Though this investigation, I have tried to make a contribution myself to the scientific field of urban design. At the same time, I have attempted to add to the toolkit that urban designers use in practice. The point is that given the changes that are currently underway in metropolitan areas – and of course in view of the increasing significance of information technology – the field of urban design will have to make a full-fledged contribution in the coming period.

Summary

Since the 1950s, the big cities in the United States have changed dramatically before our very eyes. Starting a little later, West European cities have done the same. The traditional city – as people generally imagine it to be, a city with one dazzling center – is gradually turning into an urban area with multiple centers. The shopping malls and the peripheral office estates are the inventions of twentieth-century urban design. These innovations are signs that the modern city is coming into its own, breaking loose from the nineteenth-century principle of the nodal city.

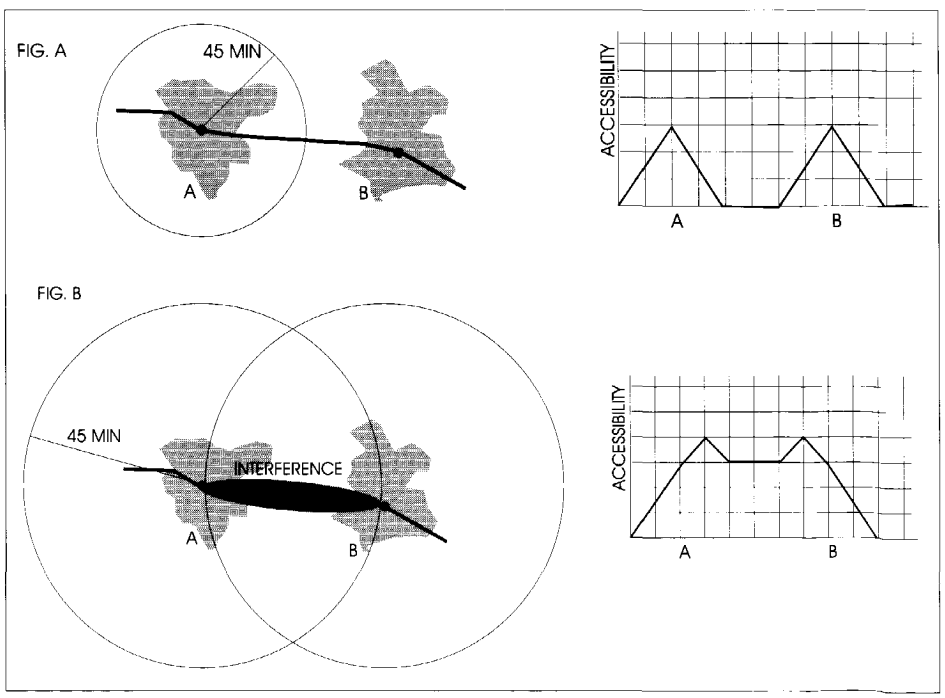
This investigation is concerned with that process of change, examining it from the angle of urban design. The main objective is to discover how these multicentered areas – or multinodal urban systems – come into being. To that end, we have to identify the factors that play a role in their emergence. This raises a question that lies at the core of the field of urban design: *Which spatial interventions are suitable to guide that process of change?* The issue of the multinodal system is not only close to the hearts of researchers. Indeed, it poses an urgent design challenge to practitioners in the field. In this thesis, we call an urban system multinodal when it has more than one concentration of collective activities at the scale of the entire urban system.

To address these questions, this thesis formulates a theory of multinodal urban structures. That theory names several ways in which a multinodal structure can arise. The first possibility is through *transformation*. This is perhaps the most prevalent process of change. It implies that the structure of an urban system changes – is transformed– from a nodal into a multinodal structure. This can happen when activities that took place in the original center are relocated – decentralized – or when new activities are established at a site outside of that original center. The second possibility is through *design*. In other words, the city is originally – when it is founded or laid out – conceived as a multinodal system. So far, this is a theoretical notion. To my knowledge, no city ever started out as a multinodal urban system or in fact was even designed with the intention of becoming one.

The third possible way in which an urban system can take on a multinodal structure is through the process I call *emergence of conurbation*. This term denotes a process whereby two or more urban systems turn into a new (and bigger) urban system. Especially when this process involves two or more cities of approximately the same size, there is a good chance that a multinodal urban system will come of it.

According to the theory, emergence of conurbation takes place in several steps. The first one involves *interaction* between two urban systems. The most characteristic form of such interaction is an exchange of people, goods and information. This does not affect the separate functional structures (that is, the pattern of distribution for the collective activities). These structures are affected in the next step, however. Thus, the term *interference* is an appropriate name for the next step. At that point, a segment of one urban system may come under the influence of another urban system, and the effect may show up as a change in the functional structure. For instance, a Furniture Row might appear on one side of the city to take advantage of the siteís proximity to the other city or cities in that direction. The third step in the emergence of conurbation concerns the development of a new urban system. If two or more cities are joined, the new city that is thereby created plays a role at a higher level. That step, for which we use the term *system formation*, may be recognized by the creation of new functions that go beyond the level of the existing ones. For instance, an opera house is a function at a higher level than a theater, and a museum of modern art is at a higher level than a regional museum.

By specifying the processes involved in the development of multinodal structures, we get a clearer understanding of the factors that play a role in the development of such a structure. In addition, only by specifying the relation between space and the urban system can our research be meaningful. One thing we should realize is that the urban planner does not make the system.



Interference

An urban system is no more than the sum of all kinds of human activities – of people, institutions, companies – and the decisions people make regarding those activities. Space and its associated characteristics do impose conditions on the urban system, however. Differences in the characteristics of that space are also expressed in the structure that is specific to that system. This raises the issue of the relationship between the characteristics of that space and the development of a multinodal structure. The question is, which spatial features provide the conditions for a development of that kind? An unambiguous answer to that question emerged from the literature that was studied as part of this research project: first and foremost, accessibility. Up till now, and in as far as the collective activities at the urban and regional level are concerned, the most important spatial condition is accessibility. Of course, accessibility is better at some locations than at others. That would suggest that the difference in accessibility is what determines the functional structure. On that basis, we formulated the expectation that a change in accessibility provides the condition for a change in the functional structure. Assuming that this expectation is correct, we may turn to the next question: What precisely is the correlation between accessibility and the functional structure? To find out, we developed a method to establish the absolute and the relative accessibility for every location. That exercise offers insight into the difference in accessibility throughout the urban region. On the basis of that insight, the dispersal of collective activities was analyzed to see if any relationship could be found.

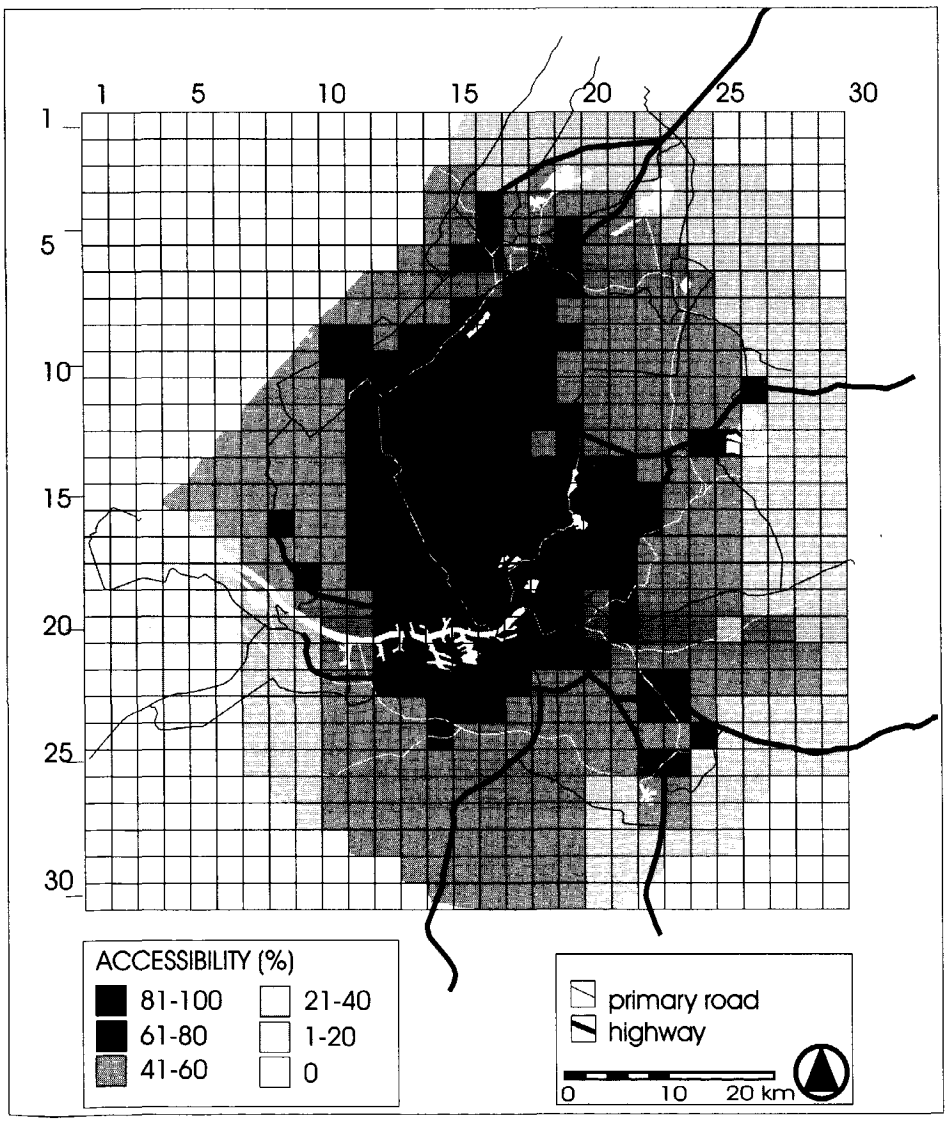
The first expectation was tested on the grounds of the development of the urban region of Minneapolis – Saint Paul (USA) and the South Wing of the Randstad Holland (the Netherlands). The method chosen for that purpose was the case study, whereby we studied two single cases. This approach allowed us to apply insights gained from the first case to the second study. The case of Minneapolis – Saint Paul deals with the development of this urban area from about 1850 on. The study relates the changes in accessibility within the area – initially by horse and wagon and then by horse-drawn tram, electric tram, and now by automobile, which obviously required changes in the road network – to the process we call emergence of conurbation. As the case of Minneapolis – Saint Paul reveals, the changes in accessibility led initially to interaction between two urban systems and subsequently to interference, followed by emergence of conurbation. The urban system of Minneapolis – Saint Paul was then subject to the process of transformation, whereby new centers appeared in the area. The ascendancy of the automobile in Minneapolis – Saint Paul during the 1950s led to a major change in the accessibility of diverse locations. As a consequence, the functional structure changed more and more. At first, this trend was reinforced by the construction of radial highways; later, the construction of beltways kept up the momentum of change. As a result of those beltways, in particular, a new process of transformation got underway.
The case of the South Wing of the Randstad describes the development that took place in that area during the same period. Here too, we see a major change in accessibility. However, in this case, it was not until about 1980 that there was any real sign of interference. Several factors proved to play a role: the slightly larger distance between the cities of The Hague and Rotterdam compared to the Twin Cities; the fact that automobile traffic took hold later in the Netherlands than in the United States; and the more limited network of roads in the Randstad compared to Minneapolis – Saint Paul. As the case study shows, the South Wing of the Randstad does not yet meet the criteria for classification as an urban system.
The conclusion that we could draw from the cases is that a change in accessibility is the most important condition for a change in the functional structure. Changes in the mode of transport and changes in infrastructure preceed changes in the functional structure. On the basis of that outcome, we proceeded to study a multiple case. In that exercise, we tried to establish a correlation between accessibility and the functional structure. The assumption was that if the degree of accessibility is insufficient or lies under a specified critical level, the spatial condition for the location of collective activities that are urban or regional in scope will not be fulfilled either. What we are looking at is not a linear relationship, whereby better accessibility would generate more collective activities. Rather, we are looking at a threshold value, which indicates the difference between sufficient and insufficient accessibility.
In the multiple case, the differences in accessibility were analyzed for the entire urban region. The outcome of this analysis was compared with the distribution pattern of employment in the tertiary and quaternary sectors (especially in office jobs) as well as with the distribution of urban and regional services (the main retail sector and important institutions). The multiple case was composed of four areas: Minneapolis – Saint Paul (USA); the South Wing of the Randstad Holland (the Netherlands); Dallas – Fort Worth (USA); and Frankfurt am Main – Wiesbaden – Mainz (Germany). In each one, we expected to find a certain degree of multinodality. On the basis of the multiple case, we concluded that a correlation does exist between the weighted accessibility and the functional structure, whereby the threshold value is 80 percent. This value indicates that if any given location can be reached from 80 percent of the entire region within 45 minutes by the most prevalent mode of transport (currently, the automobile), then this location satisfies the spatial condition required of potential sites for collective activities. For the South Wing of the Randstad, the analysis showed some deviation with respect to the inner cities of The Hague and Rotterdam. It should be noted that besides the late ascendancy of the automobile in the Netherlands and the possible impact of historical qualities, the influence of spatial planning also plays an important role. That is most evident with regard to efforts to stimulate development in the inner cities.

The outcome of the multiple case gives a strong impulse to urban design at the scale of the city and the region. With respect to the applicability of the research

results, we first evaluated various models of spatial structure such as the finger-shaped model. They were tested for consistency and adapted where deemed necessary. These models, which were presented in Chapter 8, may be considered as instruments that can be applied in the field of urban design. As a representation of the spatial pattern and the associated functional structure, a model can be used for various tasks, including designing urban extension schemes or finding a solution for regional infrastructure. The evaluation of these models led to several important insights. For one thing, it brought some side effects of policy to light. Specifically, the compact-city policy pursued in the Netherlands, but also the goal to implement the bundled urbanization principle in urban corridors over the coming decades, will reinforce the current trend toward further dispersal of urban and regional activities. Because of this side effect, that policy will come into conflict with two other aims of spatial policy, namely to stimulate the use of public transport and to reduce the use of the automobile. With regard to this conclusion it should be clear that the analysis in this research did not focus on possible other aspects of the Dutch policy.

The results of the multiple case served as a basis for considering the issue of instrumentation. We tried to determine which spatial interventions could be used to achieve a nodal structure and which would create a multinodal structure. In the course of this design research, it proved that a drastic intervention in the road network and in the spatial pattern would open up the opportunity to improve the accessibility of the inner cities selectively and in relation to other parts of the urban area. This would call for a reduction in the number of exit ramps from highways on the periphery of the urban area. It would also require adjustments in existing or new roads leading into the inner city. These measures would have to be combined with a dispersed pattern of urbanization by emphasizing small towns (up to 10,000 inhabitants). These measures would definitely restrict the development of the multinodal structure. It should be noted that in areas the size of the South Wing of the Randstad, such interventions have not succeeded in creating the necessary spatial condition in one and only one center while ensuring that the condition would not be met in the rest of the area. More extensive measures that influence accessibility, and perhaps consistent spatial planning, might make a further contribution to this effort. However, it seems that there is an easier way to promote the process in which a multinodal structure continues to develop further. Expanding the road network, selectively or not, and moving the edge of the city outwards are two proven ways to significantly increase the number of locations where the weighted accessibility becomes more than 80 percent.

In this thesis we took accessibility to be the most important spatial condition. Over the coming decades, there will be widespread debate on whether and to what extent developments in the field of information technology will reduce the significance of physical accessibility. Even now, there are some preliminary indications that the significance of high-grade IT infrastructure is becoming a key condition of the location choice for business establishments. In the near future, it will be imperative to investigate this topic in relation to the functional structure of the city.



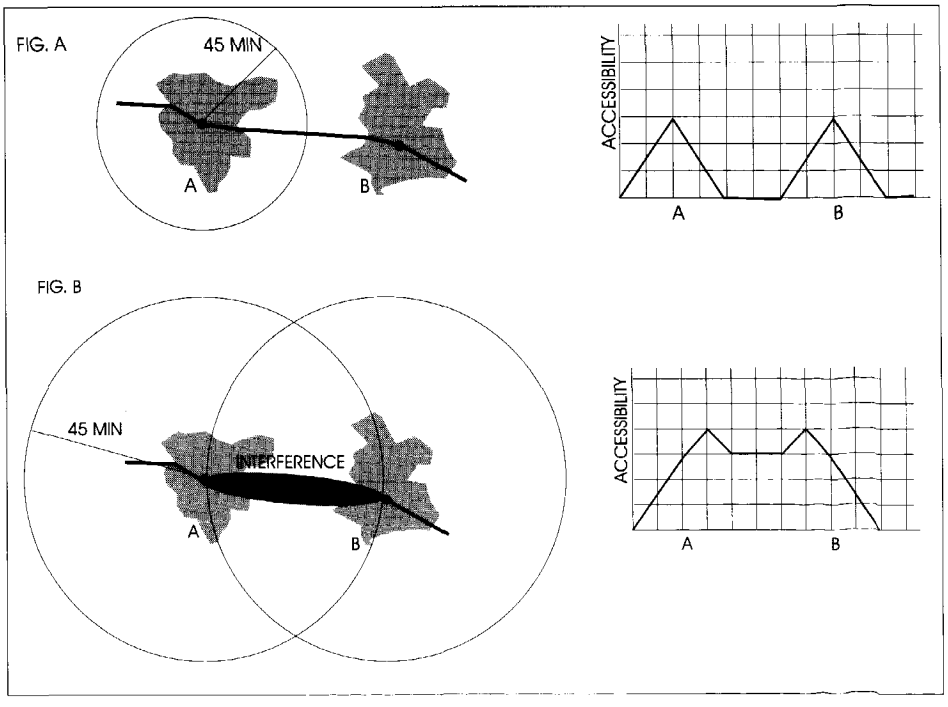
Accessibility Analysis South Wing (NL)

Samenvatting

Sinds de jaren vijftig zien we de grote steden in de Verenigde Staten, en enige tijd later ook in West-Europa, ingrijpend veranderen. De traditionele stad zoals velen zich een stad voorstellen, een stad met één bruisend centrum, verandert gaandeweg in een stedelijk gebied met verschillende centra. De shoppingmalls en de perifere kantoorlocaties zijn stedebouwkundige inventies van de twintigste eeuw, die tekenend zijn voor dat veranderingsproces waarin de moderne stad zich losmaakt van het 19e eeuwse principe van de nodale stad.
Dit onderzoek richt zich op dat veranderingsproces vanuit een stedebouwkundige invalshoek. De kernvraag is op welke wijze deze gebieden met meerdere centra, ofwel multinodale stedelijke systemen, ontstaan. Welke factoren spelen hierbij een rol, en, voor de stedebouwkunde essentieel, door middel van welke ruimtelijke ingrepen kan dat veranderingsproces gestuurd worden? Immers, het vraagstuk van het multinodale systeem is niet uitsluitend voer voor onderzoekers: voor de praktijk van de stedebouwkunde vormt het een actuele ontwerpopgave. We noemen in dit onderzoek een stedelijk systeem multinodaal indien er meer dan één concentratie van collectieve activiteiten waargenomen kan worden, op de schaal van dat hele stedelijke systeem.

Teneinde een antwoord te vinden op de hiervoor geformuleerde vragen, is in dit onderzoek een theorie over multinodale stedelijke structuren geformuleerd. In die theorie wordt gesteld dat er een aantal verschillende mogelijkheden zijn waarop een multinodale structuur kan ontstaan. De eerste mogelijkheid is *transformatie*. Dit is wellicht het meest voorkomende veranderingsproces. Het houdt in dat de nodale structuur van een stedelijk systeem verandert – transformeert – in een multinodale structuur. Dit gebeurt bijvoorbeeld doordat activiteiten uit het oorspronkelijke centrum op een andere – decentrale – locatie gesitueerd worden, of doordat nieuwe activiteiten gesitueerd worden buiten dat oorspronkelijke centrum. De tweede mogelijkheid is *ontwerp*. Met andere woorden: de stad is in oorsprong – bij stichting of aanleg – opgezet als multinodaal systeem. Dit is tot dusverre een theoretische notie. Er zijn geen steden bekend die ook werkelijk opgezet zijn als multinodaal stedelijk systeem, dan wel met die intentie zijn ontworpen.
De derde mogelijkheid waarop een stedelijk systeem een multinodale structuur kan krijgen noem ik *conurbatievorming*. Met deze term wordt een proces aangeduid waarbij twee of meer stedelijke systemen overgaan in een nieuw (groter) stedelijk systeem. Met name indien dit proces betrekking heeft op twee of meer steden van ongeveer gelijke omvang, dan is de kans dat een multinodaal stedelijk systeem ontstaat reëel. In de theorie is aangegeven dat conurbatievorming via een aantal stappen verloopt. De eerste stap houdt in dat er *interactie* is tussen twee stedelijke systemen, hetgeen omschreven kan worden als de uitwisseling van mensen, goederen en informatie. Hierbij worden de afzonderlijke functionele structuren (kortweg het spreidingspatroon van de collectieve activiteiten en de bijbehorende relaties) niet beïnvloed. In de volgende stap gebeurt dit wel. Deze stap is dan ook aangeduid met de term *interferentie*. Hierbij ondervindt een gedeelte van ÈÈn van de betrokken stedelijke systemen een dusdanige invloed van de andere, dat dit effect heeft op de functionele structuur. Aan die zijde van de stad ontstaat bijvoorbeeld een meubelcentrum dat profiteert van de nabijheid van die andere stad of steden. De derde stap betreft de ontwikkeling van een nieuw stedelijk systeem. Als twee of meer steden samengaan, ontstaat een nieuwe stad die in feite meespeelt in een hogere divisie. Deze stap, aangeduid met de term *systeemvorming*, is herkenbaar aan het ontstaan van nieuwe functies die het niveau van bestaande overstijgen. De opera ten opzichte van de schouwburg, musea voor moderne kunst ten opzichte van het streekmuseum bijvoorbeeld.

Door de verschillende processen in de ontwikkeling van multinodale structuren te definiëren, wordt gaandeweg helder welke factoren een rol spelen bij de ontwikkeling



Interference

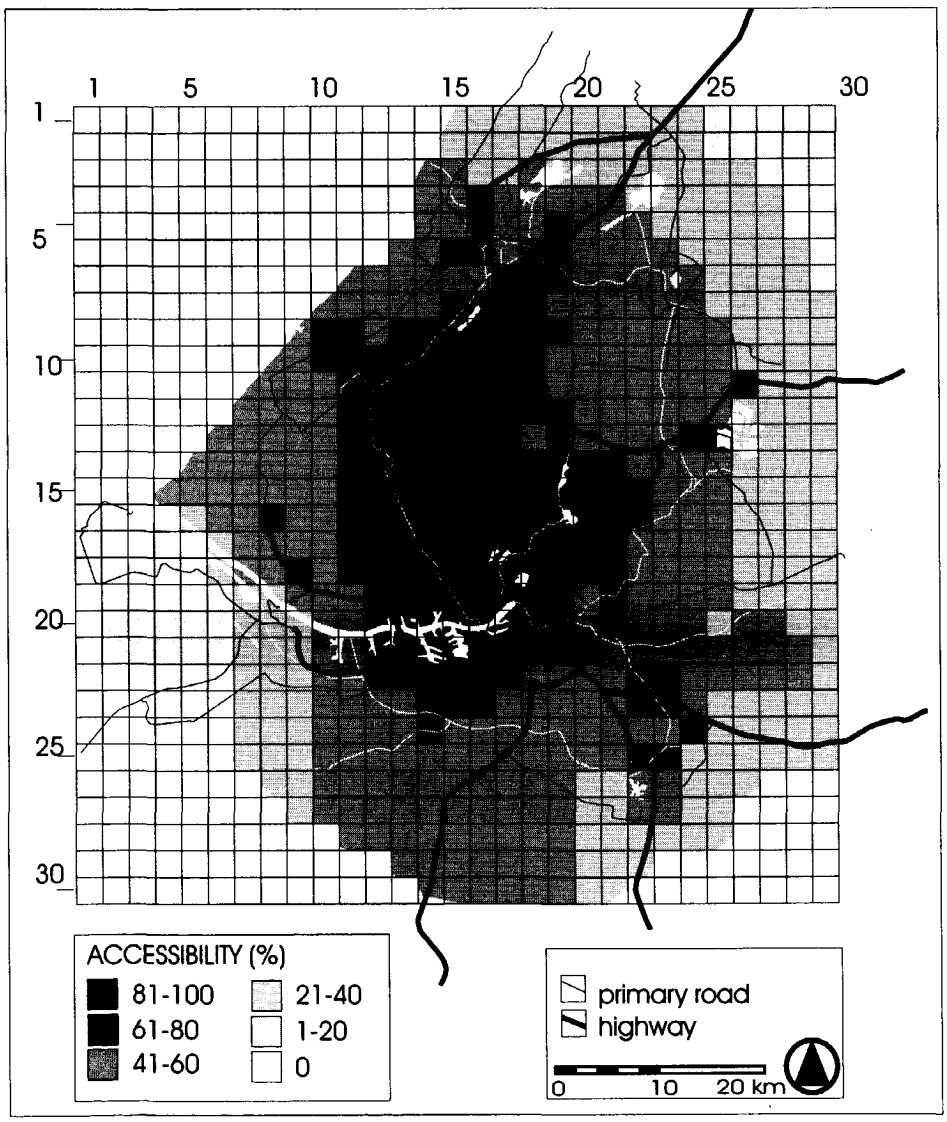
van zo'n structuur. Daarnaast is het van fundamenteel belang om de relatie tussen ruimte en het stedelijk systeem te definiëren teneinde zinvol onderzoek te kunnen doen. Hierbij geldt dat de stedebouwkundige het systeem niet maakt. Het stedelijk systeem is niet meer dan de optelsom van allerlei activiteiten van mensen, instellingen, bedrijven, alsmede de beslissingen die daarbij genomen worden. Ruimte en bijbehorende eigenschappen scheppen echter wel voorwaarden voor het stedelijk systeem. Verschillen in de eigenschappen van die ruimte zorgen ook dat er een bepaalde structuur ontstaat in dat systeem. De vraag is nu welke eigenschappen van de ruimte bepalend zijn bij de ontwikkeling van een multinodale structuur: welke ruimtelijke eigenschappen bieden de voorwaarde voor zo'n ontwikkeling? Het in dit onderzoek uitgevoerde literatuuronderzoek geeft hier een helder antwoord op. Bereikbaarheid geldt tot dusverre, voorzover het collectieve activiteiten op stedelijk en regionaal niveau betreft, als belangrijkste ruimtelijke voorwaarde. Aangezien sommige locaties beter bereikbaar zijn dan andere, kan vermoed worden dat het verschil in bereikbaarheid bepalend is voor de functionele structuur. Vanuit dat gegeven is gesteld dat verandering van die bereikbaarheid de voorwaarde biedt voor verandering van de functionele structuur. Er van uitgaande dat de voorgaande stelling juist is, kan de vraag gesteld worden welke correlatie er precies bestaat tussen bereikbaarheid en de functionele structuur. Hiertoe is in dit onderzoek een methodiek ontwikkeld waarin voor iedere locatie de absolute en de relatieve bereikbaarheid wordt gemeten. Hiermee ontstaat inzicht in het verschil in bereikbaarheid voor de hele stedelijke regio. Dit inzicht kan vervolgens gerelateerd worden aan de spreiding van collectieve activiteiten teneinde te bepalen of er een verband kan worden gevonden.

Aan de hand van de ontwikkeling van de stedelijke regio Minneapolis – Saint Paul (U.S.A.) en de Zuidvleugel van de Randstad-Holland (NL), is de eerste stelling onderzocht. Hierbij is gebruikt gemaakt van de methode van casus-onderzoek, waarbij twee enkelvoudige casussen zijn uitgevoerd. Hierdoor is het mogelijk om inzicht uit de eerste casus te gebruiken bij de tweede. De casus Minneapolis – Saint Paul gaat in op de ontwikkeling van dit stedelijk gebied vanaf circa 1850. De verandering van de bereikbaarheid in het gebied, vanaf paard en wagen, via tram, elektrische tram, tot aan het autoverkeer van nu, inclusief de veranderingen in de wegennetten, is daarbij gerelateerd aan het proces van conurbatievorming. Uit de casus Minneapolis – Saint Paul blijkt dat als gevolg van de veranderingen in bereikbaarheid, er eerst sprake is geweest van interactie tussen twee stedelijke systemen, gevolgd door interferentie en vervolgens systeemvorming. Het stedelijk systeem Minneapolis – Saint Paul is vervolgens onderhevig aan het proces van transformatie, hetgeen zichtbaar wordt aan de opkomst van nieuwe centra in het gebied. De opkomst van de auto leidt er in Minneapolis – Saint Paul in de jaren vijftig al toe dat als gevolg van een sterke verandering van de bereikbaarheid van diverse locaties, de functionele structuur steeds meer verandert. Deze verandering werd in eerste instantie versterkt door de aanleg van radiale snelwegen, en later door de aanleg van ringwegen. Met name als gevolg van die ringwegen heeft zich een nieuw proces van transformatie ingezet. De casus Zuidvleugel beschrijft over dezelfde periode de ontwikkeling van dat gebied. Ook hier zien we een grote verandering van de bereikbaarheid. Het duurt hier echter tot de periode rond 1980 voordat serieuze tekenen van interferentie waarneembaar zijn. Een iets grotere onderlinge afstand tussen de steden Den Haag en Rotterdam, de late opkomst van het autoverkeer in vergelijking met de Verenigde Staten en een beperkter wegennet, blijken hier een belangrijke rol te spelen. De Zuidvleugel kan als zodanig nog niet geclassificeerd worden als stedelijk systeem, zo blijkt uit de casus.
De conclusie uit de casussen is dat de verandering van bereikbaarheid de belangrijkste voorwaarde is voor de verandering van de functionele structuur. Gebleken is dat veranderingen in vervoerswijze en infrastructuur steeds voorafgaan aan veranderingen in de functionele structuur. Op basis van die uitkomst is aan de hand van een meervoudige casus onderzocht welke correlatie er bestaat tussen bereikbaarheid en de functionele structuur. Hierbij geldt dat als de bereikbaarheid onvoldoende is, ofwel onder een bepaalde kritieke grens is, de ruimtelijke voorwaarde voor de situering van collectieve activiteiten met een stedelijk of regionale betekenis, ook onvoldoende is. Het gaat aldus niet om een lineair verband waarbij meer bereikbaarheid meer collectieve activiteiten zou betekenen, maar om de grenswaarde die het verschil tussen voldoende en onvoldoende bereikbaarheid aangeeft.
In de meervoudige casus wordt een analyse gemaakt van de bereikbaarheidsverschillen voor de hele stedelijke regio. Deze analyse wordt vergeleken met het spreidings-patroon van tertiaire en quartaire werkgelegenheid (met name de kantorensector) alsmede met de spreiding van stedelijke en regionale voorzieningen (het kernwinkelapparaat en belangrijke instellingen). De meervoudige casus richt zich op vier gebieden waarvan een zekere mate van multinodaliteit wordt vermoed. Het betreft de stedelijke gebieden Minneapolis – Saint Paul (U.S.A.), de Zuidvleugel (NL), Dallas – Fort Worth (U.S.A.) en Frankfurt a.M. – Wiesbaden – Mainz (D).
Op basis van de meervoudige casus wordt geconcludeerd dat er een correlatie bestaat tussen de gewogen bereikbaarheid en de functionele structuur, waarbij geldt dat de grenswaarde 80% is. Deze 80% geeft aan dat indien een willekeurige locatie vanuit 80% van de hele regio, binnen een reistijd van 45 minuten met het belangrijkste vervoermiddel (thans de auto), bereikt kan worden, deze locatie de ruimtelijke voorwaarde biedt voor de situering van collectieve activiteiten. De analyse van de Zuidvleugel laat daarbij een afwijking zien voor wat betreft de binnensteden van Den Haag en Rotterdam. Hierbij wordt aangetekend dat naast het late moment waarop het autoverkeer is opgekomen in Nederland en de mogelijke betekenis van historische kwaliteiten, de invloed van ruimtelijke planning een belangrijke rol speelt, met name waar het gaat om het

stimuleren van ontwikkelingen in de binnensteden.

De uitkomst van de meervoudige casus vormt een belangrijke handreiking voor het stedebouwkundig ontwerp op de schaal van stad en regio. Voor de toepasbaarheid van de onderzoeksresultaten zijn in eerste instantie ruimtelijke structuurmodellen zoals het vingerstadmodel, onderzocht op hun consistentie en indien nodig aangepast. De daarbij in hoofdstuk 8 gepresenteerde modellen gelden aldus als instrument dat toegepast kan worden in de stedebouwkunde. Het model, als representatie van het ruimtelijk patroon en de bijbehorende functionele structuur, kan ingezet worden bij vraagstukken als stadsuitbreiding en aanpak van regionale infrastructuur. Een belangrijk inzicht dat uit deze modellen naar voren komt is dat het in Nederland gevoerde beleid met betrekking tot de compacte stad, maar ook de inzet voor de komende decennia om corridors als gebundeld verstedelijkingsprincipe te hanteren, als neveneffect heeft dat de verdere spreiding van stedelijke en regionale activiteiten wordt versterkt. Daarmee komt dat beleid op gespannen voet te staan met de beleidsuitgangspunten om openbaar vervoer verder te stimuleren en het autogebruik terug te dringen. Overigens geldt dat de analyses in dit onderzoek niet zijn gericht op eventuele andere aspecten van het gevoerde beleid in Nederland.
Op basis van de uitkomst van de meervoudige casus is ook onderzocht met behulp van welke ingrepen het mogelijk is om enerzijds een nodale en anderzijds een multinodale structuur te bereiken door ruimtelijke ingrepen. In dit ontwerpend onderzoek is gebleken dat een drastische ingreep in het wegennet en het ruimtelijk patroon de mogelijkheid biedt om de bereikbaarheid van de binnensteden selectief – en in relatie tot andere delen van het stedelijk gebied – te versterken. Dit vereist de reductie van het aantal afslagen van snelwegen in het perifere gebied, aanpassing van bestaande of nieuwe wegen richting binnenstad, in combinatie met een gespreide verstedelijking door middel van kleine kernen (tot 10.000 inwoners). De ontwikkeling van de multinodale structuur wordt hierdoor nadrukkelijk beperkt. In gebieden met een omvang zoals de Zuidvleugel, is het overigens met dergelijke ingrepen niet mogelijk gebleken om uitsluitend één centrum de vereiste ruimtelijke voorwaarde te bieden, en de rest van het gebied niet. Meer verregaande maatregelen die de bereikbaarheid beïnvloeden en wellicht consequente ruimtelijke planning leveren hier mogelijk een verdere bijdrage aan.
Het proces waarbij de multinodale structuur zich verder ontwikkelt blijkt eenvoudiger bevorderd te kunnen worden. Al dan niet selectieve uitbreiding van het wegennet en uitbreiding aan de huidige stadsranden blijkt het aantal locaties waar de gewogen bereikbaarheid meer dan 80% wordt, aanzienlijk te vergroten.

In het onderzoek is bereikbaarheid als belangrijkste ruimtelijke voorwaarde gehanteerd. Een belangrijke discussie voor de komende decennia is in hoeverre ontwikkelingen op het gebied van informatie-technologie de betekenis van fysieke bereikbaarheid zullen verminderen. Er zijn immers al eerste aanwijzingen dat de betekenis van hoogwaardige IT-infrastructuur een belangrijke vestigingsvoorwaarde voor bedrijven wordt. Voor de komende periode is onderzoek op dit gebied, in relatie tot de functionele structuur van de stad vereist.



Accessibility Analysis South Wing (NL)

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