# Chapter 6
# Strategic Planning of Bicycle Networks as Part of an Integrated Approach

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## Introduction

Strategic network planning allows for potential modifications in all dimensions of the built environment and transport networks. It questions the spatial structure and the location, design and capacities of transport infrastructure, which connects the origins and destinations defined by spatial planning.

The strategic planning of complete urban cycle networks is essential if the full potential of the mode is to be realized. Further, it is necessary for efficiently using the available financial resources for cycling policies. It also provides a rationale for getting additional resources. Well-justified schemes which form part of a network are likely to be easier to justify than discrete measures without a clear strategy behind them.

Arguing for more investment in a cycle network can become difficult when considerable cycling infrastructure already exists. The early sections of a cycle network can often be implemented at a low cost, and sometimes, which is often more important, without taking space away from motorized traffic. Once these 'low-hanging fruits' have been reaped, however, things become more difficult. Street space is scarce, especially in the inner urban areas where streets may be narrow and movement demands may be greater. Such inner areas offer a fertile ground for cycling, with their dense and mixed use spatial structures, but designing in cycle provision can be a major challenge.

Academic and professional literatures and national and urban guidelines provide limited guidance on cycle network development in a multi-modal context. They propose that 'desire-lines' should first be defined as a matrix of point-to-point movements between relevant origins and destinations, and then transposed and adapted in the second stage to the physical infrastructure (Bundesamt für Strassen 2008; CROW 2007; Forschungsgesellschaft für Straßen- und Verkehrswesen 2008; Heydon and Lucas-Smith 2014; Jones et al. 2007; Parkin and Gallagher 2014; Vereinigung Schweizer Straßenfachleute 1994). Godefrooij et al. (2009) describe participatory approaches for identifying and planning bicycle networks. To date, current guidelines provide only limited guidance on:

- how to choose and prioritize the origins and destinations that generate these 'desire-lines';
- how to coordinate network planning for the different urban transport modes: walking, cycling, public transport (PT), the car, vehicles transporting goods;
- how to deal with space-scarcity, in situations where not enough space is available for the cycling infrastructure needed to meet desire-line movements.

Parkin and Koorey (2009) mentions spatial considerations as the first step of bicycle network planning, but they focuses on requirements for cycle friendly spatial structures such as density, destination accessibility, design, distance to public transport and diversity and on the necessity to provide and protect corridors for cycling related infrastructure, rather than on the overall topology of the network. Sustrans (2014) suggests the estimation of current cycling demand and potential demand as the first step of network planning (see also CROW 2007; Godefrooij et al. 2009; Parkin and Gallagher 2014).

This chapter argues that bicycle network planning should be undertaken as part of a city-wide, multi-modal travel planning exercise that is closely coordinated with spatial planning. A core set of origins and destinations which form the desire-lines for all modes (walking, cycling, public transport and the car) should be chosen and prioritized based on land-use categories and attraction sizes, as defined in spatial planning terms. This core set can be augmented by mode-specific origins and destinations that are only relevant for some modes.

The resulting mode-specific desire-lines can then be transferred to the physical street network infrastructure by assigning mode-specific Link functions to the network elements. The final street layout can be developed by overlaying the mode-specific Link functions of each street section with other functions, such as local access and Place functions such as playing in the street.

The aim of this chapter is to set out such an integrated approach to strategic multi-modal transport network development and street layout design, in its wider transport and land use context.

Two main sources are drawn on extensively to achieve this aim:

- The German 'Guidelines for Integrated Network Design' (RIN) (Forschungsgesellschaft für Straßen- und Verkehrswesen 2008; see also Gerike et al. 2011), which bridge the gap between spatial and transport planning. Both should be carried out as part of an integrated approach, so that their complex interactions can be considered in early planning phases. This is necessary in order for spatial structures and transport supply to fit together and to allow for a high level of accessibility at a reasonable cost. The RIN develops a system of functional infrastructure network classification, which is based on the spatial planning principle of giving prime importance to central locations. The RIN covers networks for individual motorized vehicles, public transport, cycling, walking and interchange points. With such a comprehensive approach, the RIN sets the standards for all steps of infrastructure design: from network development to the alignment and assessment of specific street sections.

- Jones et al. (2007) (see also Jones and Boujenko (2007)) develop a 'Link and Place' approach for network planning and the design of each street section, providing a more objective basis for street space allocation. They identify the importance of Link-related and Place-related functions for each street section, but do not go into detail about how to assess movement patterns and levels of demand. With this approach, they perfectly complement the RIN, which focuses on the determination and assignment of movements to links. In addition, Jones et al. (2007) focus on developing a systematic approach for designing the street layout, while also taking into account functions beyond the pure Link function of a street section. They also provide guidance on how to deal with spatial scarcity and conflicts when all functions cannot be accommodated within the available space.

The remainder of this chapter is organized as follows: The RIN and the 'Link and Place' approach are presented in the next two sections. Following this, the lessons learnt from applying these approaches are discussed. Afterwards, we discuss an approach for the strategic development of transport infrastructure in coordination with spatial and transport planning, which is based on the insights gained in the previous sections. The chapter ends with conclusions and a summary of insights for policy-making.

## The German 'Guidelines for Integrated Network Design' (RIN)

The system of central locations is used as the core principle of spatial planning in Germany as well as other countries (ARL 2005). Based on the theory developed by Christaller (1933), inhabited areas are assessed for their spatial significance and are classified as either central locations of different levels, or as areas which do not provide any central location functions. Central locations provide service functions to both their own residents and to others within their catchment area.

They are centres of business, employment and education as well as favoured locations for public and private service facilities. Areas without a central location function depend on the central function areas for the provision of services. The facilities available in central locations should reflect the importance of the centre. The RIN works with the following levels of centrality:

- agglomerations (A): international or very large areas of influence;
- upper-level centres (UC): administrative, service, cultural and business centres which provide more specialized services;
- mid-level centres (MC): areas that cover special needs and are a focal point for business, industry and services;
- basic centres (BC): areas that provide basic services covering everyday needs to people within their own local area; this includes sub-centres and small centres that must be specified in spatial planning at the regional level;
- all other settlements, which are classified as communities (C) and do not have any central location function. Higher level central locations always provide services to centres at the lower levels.

The system of central locations guides spatial planning on the regional and national level, but it can also be extended to spatial structures within municipalities. An intra-municipal functional structure should be developed similarly to an inter-municipal structure and be based on the significance of land-use and available facilities. The following exemplary categories should be used: main centres, city districts or city centres, district centres and groups of shops or other relevant destinations (small centres). Main centres should be classified one level below the central location itself and be followed with subsequent intra-municipal levels in decreasing order that start from this level. This procedure results in a system of intra-municipal central locations that fits well into the system of inter-municipal central locations and is able to ensure local supply to residential areas.

The RIN uses the following three-stage approach for deriving standards for infrastructure development from these spatial planning principles:

### *Stage 1: Functional Structure and Hierarchy of the Transport Network*

Transport routes are defined as the connections between two central locations or between a central location and its surrounding residential areas. Routes are classified according to the importance of the identified origins and destinations and the consequent importance of the resulting route functions for connecting these origins and destinations. Six so-called 'Level of Connector Functions' (LCF) are defined as shown in Table 6.1. This classification results in a set of straight line, point-to-point movement desire-lines. In a second step, the functions are assigned to the physical infrastructure. The transfer of the LCFs from the desire-lines to the transport networks is made separately for each transport mode and for each relevant combination of transport modes. Preferably, this transfer uses the existing transport networks. Sometimes the same street section is assigned more than one LCF for different modes. In this case, the highest of these LCFs is chosen.

In addition to the LCF, the RIN assigns a road category to each street section and considers the road type (motorways, country roads, urban roads), location (outside built-up areas, bordering built-up areas, within built-up areas), type of adjoining land-use (non-built-up, built-up) and whether the street section is a main or access road.

The resulting matrix of network categories is shown in Table 6.1 for the example of a road network for private motorized traffic. An example for everyday bicycle traffic is shown in Table 6.2. Only some of the theoretical combinations are categorized as not all of them lead to satisfactory solutions from both a constructional and operational point of view. Further road categories do exist in practice, but in such cases there are often significant conflicts between the transport and non-transport uses, which can only (if at all) be resolved with considerable difficulty. The grey cells mark combinations that are not favourable but that might work. The cells that are marked with '–' seem to not be tenable. For example, it makes no sense to design an access road (road category ES) to connect agglomerations or upper-level centres (LCF 0 or I).

Central locations designated as being Level I are connected by motorways and secondary roads. Level II central locations can be connected by the road categories AS, LS or VS. Level III central locations can only be connected by the road categories LS, VS or HS. Lower LCF should be connected by road categories LS, HS or ES. Similar matrices exist for public transport. The outcome of this initial stage is the classification of each section of a transport route so that it is appropriate to its functions.

**Table 6.1 Connection matrix showing the assignment of road categories for motorized traffic in the RIN**

| Road categories / Level of connector function | | Motorways | Country roads | Main roads (non-built-up) | Main roads (built-up) | Access roads |
|---|---|---|---|---|---|---|
| | | **AS** | **LS** | **VS** | **HS** | **ES** |
| Continental | **0** | **AS 0** | (problematic) | – | – | – |
| Wide-area | **I** | **AS I** | **LS I** | (problematic) | – | – |
| Inter-regional | **II** | **AS II** | **LS II** | **VS II** | (problematic) | – |
| Regional | **III** | – | **LS III** | **VS III** | **HS III** | (problematic) |
| Local | **IV** | – | **LS IV** | – | **HS IV** | **ES IV** |
| Small area | **V** | – | **LS V** | – | – | **ES V** |

| | |
|---|---|
| **AS I** | Existing category designation |
| (grey shading) | Problematic |
| – | Does not exist or is not tenable |

*Source*: Forschungsgesellschaft für Straßen- und Verkehrswesen 2008.

**Table 6.2 Connection matrix showing the assignment of road categories for everyday bicycle traffic in the RIN**

| Road category / Level of connector function | | Outside built-up areas OB | Within built-up areas IB |
|---|---|---|---|
| **Inter-regional** | **II** | **OB II** | **IB II** |
| **Regional** | **III** | **OB III** | **IB III** |
| **Local** | **IV** | **OB IV** | **IB IV** |
| **Small area** | **V** | – | **IB V** |

*Source*: Forschungsgesellschaft für Straßen- und Verkehrswesen 2008.

### *Stage 2: Quality Requirements for the Development of Transport Networks, Network Sections and Interchange Points*

In stage two, general quality requirements are established for transport routes and corridors. These are based on target travel times between central locations as well as between residential non-central areas and central locations. From these target times, quality requirements for each section of a transport route are developed. The requirements are formulated as standard distance ranges and target speeds, as shown for everyday bicycle networks in Table 6.3. The table shows that the same LCF can have different target speeds depending on its adjoining land-use functions: the target speed for LCF II is 20–30 km/h for networks outside built-up areas and only 15–25 km/h for LCF II inside built-up areas. These requirements are for specific network elements within the context of transport routes.

**Table 6.3 Categories for bicycle infrastructure, standard distances and target values for travel speed for everyday cycling**

| Category | | Sub-category | | Standard range (km) | Target speed (km/h) |
|---|---|---|---|---|---|
| AR | Outside built-up areas | AR II | Interregional bicycle connection | 10–70 | 20–30 |
| | | AR III | Regional bicycle connection | 5–35 | 20–30 |
| | | AR IV | Local bicycle connection | Up to 15 | 20–30 |
| IR | Within built-up areas | IR II | Intra-municipal express bicycle connection | – | 15–25 |
| | | IR III | Intra-municipal standard bicycle connection | – | 15–20 |
| | | IR IV | Intra-municipal bicycle connections | – | 15–20 |
| | | IR V | Intra-municipal bicycle connections | – | – |

*Source:* Forschungsgesellschaft für Straßen- und Verkehrswesen 2008.

### *Stage 3: Assessment of the Connector-Related Quality of Service*

In stage three, criteria for quality of service are developed for each relevant transport route and for each individual transport mode or for a combination of transport modes. This stage determines the overall quality of network performance for different transport modes. Relevant criteria for connection quality at the level of transport routes are journey time, costs, directness, temporal and spatial availability of transport services, reliability, safety and comfort. A comparison of the characteristic values for these criteria with the target levels of quality formulated in stage two allows the routes to be assessed as 'high quality' or 'low quality' from the user's point of view.

Two indicators are used to measure time. First, the point-to-point speed is calculated by dividing straight-line distance by journey time. Second, the ratio of private motorized transport to public transport journey time describes the relative quality of public transport compared to private motorized transport.

Two indicators are also used to measure directness. First, the 'detour' indicator is defined as the ratio of travel distance to straight-line distance. Second, the 'frequency of change' for public transport is defined as the average number of interchanges that are necessary to complete a specific journey between an origin and destination. Interchanges may occur within one transport mode, but they can also include transfers between private motorized road transport and public transport, for example in combinations of car stages and public transport stages within the same trip. These two indicators of directness should only be used if a transport route's performance in the time measures is poorly assessed. In this case, the reasons for low point-to-point speeds and/or poor journey time ratios of private motorized transport to public transport can be explained by the indicators used for the criterion of directness.

The RIN does not provide measurable indicators for the other above mentioned criteria besides time and directness, and it does not set target values for any of the indicators. Rather, it works with six levels of service quality (LSQ), ranging from A (very good quality) to F (unacceptable quality).

## 'Link and Place: A Guide to Street Planning and Design'

Jones et al. (2007) (see also Jones and Boujenko 2007) assign two primary functions to each street section:

- Link: streets serve as a conduit for through movement for different road users: pedestrians, cyclists, public transport and individual motorized transport. These movements should be safe, convenient, seamless and quick. The goal is generally to minimize travel times for the Link users.
- Place: streets are destinations in their own right, as public spaces and for providing access to adjoining frontages. The Place function aims to encourage users to stay in the street, for example to shop, work, rest, eat, talk or wait and to enjoy the surroundings. Besides these activities, the Place function includes the following traffic and transport activities: loading/unloading, access for serving, vehicles dropping off and picking up passengers, parking, buses and trams stopping to drop off/pick up passengers, taxis waiting for customers and pedestrians strolling. One measure for the success of the Place function is to maximize the dwell

time spent by people taking part in activities on or adjacent to the street (Place users).

Figure 6.1 shows a two-dimensional matrix using five levels of importance to represent these two independent functions. Every street can be located within one cell of this 25 cell matrix depending on its levels for the Link and the Place function. The street's position in the matrix does not necessarily represent its current form or use but rather the intended role of this street. Categories I to V are assigned as Link functions with category I being the highest level. The place function is described by categories A (highest) to E (lowest). Streets of category I–A have the highest levels for the Link and the Place function; I–E can be urban motorways with the highest Link but the lowest Place function. Streets of category V–E are, for example, local streets in residential areas, which account for over half of urban street sections. Five levels are normally recommended (for example as has recently been applied in Birmingham in the UK, see Birmingham City Council 2014) but this can be reduced to four for small study areas or increased to six for very large study areas. The number of levels should be equal for the Place and the Link function. The method has been applied to several public highway networks (e.g. in Adelaide, London and Birmingham).

The Link status of a street section is determined by the significance of its function for general road traffic within the wider urban street network, and by any specific function for mode-specific networks, such as for buses, trams or

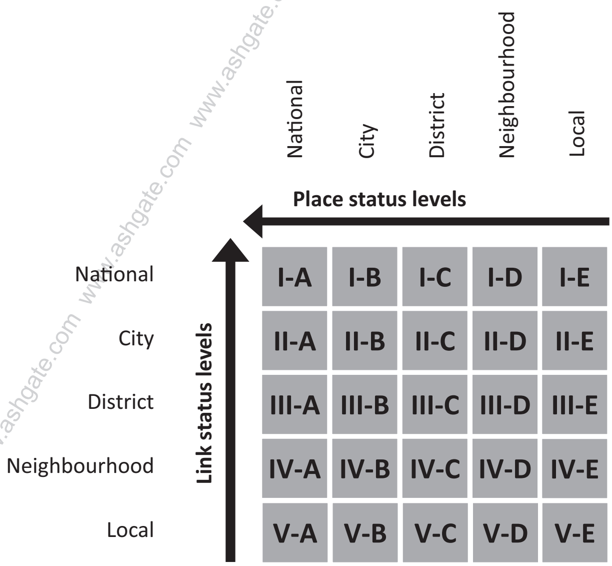


**Figure 6.1 A five-by-five Link/Place street classification matrix**

*Source*: Example 6, Jones et al. 2007.

cycling. Jones et al. (2007) suggest using existing road classifications as a starting point for the assignment of the Link function e.g. based on ownership or a conventional road hierarchy. Nevertheless, a recent application by Transport for London using a simplified 3 × 3 matrix has started with a 'blank sheet'. Modal network priorities can be reflected in the Link classification by indicating a street section's status as priority route for certain transport modes. Additionally, a minimum Link status level for streets that form part of priority routes for these modes can be applied. These might be higher than this segment's link level derived from its general traffic function.

The guidance on how to assign the Link function to a street section implicitly considers the necessity to integrate spatial and road network planning:

> Integrated street planning and design brings together the perspectives and processes of land use planning and urban design with those of transport planning and traffic engineering. Because of the geographical nature of the definition of Link status, it is not possible to say that there are set values (e.g. of traffic volumes, or design standards) that can be used to assign streets to Link status levels in a Link/Place matrix. Rather, decisions on what constitutes a given level of Link status need to take into account the characteristics of the whole urban street network. (Jones et al. 2007: 23)

Jones et al. (2007) give no specific guidance on how spatial functions of the streets and their surrounding should be considered for assigning the Link function.

The Place status should reflect the 'relative significance of a street as an urban Place within the context of that whole urban area' (Jones et al. 2007: 23). Streets with city-wide significance are assigned higher Place function than local shopping or residential streets.

Jones et al. (2007) translate the Link and the Place function of a street into specific space requirements for street design development as follows:

First, the key Link and Place street user groups for that type of street are identified. Then, the activities that each group wishes to undertake are listed, and translated into street space and time requirements – taking into account the likely numbers of users. These might just require a certain amount of street surface area (e.g. for a cycle lane, or for a parking space), or may require street 'furniture' (e.g. seating or a bus shelter). These individual requirements can be specified both at 'minimum' and 'desirable' levels of provision, reflected in different numbers (e.g. of disabled parking bays) and sizes.

The critical constraint in street design is usually the cross section. Total Link and Place requirements are determined by summing up all cross sectional space requirements for all relevant Link and Place activities. Figure 6.2 shows the envelope of opportunities for allocating the available cross-sectional space among Link and Place activities as a diagonal in each of the four diagrams.

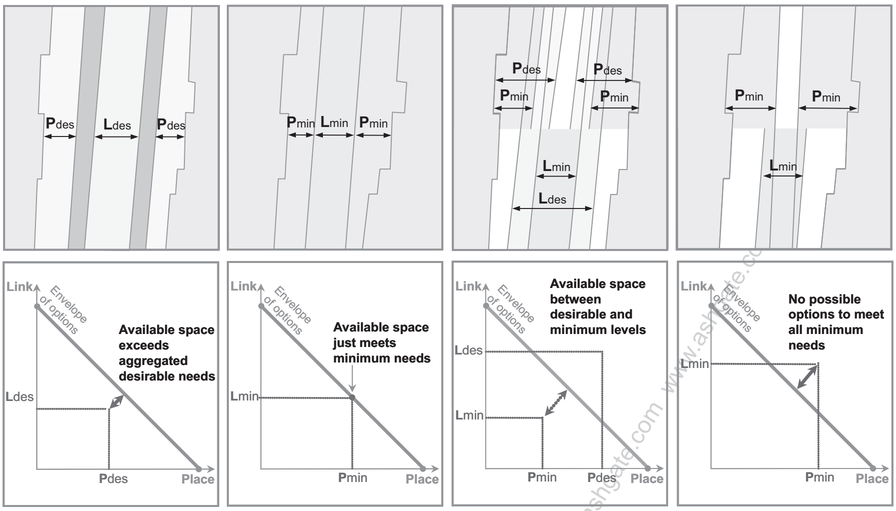


**Figure 6.2 Allocating Link and Place space within the constraint of the 'trade-off triangle'**

*Source*: Example 60, Jones et al. 2007.

Comparing the required space for activity provision and the available cross-sectional space between buildings, there are four possible outcomes resulting from this street space and capacity check:

1. More space than desirable is available. No spatial scarcity exists; generous solutions for the street layout are possible. Jones et al. (2007) recommend in these cases to allocate the extra space to Place rather than to Link functions, since the additional Place provision has a direct benefit for the street or area while the Link function only benefits from higher provision when this is applied for a complete route.
2. Space is just sufficient to meet the overall minimum space requirements. All requirements can be complied with but there is not much choice or flexibility, except in locating some facilities along the street.
3. The available space exceeds the minimum, but is lower than the desirable space requirements. In other words, there is some 'discretionary' space. Jones et al. (2007) recommend allocating this discretionary space with the help of weightings according to the relative importance of the Link and Place function of that street section.
4. Space is lower than the minimum requirements. No solution is possible that meets both the Link and the Place function.

Jones et al. (2007: 179f.) suggest three types of solutions in this fourth case:

- Decide pragmatically to accept lower-standard design solutions or completely disregard some street users' requirements.
- Decide to reduce street function levels, for either the Link (or the priority of modal networks) and/or the Place function. If possible, part of the Link or Place function can be transferred to other street sections.
- Take strategic action as a complement to network development that reduces the Link capacity requirements. Discouraging car use can reduce the number of vehicles on a street and thus allow for a lower Link function.

The outcome of the Link and Place approach described by Jones et al. (2007) is a systematic classification of the street network. The approach gives guidance for all stages from network classification through to the detailed street layout. Specific layout solutions are developed based on the two-dimensional functions of each section.

## Lessons Learnt from RIN and 'Link and Place'

The RIN focuses on the Link function of infrastructure networks, and systematically integrates network classification and spatial planning based on the system of central locations. These determine the Level of Connector Function (LCF) of transport routes as a basis for all subsequent steps of network classification. With this, the RIN helps to develop strategic networks for all modes, but does not give clear guidance on how to overlay the network requirements of different modes. Place functions are only implicitly dealt with in the RIN by assigning road categories in addition to the LCF. The RIN provides no guidance on how to deal with a scarcity of space and conflicts resulting from space requirements that are higher than the available space.

The 'Link and Place' method assigns the Link function in a way which is consistent with the RIN, but an explicit connection to spatial planning is missing. Jones et al. (2007) only give general guidance on how to determine and prioritize Link functions for each mode, but Jones and Reynolds (2012) provide a specific example of how to apply weightings to 'boost' the Link level where its functional importance is greater for a sustainable transport mode than for general traffic. 'Link and Place' covers only the road network, but it encourages a broader corridor planning approach, in which total strategic movement requirements are considered, which cover both road and rail, before the street network functions are assigned. In addition, transport interchange requirements are taken into account as part of the application of the classification system.

Unlike the Link function, where adjoining street sections are commonly assigned the same functional status, the Place function is related to specific street sections. It describes the street sections' importance in terms of the activities which take place on (staying, resting, strolling, (un-) loading, etc.) and adjacent to the street in frontages, plus any historical, architectural or cultural significance of that street, which will vary along a corridor. This notion of Place function must not be confused with the origins and destinations for the desire-lines. These determine the Link function. The Place function of a street section is not necessarily visible in the land use categories; significance may be cultural not physical, and in some cases major land use attractors may be sited off the public highway network.

In short, the core strength of the 'Link and Place' approach is its clear guidance on how to overlay the networks of the different modes and how to address problems of space allocation and scarcity.

Summarizing, the combination of both the RIN and the 'Link and Place' approach seems to be a promising basis for the strategic development of transport infrastructure networks, in close collaboration with spatial planning.

## Developing an Integrated Approach for the Strategic Planning of Transport Networks for all Modes and Functions

Figure 6.3 gives an overview of the proposed integrated approach for strategic planning of urban transport networks, within which we recommend that bicycle network planning takes place. This approach follows the 'Link and Place' process with the following three key principles:

- the two-dimensional 'Link and Place' system of street classification;
- the assignment of the Place function; and
- the procedures to deal with space scarcity and for finalizing the street layout.

The assignment of the Link function is inspired by the RIN with their close connection to spatial planning and their consistent approach across different modes and network types.

In what follows, the steps of the proposed integrated approach shown in Figure 6.3 are described in detail:

### *Step 1: Assign a Link Function to Each Street Section*

The key origins and destinations and the resulting desire-lines need to be defined and prioritized in this first step. The system of central locations as classified in

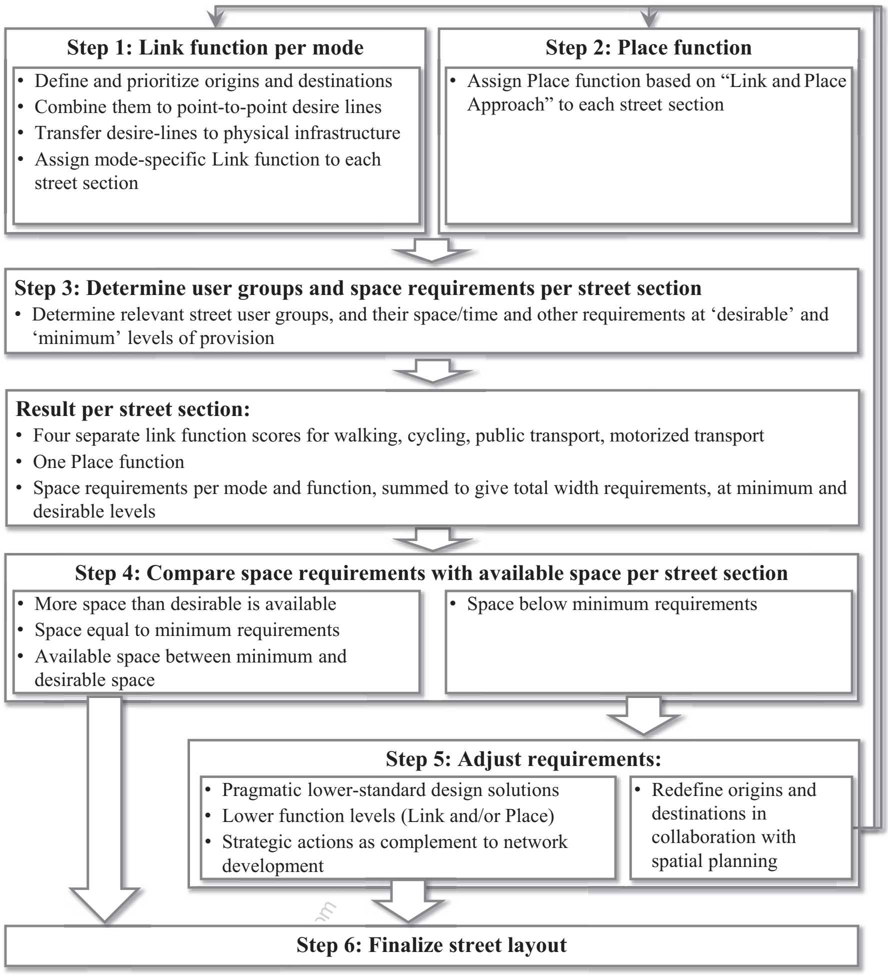


**Figure 6.3 Recommended integrated approach for strategic network development**

spatial planning provides a suitable starting point, but it needs to be extended to intra-municipal central locations as described above. The definition of key origins and destinations should be determined mode by mode. Origins and destinations which identify the key desire-lines for the bicycle network should not only be intra-municipal central areas but additionally important generators and attractors of cycling traffic, e.g. universities, schools, large employers or employment areas. Some origins and destinations will be relevant for all modes.

The close coordination of this step with spatial planning ensures not only the development of relevant, attractive, well-used and efficient transport networks, but allows in addition for the strengths and weaknesses of transport networks to be fed back into spatial planning. Spatial planning serves as the major input for the strategic development of transport infrastructure; it is the basis for defining origins and destinations which determine the desire-lines. Conversely, strategic transport planning serves as input for spatial planning; higher level spatial structures should be planned where high quality and quantity transport infrastructure exists or can be developed.

As part of Step 1, origins and destinations are converted into desire-lines, as mode-specific point-to-point connections. Then the mode-specific desire-lines need to be translated into routes and mapped onto the physical street network infrastructure.

The output of this step is a defined Link function for each relevant mode on every street section. Some cities may have guidance which recommends that some strategic Link functions are not combined on the same street section (e.g. strategic level Link for general traffic and for cycling); in such cases this would be taken into account, where practical, in the strategic routing of modal networks.

### *Step 2: Assign a Place Function to Each Street Section*

The Place function can be assigned to each street section following the 'Link and Place' approach as described above. It should reflect the relative significance of the specific street section as an urban place. Thus, Place functional importance will take into account several factors, including the size of the catchment area of the activities carried out on the street and in the adjoining frontages, cultural and historical significance, etc.

### *Step 3: Determine Relevant Street User Groups, and their Space/Time and Other Requirements at 'Desirable' and 'Minimum' Levels of Provision*

This brings together the functional outputs from stages 1 and 2, and converts these into specific street design requirements, by identifying the relevant Link and Place street user groups, and their space and other requirements. For cycling, this includes cycle lane widths and on-street cycle parking provision, as set out in local cycle design guidance.

### *Step 4: Compare Space Requirements with Available Space per Street Section*

This follows the 'Link and Place' approach outlined earlier. The space and time requirements of the different street user groups are aggregated in order to see whether there is sufficient space in the street section to accommodate these various requirements, at least at 'minimum' levels of provision. As noted earlier, the width of the street cross section is usually the critical constraint, but on short sections between junctions there may also be a significant longitudinal constraint. In addition to physical space constraints, there may also be other factors that need to be taken into account, such as incompatibilities between certain activities which may require additional 'buffer' zones. For example, car parking spaces need to be wider where cyclists use the street in order to avoid injury to cyclists when car doors are opened.

This step can directly lead to Step 6 when enough space is available to meet at least the minimum space requirements. Adjustments as described in Step 5 are necessary when the available cross sectional (or longitudinal) space is lower than the minimum requirements.

### *Step 5: Adjust Requirements*

Several methods are suggested for dealing with user needs in streets with insufficient space:

- Adopt a low-cost pragmatic solution: reduced-standard designs might be suitable when the difference between the available and the minimum required space are small.
- Some design standards are speed related (e.g. traffic lane widths), so by reducing speed limits it may be possible to accommodate user needs in a space constrained environment.
- Reducing the Link and/or Place function of a street section would tend to reduce user needs and associated space requirements; but this decision needs to be taken in a more strategic context. For example, if the Link function is reduced either a corresponding higher Link status has to be assigned to other parallel street sections (that is, by re-routing some modal flows), or a policy of traffic restraint (such as congestion charging) needs to be introduced in the area to reduce levels of modal movement.
- In areas where a whole network is severely space constrained but quite dense (e.g. in central London), it has been suggested that modal routes should be dispersed over the network; i.e. one set of street sections for cycling, another parallel set for buses, etc.

These four actions offer different means of directly solving the space scarcity problem, and directly lead to Step 6, the finalization of the layout for each street section. One other, much more radical, possibility would be to re-define and re-locate some of the key origins and destinations, to modify the modal desire-line patterns and to change the Link and Place functions of particular street sections. This is something which is already happening through market pressure in cities with weak spatial planning and with the development of car-oriented developments served by high capacity roads. This is not conducive to encouraging sustainable living patterns though, or to encouraging the uptake of cycling.

### *Step 6: Finalize Street Section Layout*

Finalizing the street section layout is the last step of the proposed approach for strategic network development. Although the impetus for carrying out an urban-wide street planning and design exercise might have been a policy decision to promote cycling, we propose that this is done in the wider context of addressing all street user requirements, at the same time. Historically, cities have often reviewed streets from a single-mode perspective (e.g. how can we speed up bus or tram journeys?), but this is rarely satisfactory and is inevitably followed in time by other modal reviews, since political priorities change. Currently, many Western cities are paying more attention to traditionally undervalued Place user requirements, which often puts further pressure on Link user requirements.

Drawing on steps 1 to 5, this final step should start with a well-specified street design brief that encourages innovative proposals. This stage should incorporate local public engagement because previous experience suggests that local stakeholder groups understand and support the logic of the Link and Place approach. It should be a relatively easy and enjoyable task, since problems of functional classification and space scarcity have been already addressed in the steps before.

It is important to stress that the outcome of this process should be a street design which takes into account both Link and Place street user needs and priorities and that, to do this in some space constrained situations, it may be necessary to accommodate some requirements at minimum levels of provision.

An example of this integrated design thinking is shown in Figure 6.4, taken from a Link and Place design workshop held in Freiburg, Germany.

It shows two street cross-sections along a radial corridor: Street Section 1 being in an outer residential area with a wide space between buildings and Street Section 2 a district shopping centre in the inner city area with less street width. Policy priorities were to provide:

- priority for tram services, in a dedicated lane;
- a continuous cycle lane along the corridor, on both sides of the street;
- good footway widths;
- vehicle parking, to support residential areas (e.g. for car-borne visitors, service vehicles, etc.) and shopping areas (customers deliveries, etc.);
- basic space for two-way general road traffic.

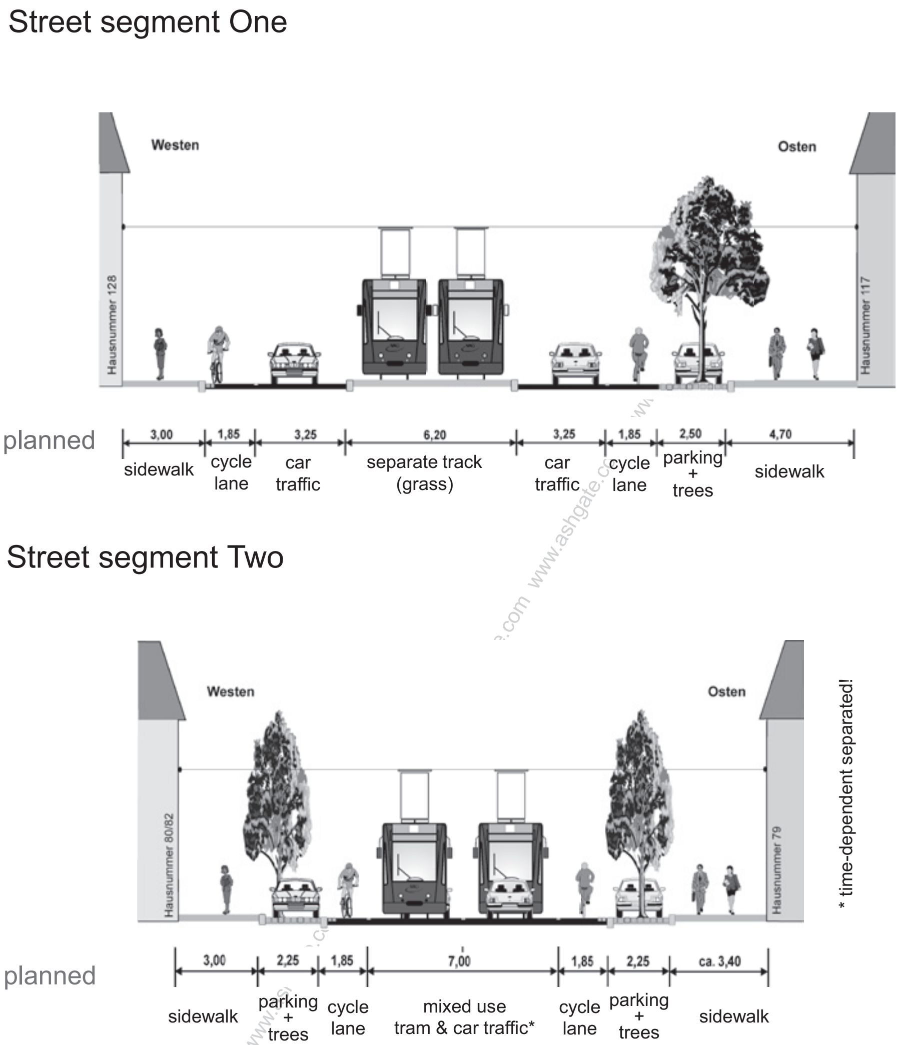


**Figure 6.4 Integrated design solution on two street sections, showing contrasting layouts**

*Source*: Example 52, Jones et al. 2007.

Section 1 shows that in the residential area it is possible to meet all user requirements at a 'desirable' level of provision, including a segregated tram track; but in Section 2 – where needs increase and space reduces – some trade-offs are necessary. Here needs are met by:



- maintaining dedicated cycle lanes at the same width for cyclists throughout;

- preserving tram priority while sharing the carriageway space with general traffic, by having traffic signals up-stream and down-stream of this area which allow trams to enter this constrained section ahead of general motor traffic;
- providing loading and parking facilities on both sides of the street (compared to only on one side in the residential area); and
- slightly reducing footway width on the side with the greater width.

This design solution contrasts with a traditional Link-based traffic engineering design, in which parking/loading would probably have been entirely banned in the shopping area and the cycle lanes removed, in order to maintain the segregated tram lanes and keep the same capacity for general traffic.

## Conclusions

Urban street networks are multimodal networks, catering for a range of modes in addition to bicycling. Besides being conduits for through movement for different road users, they also serve additional functions such as accessing properties and carrying out activities in the street. Streets support important Place activities, which have traditionally often been neglected in engineering-led urban street design. Many popular streets combine high levels of the Link and Place functions. Strategic network development considering all functions, user groups and transport modes with clear priorities help to use the available financial and space resources in the best possible way. Place functions can directly be integrated into planning procedures from the very beginning.

The Link and Place approach has proven very useful in practical applications, in four respects:

- stressing the multi-modal nature of movement and the Link function, or in other words, that design is not just about providing for cars;
- stressing the importance of Place and the need to take fuller account of Place user needs in street design;
- addressing the challenge to design attractive and effective streets which meet both Link and Place user aspirations; and
- providing guidance on space allocation between competing demands in constrained situations.

This chapter combines the Link and Place approach with the German RIN and thus adds the systematic integration of the strategic development of transport networks with spatial planning. This combined approach opens the opportunities for feedback loops with spatial planning throughout the planning process and in both directions.

Bicycle networks require both Link design (cycling lanes, right-of-way, permissive routes, etc.) and Place design (e.g. cycle parking spaces). The careful definition of origins and destinations for the desire-lines of cycle networks ensures efficient networks while also encouraging the use of bicycles. This chapter argues that land use categories should directly feed into the planning of cycle networks. Further, cycle specific origins and destinations such as universities should be added.

Space requirements for cycling are highly dependent on the Link function for motorized and public transport, including volumes and speed. In constrained situations, where space competition is intense, the distinction between cycle design provision for safety reasons (which would be part of the 'minimum' standards) and provision for speed (which should be traded off against other Link user needs, particularly pedestrians and buses/trams) might be helpful. Analyses of strengths and weaknesses of integration versus separation of different modes within the same street section, e.g. cycling and public transport, can give further insights for multi-modal network development. The provision of complete and uninterrupted bicycle networks should have high priority as this is a core requirement for usage.

The approach does not address junction designs, which are crucial for safe and attractive cycling; this is an open question that should be addressed in further work.

Overall, it is too simplistic to talk of a one-dimensional 'road hierarchy' across an entire urban street network; it will vary according to the relative importance of Link and Place functions on a particular street section, and how this disaggregates among modal uses and land use types. Design solutions, also within the same combination of Link and Place functions, are highly context specific – depending on modal mix, land use types, road widths, cultural and heritage factors, etc. – and so will differ across the network. Street designs will vary along a movement corridor in response to changing Place functions, even if Link functions are broadly similar.

The approach developed here should encourage planners to plan network development in a comprehensive and systematic manner, taking into account the legitimate needs of all street user groups and meeting the minimum needs for all Place and Link functions. The approach might seem a little abstract and academic at first sight, but its main ideas – the close coordination of spatial and transport planning and the necessity for multi-modal network planning – are hopefully a suitable basis for participatory planning. Appropriate stakeholder and community engagement throughout the street planning and design processes is vital for successfully planning and implementing inclusive street layouts.

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