# BUILDING ON BUCHANAN: EVOLVING ROAD HIERARCHY FOR TODAY'S STREETS-ORIENTED DESIGN AGENDA

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## 0. ABSTRACT

This paper examines road hierarchy as a means of establishing the roles of different streets in a street system, and explores how the concept may be updated and adapted to meet today's needs. The paper firstly briefly sets out the basic principles of road hierarchy as expressed by Colin Buchanan in *Traffic in Towns*, and then discusses more generally the purpose of road hierarchy, and the underlying basis for ranking road or street types in conventional hierarchical systems. The paper then goes on to demonstrate how this understanding may be used to generate a new formulation for classification or hierarchy, which balances the 'link status' of a street with its 'place status', in a way that allows explicit trade-offs to be made between the different roles of different streets in an urban area. This system can also form the basis of a wider system or 'code' of urban structuring. The paper concludes by reflecting on how this system builds on Buchanan's hierarchical proposition, incorporating both explicit and implicit features of Buchanan's original intentions, to suit today's streets-oriented agenda.

## 1. INTRODUCTION

In his seminal work *Traffic in Towns*, Colin Buchanan laid out in about four pages a basic principle for road hierarchy that has become an influential force in shaping the layout of urban areas for forty years (MoT, 1963:41–44).

Road hierarchy has been an influential – often dominating – factor in generating the character of modern urban layouts, by affecting the relationships between roads, buildings and urban structure. Yet road hierarchy – or more accurately, a certain kind of application of road hierarchy in practice – has often been criticised for resulting in dull or dysfunctional roads-dominated layouts lacking in urbanity or sense of place. With the emergence of movements such as New Urbanism and today's street-oriented urban design agenda, the concept of road hierarchy often seems to be ill-fitting with contemporary needs (Marshall, 2004).

However, on closer inspection, hierarchy need not be the rigid device it often appears to be, but can be a robust, flexible tool for the generation of urban

layout. Following research investigation into the nature of road hierarchy, it emerges that hierarchical principles can be used creatively to form the foundation of a broader, more general system for street management.

This paper examines the concept of road hierarchy and suggests how it may be adapted and updated to meet today's streets-oriented design agenda.

## 2. CONVENTIONAL ROAD HIERARCHY

### 2.1 Traffic in Towns

*Traffic in Towns*, also popularly known as the Buchanan Report [1], laid out a comprehensive vision for urban planning for the motor era. While this vision included some memorable images of modernistic 'traffic architecture' with a megastructural medlay of tower blocks, multi-level pedestrian decks and motorways, the 'new look' imagery was not itself essential to the basic principles, as Buchanan himself noted (MoT, 1963:46). In effect, Buchanan made the founding principle of *Traffic in Towns* the straightforward distinction between roads for traffic and those providing access to buildings:

> "Basically, however, there are only two *kinds* of roads – *distributors* designed for movement, and *access roads* to serve the buildings" [original emphasis] (MoT, 1963:44).

In effect, this 'basic principle' is a division between a system of traffic distributors, where the needs of movement are prioritised, and a system of 'environmental areas' where environmental considerations are prioritised. This directly echoes the approach of H. A. Tripp two decades earlier, who asserted that these two functions were 'mutually antagonistic', and must be separated in two kinds of urban road (Tripp, 1942, 1950; MoT, 1963:42).

In doing so, this was in keeping with the Modernist aversion for the traditional corridor street, which Le Corbusier had famously determined to kill off. Although *Traffic in Towns* became interpreted as a pro-roads and in some senses anti-urban tract – not least due to its denial of a role for the traditional arterial street – it could also be interpreted as a pioneering work for safeguarding the amenity and quality of the urban environment (Hebbert, 1993; Banister, 2002; Marshall, 2003; Hall, 2004).

While urban motorways and pedestrian decks have fallen out of favour, hierarchy continues to live on as an organisational 'code' woven into the urban fabric, which governs how different kinds of roads relate to each other and to buildings. This pervasive embedded nature gives hierarchy a potency that accounts in part for the impact that highways and traffic have had on urban form and structure for decades.

Although the concept of road hierarchy is still with us, it has become somewhat less prominent in successive guidance documents (e.g. *Roads and Traffic in Urban Areas*, DoT/IHT, 1987; *Transport in the Urban Environment*,

IHT, 1997). And, in contrast to Buchanan's clearly set out formulation, today's expression of hierarchy has become somewhat toned down, and the distinction between different kinds of distributor and access road blurred. Yet to the extent that the basic principles of road hierarchy still hold sway, they are often seen as problematic from certain urban design and planning points of view, and in the face of criticism from a variety of those quarters there is a danger of hierarchy being further compromised or dismantled altogether. The time therefore seems ripe to revisit the principles of hierarchy and explore if and how they may be adapted for today's needs.

### 2.2 Why hierarchy?

Hierarchy may be regarded as a kind of *classification* in which types are ranked in a particular way. There is a multitude of possible ways of classifying roads and streets, of which road hierarchy represents one particular way, that is geared to the functional organisation of the road network (ICE, 1994, 1996; Bartlett, 2003; Marshall, 2002, 2004).

The classification of roads in a hierarchy is not, of course, done for its own sake, but has serves a variety of purposes in the management of a network. From one perspective, classification is basically concerned with the avoidance of conflict, by separating roads serving different purposes from each other and from buildings and other non road uses. This consideration is not only to do with the functional efficiency of traffic flow, but also to safety, amenity and the environmental quality of urban areas (IHT, 1997:145, 147). Classification can allow consistent decisions to be taken about the design and management of a road or street along its length. Classification can also assist with the allocation of responsibility for upkeep of roads, and can serve to identify routes for navigational purposes.

While there are many ways of classifying roads for different purposes, at heart, a classification of the type employed in conventional road hierarchy can be seen as a strategic tool for prioritising the use of the different routes in a network for different purposes; or, in the urban context, prioritising the use of scarce street space between competing activities, including through movement and other urban activities. In effect, the designation of the 'function' of a road leads to a functional 'division of labour', set at the strategic level for the benefit of the system as a whole.

If there were no hierarchy, if all streets were required to be equally and comprehensively multi-functional, then all streets would be trying to act simultaneously as traffic conduits, as trading places, as play areas, as meeting places, and so on. Since these roles are to some extent conflicting, the result would be a series of streets none of whose roles was necessarily satisfied to its full potential. But street management can intervene and make one street more efficient as a dedicated traffic conduit, and make another more amenable as a local environmental space, and so on. This 'division of function' can boost efficiency of the system to the overall benefit to the whole.

The question becomes which streets are allocated what role, and why. Following the rationale of *Traffic in Towns*, a decision might be taken as to whether an existing street should become a traffic distributor (upgrading to modern road standards and removing its urban functions) or become a street within an environmental area (upgrading its environmental quality and removing its through traffic function). Today, possible decisions would also be likely to include whether to give over some road-space to bus lanes or cycle lanes, on major arterial routes as well as lesser routes. In each case, the decision on how to allocate space to different street uses can be guided by the classification, whose strategic nature takes account of the prioritisation of the different potential roles of each street-space relative to the whole system.

### 2.3 The basis for ranking

There are many kinds of road hierarchy in existence, and they all appear to be ranked by some kind of 'traffic function'. This traffic-oriented impression is reinforced by the typical ranking from major traffic roads such as primary distributors – or traffic-only roads such as motorways – at the 'top' of the hierarchy, down through intermediate road and street types, to pedestrian-only streets or paths at the 'bottom' of the hierarchy (Table 1).

Table 1. Examples of hierarchies

| *Traffic in Towns*, UK [(a)] | *Transport in the Urban Environment*, UK [(b)] |
|---|---|
| Primary distributor | Primary distributor |
| District distributor | District distributor |
| Local distributor | Local distributor |
| Access road | Access road |
| | Pedestrian street |
| | Pedestrian route |
| | Cycle route |
| City of Copenhagen [(c)] | Belgium, Functional Classification [(c)] |
| 1. Motorway | 1. Motorway |
| 2. Regional road | 2. Metropolitan Road |
| 3. Primary road | 3. Trunk Road |
| 4. Distributor street | 4. Inter-District Road |
| 5. Local street | 5. Through Street |
| | 6. Local Street |
| Italy [(d)] | Institute of Transportation Engineers, USA [(e)] |
| Motorways | Freeway |
| Principal inter-urban roads | Expressway |
| Secondary inter-urban roads | Major arterial |
| Urban roads (connectors) | Collector Street |
| District urban roads | Local Street |
| Local roads | Cul-de-sac |

(a) MoT (1963); (b) IHT (1997); (c) Marshall (2002); (d) Bartlett (2003); (e) Jacobs *et al.*, (1995). Fuller catalogues are provided in Marshall (2002) and Marshall (2004).

While the classification terminology differs in each case, the basic principles follow the same general pattern, with a spectrum from major roads to minor roads. Major roads tend to be associated with strategic routes, heavier traffic flows, higher design speeds, with limited access to minor roads with frontage access; minor roads tend to be associated with more lightly trafficked, local routes, with lower design speeds and more frequent access points and with access to building frontages.

While the rankings may appear to be by some kind of 'traffic function' – and hence the criticism of hierarchy for being traffic-oriented and part of the urban problem – on closer inspection the actual criterion for distinguishing and ranking different roads is found not to be based on traffic flow, or traffic speed, or any actual traffic or engineering criterion (Marshall, 2004). It turns out that the ranking is actually based on the geographical scale of significance of the network to which a road belongs, where roads are arranged topologically according to a structural property known as 'arteriality' first identified in a cartographic context (Morrison, 1966).

On revisiting *Traffic in Towns*, indeed, we note that Buchanan's distributors form a hierarchy based on the scale of geographical network to which a road belongs – effectively a spectrum from national to local (Figure 1). Hence Buchanan states: "The number of stages required in a distributory hierarchy will depend upon the size and the arrangement of the town" (MoT, 1963:44). In the frame of reference of a single city, where the top level tier is referred to as 'primary distributor', and where 'access road' is added at the bottom, the geographical basis of the distinction tends to be obscured. But the spatial nesting of networks from national through city to district to local level is clear from any map, and despite the obscurity of terms such as 'arteriality' which describe the topological structure so formed, the structure itself is readily and intuitively applied by engineers in practice up and down the country, and indeed around the world.[3]

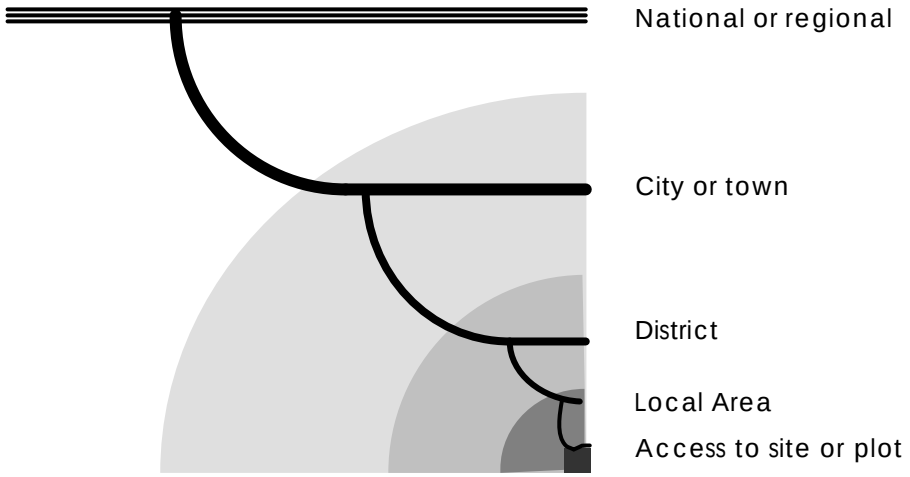


**Figure 1. Hierarchy and geographical scale.** Road types are closely associated with the geographical scale of the network they belong to and the area they serve.

Seen this way, Buchanan's hierarchy has more sympathy with urban planning and design concepts (cities, districts and *urban* hierarchy) than the common perception of hierarchy (to do with traffic capacity, flow, etc.) would suggest.

The significance of this is that road hierarchy is not after all based on some inscrutable and unassailable 'traffic engineering' principles that urban designers and planners find themselves unable to challenge, but is in fact based on a simple nesting of geographical scale, that is transparent to all. This means that when it comes to revisiting or revising principles for street layout, it is not necessary to throw out hierarchy as an irredeemably traffic-oriented straitjacket, but may be seen as a flexible tool that may be adapted to suit today's needs.

### 2.4 The need for a new formulation

A problem with conventional hierarchy is that it fixes certain roles to different road or street types in a rather limiting way. In particular, under Buchanan's system, streets (i.e. roads with frontages) are restricted to the lowest rung in the hierarchy, as access roads. Also, in practice, roads with pedestrian access tend to be limited to access roads, separate from the distributor roads intended for use by buses. The result – especially when applied to new development – has often been a disjointed system where oases of urbanity, constituted by pedestrian-friendly local streets, are marooned in a desert of car-oriented distributor roads. It has also meant that there is no place for traditional street types such as arterial streets or boulevards, which were once considered dysfunctional, but which now are considered to be potentially useful types catering for a variety of transport modes and a mix of urban functions.

At the root of the problem is the way in which conventional hierarchy or 'functional classification' fixes street types to an idealised spectrum in which 'mobility function' is lies is inversely related to 'access function' (Figure 2; Marshall, 2004; Marshall *et al*., 2004). While these two functions may often be contrasting or opposing, they may also be coincident, especially in the case of the traditional arterial street (Table 2).

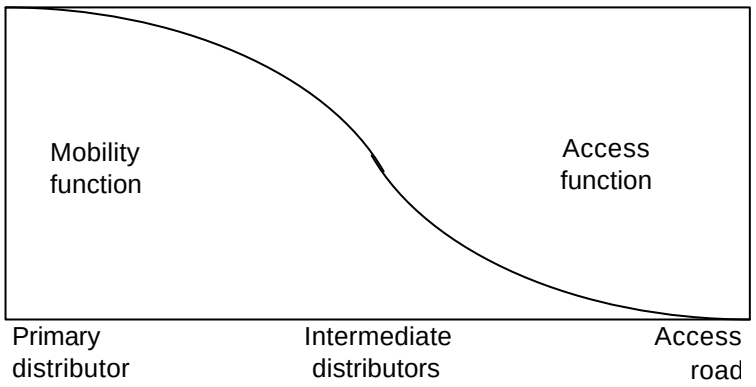


**Figure 2. The 'inverse relationship'.** The conventionally assumed idealised relationship between 'mobility function' and 'access function' (based on AASHTO, 2001; interpreted with respect to Buchanan's types).

Table 2. The roles of streets as a set of related pairs of contrasting properties.

| | |
|---|---|
| Mobility function | Access function |
| Circulation | Occupation |
| 'Through' users | 'Locale' users |
| Arterial | Place |
| Movement space | Exchange space |
| Street as link / transition | Street as place / destination |
| Transport sphere | Urban sphere |
| Flow (vehicles/people) | Land use (people/ activity) |

This situation is problematic because streets such as arterial streets do not fit onto this spectrum. And if types such as arterial streets are not recognised in the first place, then there is no guidance for them; the use of existing streets is not optimised, and new streets of this type are no longer built. We end up with a limited palette of road and street types. Hence there is a need for a new formulation for hierarchy, where these functions (or their equivalents) are recognised as separate but not necessarily incompatible entities.

The system described in the rest of this paper was developed as part of the ARTISTS project (Arterial Streets Towards Sustainability) which demonstrates a revised classification or hierarchy to accommodate arterial streets, as part of a wider set of design and management guidance for arterial streets.

## 3. A NEW FORMULATION FOR HIERARCHY

### 3.1 Introduction

This section develops an approach to classification that acknowledges the roles a street plays in the overall street system. The approach starts by *decoupling* the conventionally fixed relationship between 'mobility function' and 'access function', to allow street types to have any combination of both as independent variables. In particular, this allows *arterial streets* to feature in the system: streets that combine a high circulation function with a high access function.

Although an evolved version of 'hierarchy', the term 'classification' is used here since the system devised results in a two-dimensional construct, which does not have a single hierarchical ranking.

The objective of the new classification is to identify the appropriate functional role of a particular street or street section, with respect to the whole system, in order to guide decisions on the trade-off between different users of street-space (and signal time) in particular localities.

### 3.2 Basis of classification system

The fundamental basis for the system is premised on the linking of two ideas:

(1) Any street section has a combination of *link status* and *place status*.[2] These variables are independent – and not one the inverse of the other, as with the 'mobility function' and 'access function' of conventional hierarchies (Figure 3); and

(2) Link status and place status will depend not only on the immediate attributes of the street section (including physical form and demand for use), but on their role with respect to the wider street and urban system considered as a whole.

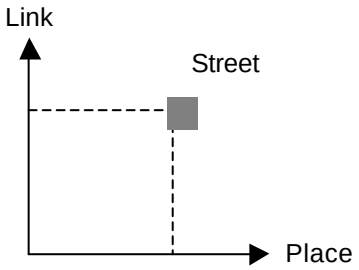


**Figure 3. Classification framework based on a combination of link status and place status.**

### 3.3 Link status

Link status denotes the relative significance of a street section as a link in the network. It is effectively based on its scale of significance within the network it belongs to: for example, local access street, district distributor, city arterial. In principle this could relate upwards to a national or international scale significance (Figure 4).

The link status as presented here is effectively a restatement or repackaging of (some) conventional practice. In particular, it follows the underlying principle of Buchanan's hierarchy based on geographical scale of significance.

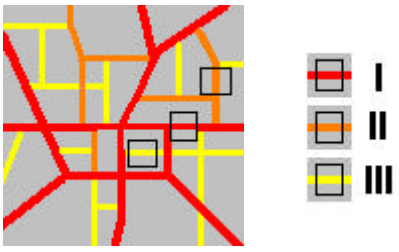


**Figure 4. A three level 'hierarchy' based on link function.** The levels could represent, for example, city roads (I), district roads (II) and local roads (III).

### 3.4 Place status

Place status denotes the relative significance of a street locale as an urban place in the whole urban area. For example, a street or square may perform a city-wide role or a more local role. Therefore, the place status is – like link status – related to geographical scale, and in principle relates upwards to national or international scale significance (Figure 5).

There is no direct equivalent to place status in conventional street classifications or road hierarchies. However, the designation of status of place is often carried out by urban planners or geographers when ranking places in other contexts – for example, nominating a 'district centre'. The designation of place status is no more or less subjective than the conventional designation of road function.

Whereas the link status of a route will tend to stay constant over the length of a particular street, place status will vary along a street, and could be different in principle for each locale. Indeed, street sections can be defined by changes in place status along a given street, as well as by changes in link status.

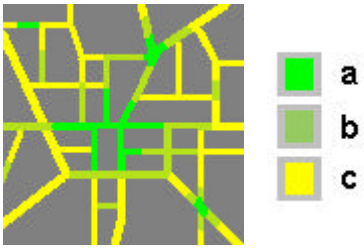


**Figure 5. A three level 'hierarchy' based on place status.** The levels could represent, for example, places of city scale significance (a), district centres (b) and local centres or places of local significance (c).

### 3.5 The 'periodic table'

Each street section is classified according to its link status and its place status. In accordance with the way they are defined, these are independent variables. They can therefore be arranged as a two-dimensional classification framework, rather than the linear ranking typical of conventional practice (Figure 6).

Link status and place status are both ordinal entities (i.e. they can be classified in order in a ranked scale); although they may well be informed by contextual data, including quantitative data, they are in the end allocated by designation. This designation is based on geographical significance in both cases, so both axes have the same scale. This puts link status and place status intrinsically on an equal footing, therefore allowing a real sense of balance between the different roles of the street. This accords with the aspirations of those advocating a better balance between 'right of way' and 'right of place' (ICE, 2002).

From this kind of framework it is therefore possible to distinguish different *types* of street. These types are defined by their combination of link and place status (Figure 7). Such a typology includes the general class 'arterial street' and within this a series of sub-classes or individual types of arterial street.

These types may be represented as 'cells' in a 'periodic table' of street types (Figure 8). The number of types recognised (related to the number of levels recognised) and their labels would be tailored to the context of application (as per Buchanan's comment about the size and arrangement of a town). Here, a generic notation is used to assist the demonstration of the cellular basis of the classification, since this classification has been devised for possible application in different countries. In practice, more specific terms would be used, appropriate to the institutional context and language of application.

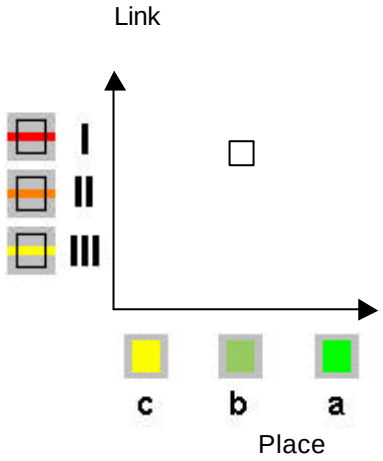


**Figure 6. Each street section is classified according to two criteria: link status and place status.**

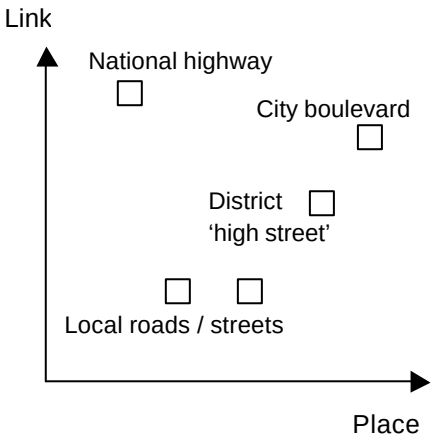


**Figure 7. Different types of street can be recognised according to their combination of roles as link and place.**

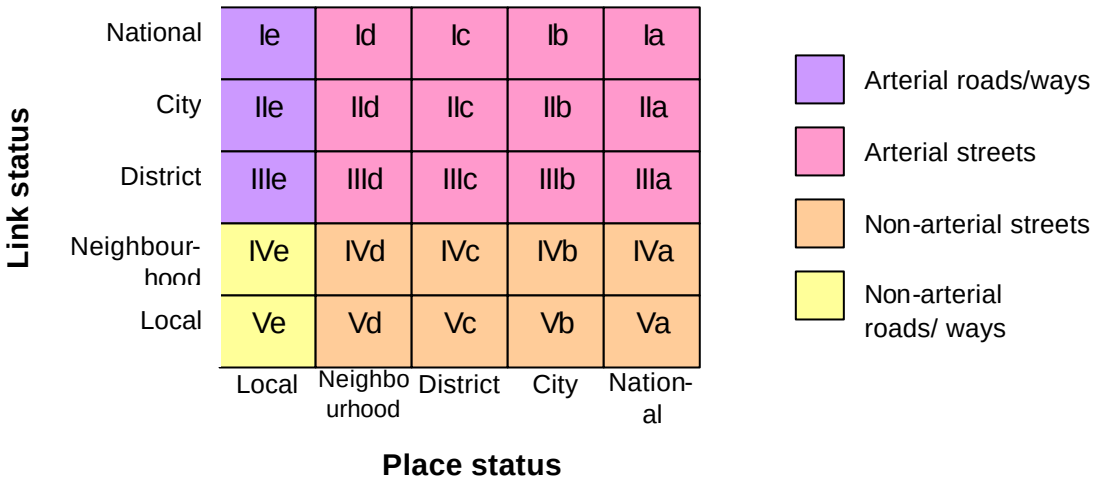


**Figure 8. Classification framework as a set of cells or 'periodic table'.**

Key features of the system are:

1. The classification serves to classify any street section in *strategic* terms – that is, it relates the significance of a street section with respect to all streets / places the whole city, according to the two independent dimensions of link status and place status.
2. The units on each axis are comparable – they relate to *geographical scale* – for example, district distributor, district centre.
3. Because of the way they are defined, link status and place status are not mutually exclusive, and a given street or street type can combine both, in principle – such as in the case of the traditional arterial street or boulevard.
4. The 'periodic table' is felt to provide a good balance between simplicity and complexity. It is complex enough to give a 2D spread of types of street, but by limiting to 2D is easily graspable by users.

A suggested procedure for designating link status and place status as part of a network classification is given in the ARTISTS Guide (ARTISTS Consortium, 2004).

### 3.6 Interpretation

The classification system outlined here can accommodate a variety of existing street types – including those based on form or use – and in principle can be applied to any street system.

Although a new construct, the 'periodic table' can include within it the types found in conventional hierarchies, as well as explicitly accommodating different types of arterial street, which are not currently recognised.

Indeed, it can incorporate within it Buchanan's existing types (Figure 9). In this interpretation, the distributor roads are assumed to have little or no 'place status', while streets and squares of any urban significance are assumed to have low link function. This accords, at any rate, with the theoretical ideal of the inverse relationship between 'mobility' and 'access'.

Buchanan's types are therefore still present: but a wider palette of street types is also explicitly present. In many cases the streets represented by these types never went away, but still had to be uncomfortably placed somewhere into the system of distributors and access roads.

Because the new system is based on and incorporates the existing principles and some existing types, it need not be seen as an 'alien imposition' from 'anti-engineering' urbanists, but can be seen as an evolution from the existing foundation.

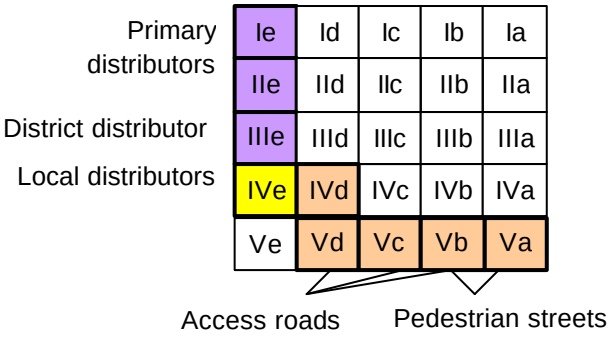


**Figure 9. An interpretation of Buchanan's hierarchy with repect to the 'periodic table'.** Pedestrian streets are also added.

## 4. APPLICATIONS

This exercise in classification is, as been stated, not done for its own sake, but for the purpose of assisting the design and management of individual street sections relative to the functioning of the whole system. Here, the combination of link status and place status – which say something about the relative significance of a given street section relative to all others – can be used to guide decisions in the trade-off of street-space, between different transport modes and different urban activities (Marshall *et al.*, 2004; ARTISTS Consortium, 2004).

Hence, the trade-off of the street-space in a particular locale will be affected not only by the immediate demands placed on that locale, but its strategic significance relative to the wider city context.

This means that in designing street-space within a particular locale, there will be a simultaneous trade-off between immediate demands for space and time (for pedestrians to cross; for one stream of traffic to turn right or left across another stream; for street trading, etc.) and the overall functioning of the city.

As well as guiding decisions on street design and management, the classification can be used as a basis against which to judge the performance of a street. Here, assessment of performance is based on the observation of the way in which streets are used, with respect to the intended function of the street.

This means, for example, that if a given street is deemed to have a high place status, then street performance should be judged in terms of parameters that are compatible with this level of place status. In this context, high traffic flow may be seen as an indicator of poor performance from the perspective of the person on foot using the street as an urban place. Similarly, if a given street is supposed to act as a 'bus corridor', or a 'local high street', then assessing 'performance' only in terms of traffic flow would miss the point. Assessment therefore relies on relating observed performance with respect to the intended function or role of a given street (section), identified in association with classification.

Hence classification can take its part in an integrated framework that includes street design and management, street use and performance assessment (Figure 10).

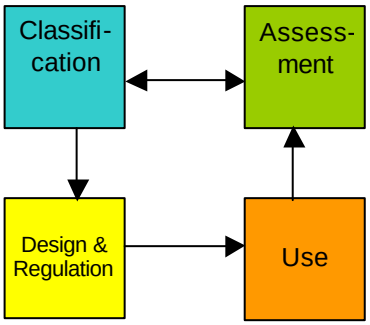


**Figure 10. An integrated framework.** (Marshall *et al.*, 2004; ARTISTS Consortium, 2004)

The classification here can also be used as the basis for a wider system for urban structuring. The classification of a street in accordance with its role in the network can be related to different transport modes and speeds, to give an integrated route hierarchy. This route hierarchy can in turn provide the foundation or 'skeleton' for a broader urban code, that would relate the different kinds of route type to different permutations of land use and built form, hence creating a comprehensive 'code' for urban design. This means that the core rules of structure – as constituted by road hierarchy – are not discarded, but may be 'built on', in such a way that they are 'built in' or integral to urban design guidance (Marshall, 2004).

## 5. CONCLUSIONS

This paper has demonstrated a classification system where a street is classified according to two independent criteria, namely link status and status. Link status and place status both relate to geographical scale of significance (effectively, area at the macro scale), allowing a direct comparison of the relative significance of the link and place-related functions of a street. This classification can then be used as a basis for trading off street space (area at the micro scale) to support those functions.

This is considered an advance on conventional classification, for the purpose of meeting today's streets-oriented agenda, in that:

- it can readily accommodate street types not currently recognised, such as the arterial street;
- the classification allows the link function of the street to be traded off against activities relating to the role of the street as an urban place, on an explicit and transparent basis.

This system allows the concept of 'hierarchy' to be updated, so that it is not simply expressed as a one-dimensional list ranked by link status alone, but a two-dimensional 'periodic table' that also includes places status. By updating hierarchy in this way, Buchanan's extant principles are not discarded, but are placed within in a wider, more general framework. Buchanan's system, after all, is still appropriate for an idealised traffic network, but for application to today's towns and cites, the multi-functional role of streets must also be addressed, taking account of 'sustainable' modes of transport and wider urban design and planning considerations.

The new formulation for hierarchy is in part based on link status that is more or less directly related to the principles of ranking set out by Buchanan in *Traffic in Towns*, while it adds in the concept of place status. Although Buchanan's hierarchy did not explicitly feature any equivalent of place status, the consideration of urban place may be related to Buchanan's intention that environmental considerations should be taken into account, and indeed lead traffic considerations, rather than the other way around (MoT, 1963:52).

In effect, a problem with the application of Buchanan's principles to practice was that the system of road hierarchy gave a definite and robust organisational logic for the formation of the road system – catering for the traffic side of things – but did not provide a similarly robust means of securing a desirable spatial logic for environmental areas.

That is, the structural logic for the road network provides a simple and compelling rationale for linking up adjacent sections of street to form a single route of consistent status and standard. This structural logic, based on arteriality, though not fully expressed as such in *Traffic in Towns* (or other guidance documents), was nevertheless readily understood and applied intuitively by the following generations of traffic engineers. This gave the compelling prerogative for street sections finding themselves part of an arterial route to be judged (only) as traffic arteries, irrespective of their other qualities. Although a section of arterial street could in principle be designated as part of an environmental area, in practice there would be little to stop it being designated as part of a primary distributor, to be 'upgraded' as a traffic distributor, and denuded of its other urban functions, because the urban or environmental aspiration was not backed by any counterbalancing topological rationale.

In the two-dimensional system here, a more definite sense of balance is provided, by explicitly including place status as part of the classification. And because this is ranked on the same basis as link status – ie, based on a geographical scale of significance – this should allow for treatment that does not allow link status to override place status. In the end, hierarchy need not be seen as a 'tyranny of traffic regulation', but can be 'built upon' to provide an organisational logic that can bridge the professional divide – between planning and engineering traditions – just as Colin Buchanan himself did personally.

## 6. ACKNOWLEDGEMENT

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## 7. NOTES

1. Strictly speaking *Traffic in Towns* incorporates both the Buchanan Report and the Crowther Report.
2. The terms link status and place status echo the distinction between 'link qualities' and 'place qualities' of Caliandro (1986) and are equivalent to the terms 'arterial connection' and 'urban place' used elsewhere (Marshall, 2004).
3. It also means that there is a natural potential for this kind of hierarchy (identified with 'functional classification') to correspond quite closely with the 'administrative classification' for a network, although these are traditionally separate classifications.

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