**Original Article**

# Urban nuclei and the geometry of streets: The 'emergent neighborhoods' model

Michael Mehaffy[a,b,*], Sergio Porta[b,*], Yodan Rofè[c,†] and Nikos Salingaros[d,†]

[a]Structura Naturalis Inc., 900 Cornell Street, Lake Oswego, Oregon 97034, USA.
[b]UDSU – Urban Design Studies Unit, University of Strathclyde, 131 Rottenrow, Glasgow G4 0NG, UK.
E-mail: sergio.porta@strath.ac.uk
[c]Desert Architecture and Urban Planning Unit, The Jacob Blaustein Institute for Desert Research, Ben-Gurion University of the Negev, Sede Boqer Campus, 84990 Midreshet Ben-Gurion, Israel.
[d]University of Texas at San Antonio, One UTSA Circle, San Antonio, Texas 78249, USA.

*Corresponding author.

[†]All authors are members of the Environmental Structure Research Group.

AUTHOR COPY

**Abstract** A controversy remains among planners and urban designers about the proper location of the non-residential core (nucleus) of a neighborhood in relation to thoroughfares. One school of thought suggests that the nucleus should be located along the busiest thoroughfares; a second school holds that it must be some distance away from them – which, because of their disruptiveness, should form the edge of the neighborhood; and a third school proposes that it should be somewhere between the two as an 'eccentric nucleus'. The three schools may be overlooking the underlying variables that govern this problem under different conditions, and so we propose a model for establishing the best location and distribution of urban nuclei as these conditions vary. This requires firstly, a redefinition of the 'neighborhood' as distinguished from a 'pedestrian shed'. We argue that a 'neighborhood' can either emerge within a 'sanctuary area' between thoroughfares, or span across both 'sanctuary areas' and thoroughfares, if the latter are properly designed; a 'pedestrian shed', by contrast, can overlap with neighborhoods and with other pedestrian sheds. We propose a '400 meter rule', a surprisingly small maximum spacing of main thoroughfares that empirical observation shows that traditional, pedestrian-governed urban fabric has always tended to obey, for reasons that are likely to have to do with the self-organizing logic of pedestrian movement and social activity. In so doing, we advance a more fine-grained, permeable, potentially lower-carbon model and illustrate its advantages with several historic and modern examples.
*URBAN DESIGN International* (2010) **15,** 22–46. doi:10.1057/udi.2009.26

**Keywords:** urban nucleus; thoroughfare; neighborhood; urban morphology; urban model

## Introduction

This article takes up one of the major issues under debate in New Urbanism and other reform movements in urban planning theory and practice. Should the commercial nuclei of neighborhoods be placed to straddle major thoroughfares, or should they be planned to locate away from them in order to allow for a safe and tranquil pedestrian neighborhood environment? We interpret this issue as a composite of two separate, if interrelated, questions: (1) the need for pedestrian access to everyday needs and city wide and regional public transit (the pedestrian shed); and (2) the importance of neighborhood community for urban life.

We begin by showing that the urban structure typical of post World War II development was brought about by the application of two modernist city planning concepts: the 'neighborhood unit', and the 'hierarchical classification of urban streets'. These two concepts developed independently in the early years of the twentieth century and were joined together, after World

War II, to form the contemporary orthodoxy of planning for urban areas. As many critics have noted, this orthodoxy is the cause of much of the segregation of activities and lack of life in urban streets so typical of modern planned development. The New Urbanist movement has done much to expose the damage to the city caused by the hierarchical classification of streets, and to bring back (at least at the local level) the traditional urban network of streets. But it has kept on the modernist idea of the neighborhood, surrounding a distinct center, as a structuring element of the urban region. The debate within the movement only varies (often vociferously) on the appropriate location of the neighborhood's commercial center: should it be within the neighborhood, within walking distance from all the homes in it, and removed from through going traffic on the major arterials surrounding the neighborhood, or should it be at the edge of the neighborhood, and enjoy the accessibility and visibility that such a location provides? If at the edge, what happens in the very busy thoroughfares between centers?

We offer here a way to break the impasse of the debate, by shifting to a deeper examination of neighborhood structure. To do so we develop ideas based on the notion of urban configuration as a network phenomenon. We rely on insights of Christopher Alexander and his colleagues (Alexander *et al*, 1977; Alexander, 2001–2005), the New Urbanists (Krier, 1998; Duany *et al*, 2000) as well as previous work on urban form and spatial networks (Hillier and Hanson, 1984; Rofè, 1995; Hillier, 1996; Porta & Renne, 2005; Salingaros, 2005; Porta *et al*, 2006; Steil *et al*, 2008; Porta *et al*, 2009). We introduce an abstract model for the location of urban nuclei, relative to the neighborhood and the movement network, and use it to classify the various positions in the debate, as well as variants that can be found in urban regions today. The analysis of those combinations as either conducive or deleterious to urban community formation leads us to propose what we term the *emergent neighborhood model*. In this model, *neighborhoods are not fixed-designed entities, but may emerge historically and socially from inhabitants' patterns of movement and activity, as well as from administrative decisions and actions*. For neighborhoods to emerge, however, they need the basis of a well-formed urban structure. This structure is based on *urban nuclei* that shape pedestrian sheds, and whose size is dependent on their nature, density and characteristic uses. These nuclei span or abut the main thoroughfares of the city's movement network, while forming an edge to *sanctuary areas* protected from through movement. The thoroughfares, in turn, are smaller and more permeable, allowing greater transversal connectivity across them and a greater range of uses (including residential and institutional) along their length.

Based on our observation of historic cities from different cultures, and the work carried out by the Italian morphologists (Caniggia & Maffei, 2001) we propose that the maximum edge length for a sanctuary area (the area between major thoroughfares) is governed by a surprisingly small *400-meter rule*. An extensive case-study research is presently being carried out by the authors that will provide empirical support to the '400-meter rule' idea. The study is basically a morphological comparison of many urban layouts at the same scale taken form Google Earth. Cases include 'spontaneous' and 'planned' urban fabrics characterized by the most different historical, geographic and broadly cultural (including religious) conditions. Here we anticipate the broadest result of the study, the existence of the 'rule' itself; we then explain why this finding is so relevant in the history of urban form and the theory of urban design, and finally we propose a model to explain its formation in practice as the outcome of a piecemeal, largely self-organized process of evolution in time.

But neighborhoods may emerge in one sanctuary area, or span between two or more of them. Different people, or even one person at different times in his/her life cycle, may come to relate to different levels of the neighborhood, but from our studies and that of other authors it seems that the natural limitations of pedestrian movement in time (manifested in the 5 min walk) are fundamental to community formation.

A key feature in our model is its ability to explain how normal forces of urbanization will drive one configuration to mutate into another, often resulting in a sudden reversal of urban morphology.

This model can be used to design new urban fabric, or to upgrade existing inhuman urban regions into genuine communities. We discuss several contemporary urban pathologies, such as cities with neither pedestrian sheds nor urban nuclei, and describe some built examples that embody those pathologies. We then show our model's extension to the regional scale, and highlight how it resolves the aforementioned

AUTHOR COPY

debate within reformist urbanism. We conclude with some thoughts on the importance of emergent neighborhoods in today's globalizing world, and their importance in preventing the social exclusion and complete isolation from any functional urban life, for those without the means or the capacity to connect with larger scale city and global networks. Reiterating the role of urban design in facilitating this complex urban growth over time, we propose 'seeding' those neighborhoods through the optimal organization of main streets, urban nuclei and sanctuary areas.

## The Modernist Destruction of Urban Structure

Urban fabric built today is pathological because the integrated pedestrian system typical of the traditional city has been transformed by design into a fragmented and dispersed car-oriented environment. The two main reasons for this pathology are: the hierarchical functional classification of urban streets, and the way in which it was married to the neighborhood unit idea (Perry, 1929).

The neighborhood unit idea stems from a social and functional critique of the nineteenth century industrial city, where for the first time in human history many cities grew beyond the size that allowed easy access to the open space surrounding them, and where the social control of a close community of kin and neighbors, typical of villages and small towns was absent. The concept attracted universal attention after its application by Clarence Perry for the First Regional Plan of New York in 1929 and has become an accepted mode of practice after the Second World War (Ben-Joseph, 2005). This despite early criticism on the grounds that it fosters segregation, and studies that showed that the neighborhood unit is not perceived as a community by its residents, and that people's expectations with regard to their community are very different (Banerjee and Baer, 1984 is perhaps the most explicit. See also Brower, 2000 and Biddulph, 2000).

On the other hand, city planners addressed movement across larger areas with a thoroughfare ('arterial') system, whereas access was relegated to so-called 'collector' and 'local' streets. The result was that the thoroughfares were designed with speed as an overriding consideration, which was most efficiently addressed with relatively few, larger thoroughfares or 'arterials'. By separating movement from accessibility, and by closing major urban streets to their immediate surroundings, their role as meeting places and urban economic generators is thwarted. Because of this separation of movement from accessibility, present-day streets fail to become social spaces, and thus fail to coalesce into a living city (Gehl, 2002). This compromises pedestrian safety, and, ultimately, neighborhood integrity. Moreover, it creates an area between retail-supportive and transit-served streets that is simply too large.

Because the rationale behind Perry's 'neighborhood unit' was to create an area with sufficient population for a primary school, so that young children will not have to cross major streets on their way to school or open space, the amalgamation of both paradigms was natural, and occurred sometime after World War II. The combination of both paradigms, enshrined as they were in city planning and transportation manuals and guidelines is the reason for the marked difference in urban structure between pre-war and post-war development in all countries of the developed world, as well as in communist-controlled countries. Its outcome is the lack of civic and street life in cities and city parts developed throughout the world – a lack of life that has laid cities bare to the development of out-of-town shopping centers and malls – which obviously tend to develop as close as they can to the movement network.

In fact, it is the movement network and the way it structures daily movement patterns that drives people's social awareness and sense of community, as masterfully described by Jacobs (1961) and formally shown by Hillier (1996).

Empirical studies of people's cognition of the city reveal that major streets, their organization and their relationship to surrounding areas are the primary elements used for cognition and representation of the urban environment (Conroy-Dalton, 2003). Thoroughfares that are still connected to the city fabric (those that have not been turned into expressways) are the primary elements for localization and orientation in a neighborhood. Usually, they are not perceived as boundaries between neighborhoods. People's images of their city also reflect their neighborhood's access to the larger movement and social networks of the entire city, that is, how well their local area functions as an entry point to the regional transportation and social networks (Rofè, 1995; Talen, 2000).

AUTHOR COPY

Certain routes will be favored over others for everyday use, creating social patterns of interaction through shared paths. Nevertheless, community (as a shared system of spatial recognition and awareness) is shaped both by the integrators of the urban grid and by the barriers. Local breaks in the grid, such as institutional buildings, gardens and so on, help to shape these gradients. By their very presence away from the busiest thoroughfares, small squares or parks constrain movement and reduce centrality, and yet they are a destination that draws people by virtue of their nature and use. The same goes for schools and other institutions.

The lesson for city planning is that all streets must provide for both movement and access. That means that thoroughfares (not expressways) must allow transversal permeability by pedestrians and all other kinds of road users (Philibert-Petit, 2006); it also means that intersection and direct exchange must connect thoroughfares and local streets without other intermediate classes of streets in-between. In a recently proposed taxonomy by Marshall (2005), any subjection to 'access constraint' (that is the rigidly hierarchical succession of intersecting streets) is abandoned. This is a precondition to re-establishing a traditional 'conjoint' type of street layout in city planning after decades of an ideological shift towards 'dendritic' or 'mosaic' models. In this way, thoroughfares can be properly re-framed as actual *main streets* (Jacobs, 1993).

Within the New Urbanist movement, and in the urban design literature there is an acknowledgment that the functional hierarchy of streets has been damaging to the city (Murrain, 2002; Hebbert, 2005; Marshall, 2005). Even some transportation engineers have begun to realize that it was not even an efficient transportation network (Kulash, 1990; US-EPA, 2004). Others, have contested the safety benefits of the hierarchical classification (Ernst and McCann, 2002) and particularly for low-income groups (Loukaitou-Sideris *et al*, 2007). Questions are also arising regarding the overall public health benefits of hierarchical classification if it leads to higher reliance on car travel (Cervero and Duncan, 2003; Badland and Schofield, 2005; Ewing and Kreutzer, 2006; Frank *et al*, 2006; Boarnet *et al*, 2008; de Nazelle and Rodríguez, 2009; Forsyth *et al*, 2009; Townshend and Lake, forthcoming).

However, the neighborhood idea still persists, as an essential part of the tools to create urbanism. This can be seen in the chapter devoted to it in the Charter of New Urbanism, in various diagrams produced by Duany Plater-Zyberk (DPZ 1990) as examples of 'good' urbanism, in the diagrams produced by Calthorpe (1993) as part of his ideas for Transit Oriented Development, (see also Bernick & Cervero, 1997), in the literature on urban villages (Franklin, 2002; Brindley, 2003; Sucher, 2003) and most recently in the diagrams of sustainable urbanism produced by Farr (2008). Although these ideas have been contested strongly within the New Urbanist movement – mostly by Jones and Kauffman (2009) and Murrain (2009) who developed different models of district development – the debate so far has been raging about the location of neighborhood centers and their location relative to the movement network. Here we attempt to analyze this debate, and offer our resolution of it, by redefining the relationship between urban nucleus, its pedestrian shed and the neighborhood.

AUTHOR COPY

## Framing the Debate: Urban Nucleus, Pedestrian Shed, Neighborhood and Main Thoroughfares

Let us sketch out the current debate in planning and urban design literature and practice, in terms of how one defines a neighborhood or urban quarter, and where its core is to be located. The urban nucleus contains the highest density of each function (residential, commercial and so on) as well as the densest mixture of all distinct functions. There are several choices, but some of them represent dysfunctional city form.

We propose here a four-way classification based upon combinations of the two independent factors of *position* and *connectivity* (Figure 1): protagonists of these combinations are *urban nuclei* (red-to-yellow smaller circles), *urban neighborhoods* (pink larger circle), *pedestrian sheds* (dotted red circumference), *thoroughfares* (thick black lines, dotted when 'tamed' for pedestrian compatibility) and *local streets* (thin dashed black lines). Every urban situation can be described as some binary combination, simple or complex, of these factors.

1. CENTERED NUCLEUS. The urban nucleus is located somewhere around the geographic center of the neighborhood.
2. EDGED NUCLEUS. The urban nucleus is located somewhere at the edge of the neighborhood.
3. EXPOSED NUCLEUS. The urban nucleus is mainly considered a result of the movement

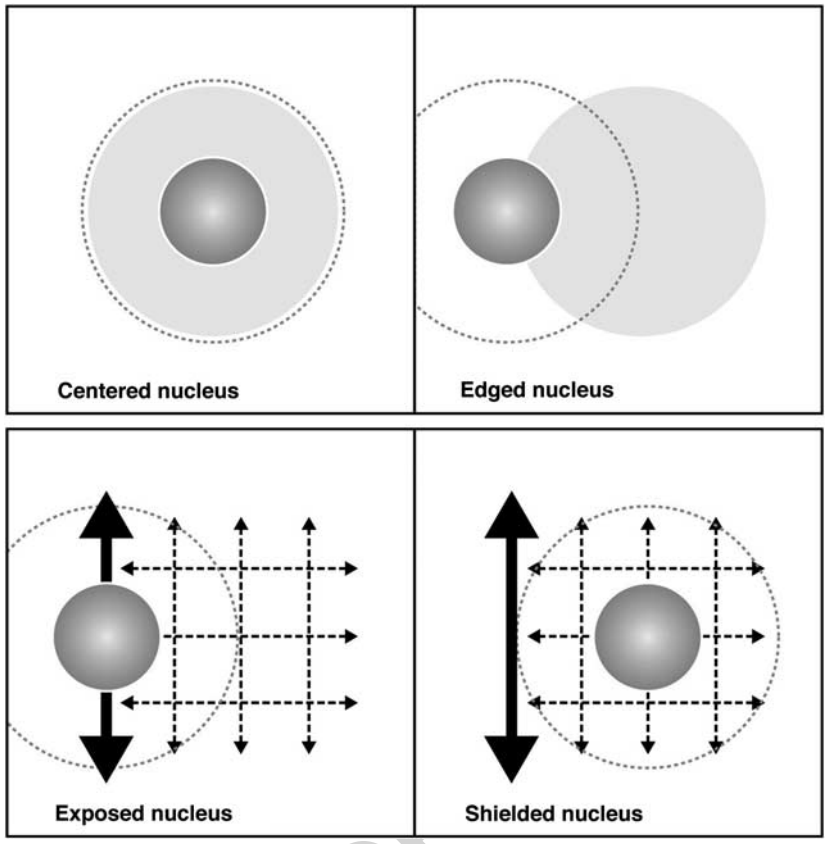


**Figure 1:** Urban nucleus and edge conditions.
Note: colours described in the text can be seen in the online version of this article at www.palgrave-journals.com/UDI.

AUTHOR

network and is therefore located in close proximity to urban thoroughfares.

4. SHIELDED NUCLEUS. The urban nucleus is conceived as the outcome of far more complex dynamics, where the movement network is just one factor among many others, thus the nucleus is considered suitable for quieter 'sanctuary street' realms.

Some urbanists are in favor of a CENTERED/SHIELDED option, where 'centered' urban nuclei serving the local community are not located necessarily in combination with urban thoroughfares (Figure 2). This model places activities at the core of a neighborhood, where the neighborhoods are enclosed by but are detached from thoroughfares. Neighborhoods and pedestrian sheds therefore overlap, which ensures a good efficiency for the latter. The limitation with this model is that neighborhoods cannot grow beyond the limit imposed by surrounding thoroughfares, and the urban space remains fragmented in disconnected patches. More seriously, major mixed-use hubs inevitably gravitate around prominent crossings of motorways or major urban arterials in a car-oriented environment, which undoes the CENTERED/SHIELDED typology. This process separates the local neighborhood community level of mixed-use locations from the district-to-metropolitan level (around thoroughfares) in different areas of the city, thus creating unresolved forces that lead to morphological instability.

Other urbanists are more supportive of an EDGED/EXPOSED option, where 'edged' urban nuclei are this time tightly connected in space with thoroughfares that bring with them the so-called 'movement economy' (Figure 3). This represents social and commercial hubs traversed and served by major channels of information/human/goods flows. An example is the shopping mall or high-rise office cluster at the intersection of thoroughfares. In this case, neighborhoods are bounded by thoroughfares but are kept away from each other, from the thoroughfares, and from urban nuclei alike. Even when the traffic is calmed, transversal connections are spatially distant. Although in a traditional urban fabric the neighborhood might possibly benefit from a

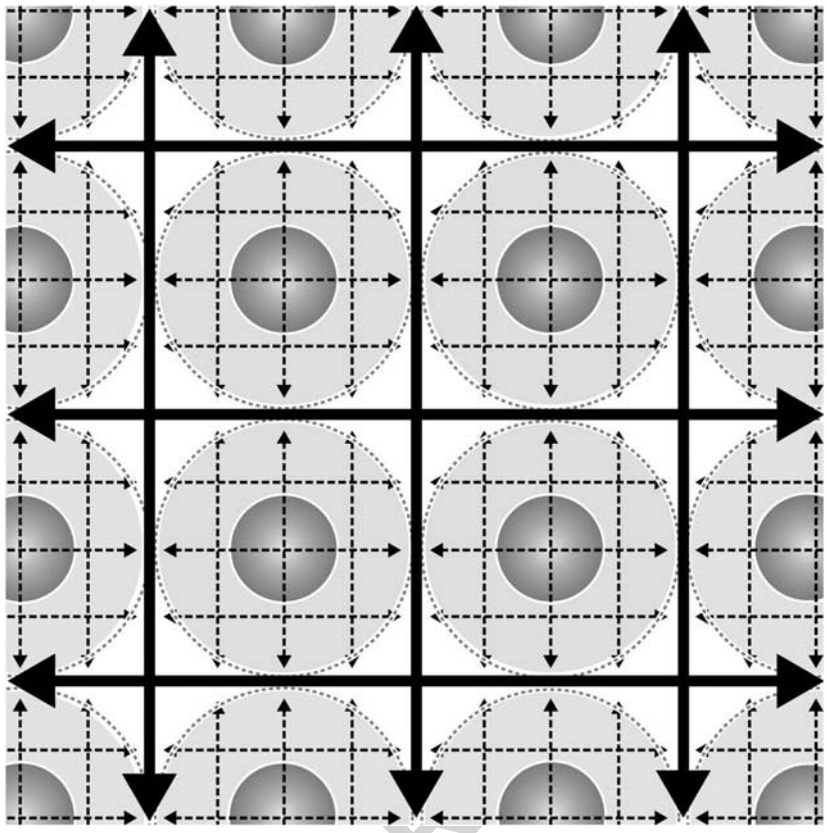

**Figure 2:** Centered/Shielded relationship of pedestrian shed, neighborhood nucleus and movement network.

AUTHOR

direct walkable connection to urban nuclei at intersections, in many later instances it is disconnected, and access is roundabout and by thoroughfare only. Posed in this way, the opposition between the CENTERED/SHIELDED versus EDGED/EXPOSED standpoints could not be sharper: it is in fact irreconcilable.

The alternative CENTERED/EXPOSED core (Figure 4) places urban nuclei close to the geographical center of the neighborhood in strict and direct proximity to trafficked roads in order to take advantage of the movement economy. This is the 'traditional' compact urban scenario, a remarkable scheme that has always been a model for traditional urbanization processes before the motor age. It survived until main streets began severing rather than joining urban communities due to an increased level of traffic, and separating through movement from access, as mandated by transportation engineers. Here, neighborhood boundaries are no longer created by streets, but by some other type of natural or artificial barrier or discontinuity. The model becomes problematic with the disturbance of fast moving automotive transportation on major roads through the urban centers. Unresolved forces generated through increasing traffic flow create an instability that can push the CENTERED/EXPOSED core (Figure 4) to transform into the EDGED/EXPOSED model (Figure 3). To prevent this, the whole scheme is made practicable when thoroughfares are traffic-calmed locally into 'main streets', which therefore become supportive of the denser social dynamics that give life to urban nuclei.

The opposite alternative is EDGED/SHIELDED (Figure 5), in which urban nuclei are placed at the edges of neighborhoods, or actually removed from them, but are also disconnected from thoroughfares. This model combines all possible negative aspects of severed communities, secluded social/commercial hubs and inefficient pedestrian sheds. Abstract though it is, this model has nevertheless been widely practiced for the urbanization of western societies since after World War II.

## Neighborhoods and Pedestrian Sheds

A key to understanding the resolution we offer of this debate is the distinction we make between the

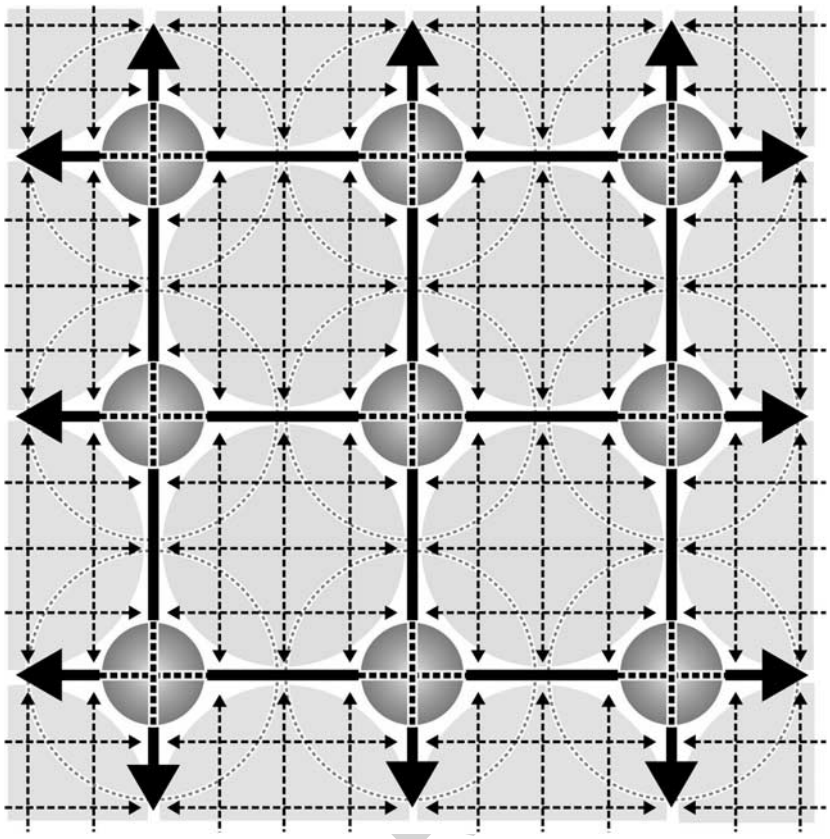

**Figure 3:** Edged/Exposed relationship of pedestrian shed, neighborhood nucleus and movement network.

AUTHOR

notions of 'neighborhood' and 'pedestrian shed' in relation to the urban nucleus. There is an assumed relation between these two notions implicit in the debate and in most urban design literature, which we seek to dissolve.

An urban nucleus is by definition the center of its own pedestrian shed, which may or may not be identifiable with a 'neighborhood'. Urban nuclei should be reachable within some 5 min walk from most residences and non-industrial workplaces. This accessibility is necessary in order to achieve several essential goals of the social and environmental sustainability agenda (Newman and Kenworthy, 1999). Urban nuclei will in most cases be located somewhere near the geographic center of the pedestrian shed, because any pedestrian shed is by definition determined by the location of the urban nucleus itself.

On the other hand, there are many ways to define neighborhoods. As a result, parish boundaries could come from centuries of history; other boundaries may be defined by the service sheds (some larger, some narrower) of different categories of services; we may have different systems of administrative boundaries, either hierarchical or partially overlapping. In historical territories, past administrative boundaries were in use in medieval times and typically enclosed main streets as central spines or 'backbones' of neighborhoods (quite the opposite of most administrative boundaries currently in use, which coincide with main streets). Finally, we have the fuzzy boundaries of ethnic group concentrations, as well as other boundaries that show up when other demographic factors (such as age or income) are mapped. When interviewing people about their neighborhoods we come up with many other different boundaries, sometimes consistent and sometimes divergent, but often different from the formal ones used by public officials.

At the local scale, the interplay and overlapping between countless personal and collective forms of social and cultural relationships (which we call 'community') finds temporary spatial configuration. This process occurs at every step of the urban evolution into emerging aggregations. Neighborhoods are layered (fractal) formations

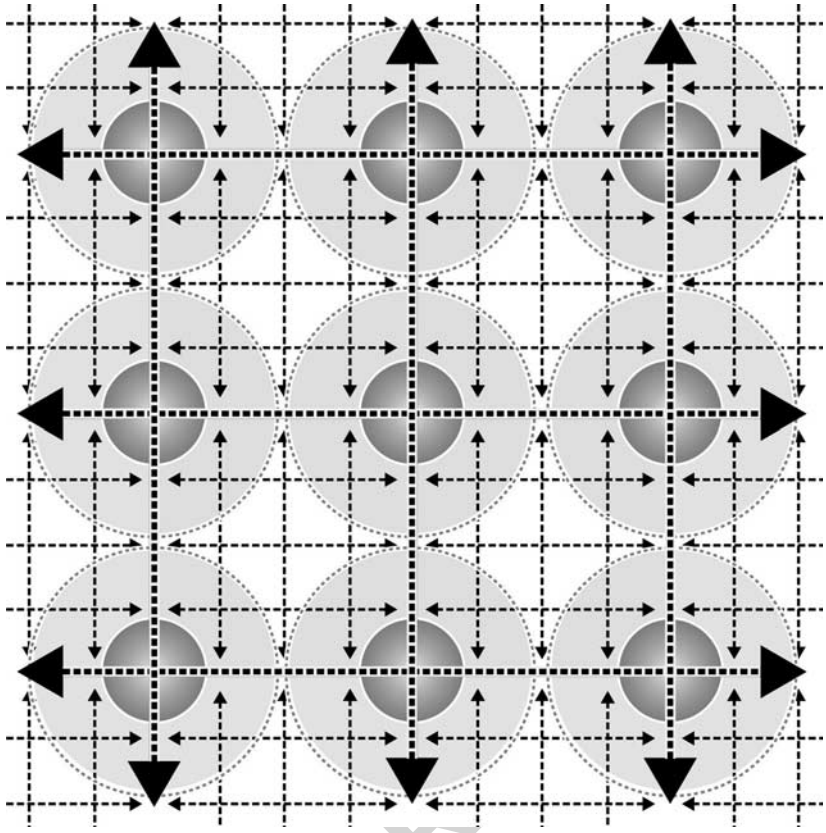

**Figure 4:** Centered/Exposed relationship of pedestrian shed, neighborhood nucleus and movement network.

AUTHOR

of overlapping sub-formations, each of which is still layered in itself: they should not be conceived as fixed and delimited geographical entities. A 'neighborhood' is not identical with the geographic and socio-cultural extension of an urban community. Spatial configurations influence evolving and borderless neighborhoods specific to site, social groups and individuals. Places and communities interact precisely because they are inherently different in nature.

Urban designers have always been conceiving neighborhoods (during the entire history of our discipline) as fixed and stable community units aggregated around a center of basic services that should ideally be accessible on foot. This image thus unites in the same concept both a socio-cultural meaning related to the term 'community', and a geographic one related to the term 'accessibility'. We, however, stress a more dynamic idea of the urban community as a social and cultural construct, especially in contemporary societies (Castells, 2000; Talen, 2000; Salingaros, 2005).

In short, neighborhoods are only definable in a space characterized by variable geographies that depend on who uses this structure. Moreover, this variable geography of use is dynamic not just in space, but in time as well. It endlessly changes and evolves along with society and values over time. That is why we distinguish very clearly the neighborhood as a social, cultural and historical entity (complex of entities, to be sure) from the pedestrian shed. A pedestrian shed is basically spatial proximity characterized by some sort of distance to be covered by citizens towards their daily destinations to satisfy ordinary needs.

Predominantly residential areas, creating areas of less through movement, but hopefully more local movement, can help to generate a sense of community among people sharing them. By themselves, however, these areas are not enough to create a neighborhood. In the final analysis, neighborhoods are created by the social networks, strong and weak, that arise in such places, and these networks are only partially dependent upon the spatial structure. Therefore, we don't believe

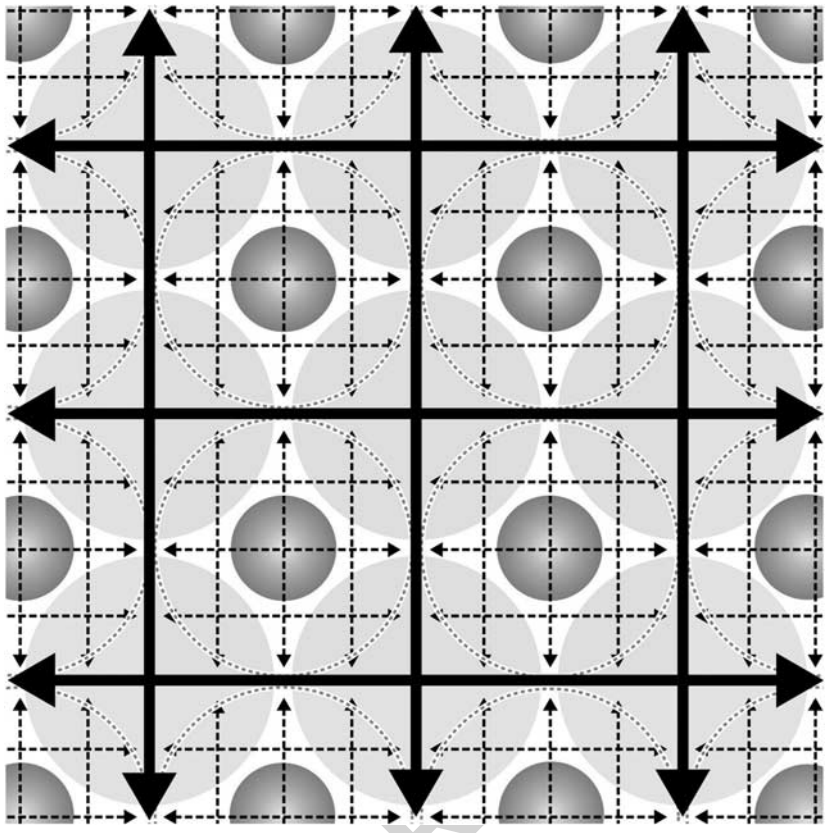

**Figure 5:** Edged/Shielded relationship of pedestrian shed, neighborhood nucleus and movement network.

neighborhoods should or can be designed: to place anything, including urban nuclei, as the center of a neighborhood is not within our domain as urban designers. Managing public policies of transport and land-use such that most residences are located at walkable distance from transit access, retail and basic services (in other words, shaping pedestrian sheds) *is* within our domain.

Summing up, our proposal implies that pedestrian shed and neighborhood need not be congruent. This leads to many possible resolutions of the disputes about urban nuclei and thoroughfares: the most important is that neighborhoods may have (but are not required to have) a 'quiet center' with civic space, a corner grocery or destination retail, and perhaps a bus stop (but even that is not needed) that should not necessarily coincide with either the center of pedestrian sheds or urban nuclei. A new scheme is therefore derived from the EDGED/EXPOSED compact urban model previously illustrated by relaxing the geographical conditions of neighborhood formation. It may be termed the EMERGENT NEIGHBORHOOD MODEL (Figure 6), and is developed in more detail in the next sections.

## The Solution: Well-connected Nuclei With Diffuse Internal Flow, or the Emergent Neighborhood Model

What brings people into a certain space more than into another? This is the great problem; yet, considering what drives urban dynamics in time, consistent evidence indicates that *centrality* is the key. Central places tend to evolve, all other things equal, into popular places with many passersby, which makes such places attractive for retail and services, which in turn makes them even more attractive for additional passersby, and so forth in a self-reinforcing cycle. Having many passersby does not necessarily mean congestion of cars and trucks, however. It just means many people, and if space is limited, then preference should be given to the modes that use space more efficiently: pedestrians, bicycles and public transit, while limiting access to other modes either by space allocation or by time allocation to off-peak periods.

We must place urban nuclei in the best conditions in which they can root in and grow in the long run. That is feasible when: (1) they

AUTHOR

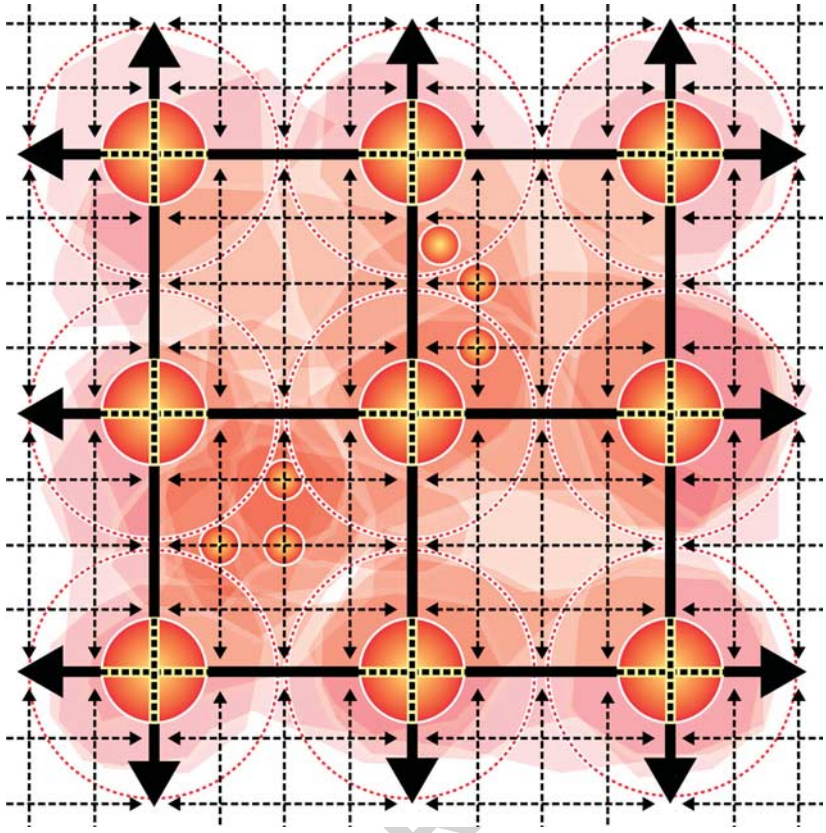

**Figure 6:** The proposed Emergent Neighborhood Model. Like in both the Centered/Exposed and Edged/Exposed options, of which this represents an evolution, urban nuclei are on thoroughfares. However, neighborhoods are no longer constrained into a fixed geography, but are represented as the outcome of the dynamic overlapping of many layers that vary in space and time through processes of self-organization. That allows including in this model the emergence of local focuses of mixed-use activities within areas of higher neighborhood 'potential' detached from thoroughfares.

AUTHOR

form out of urban clusters in close proximity to highly central places, especially intersections between popular thoroughfares; and (2) they match access points to major public transportation systems, thus establishing a convenient pedestrian shed both in terms of accessibility to local retail and services and to the region as a whole through the transit system.

All this is pictured in the proposed EMERGENT NEIGHBORHOOD MODEL (Figure 6). This model is an evolution of both the traditional CENTERED/EXPOSED scheme (Figure 4) and its contemporary 'reformed' EDGED/EXPOSED version (Figure 3) illustrated above, with two important differences: the pedestrian shed is here distinguished from the neighborhood. The neighborhood also has lost the rigidity of the one-circle shape to take the form of a variable-geography complex of layered areas. These areas gravitate towards urban nuclei but are not centered on them necessarily.

The problem is the level of conflict that ensues when a node of activity is spatially centered on a major urban road, due to the severance effect of motor vehicle traffic and, in addition, the width of the right-of-way. This is not an insurmountable problem. It has been shown that a well-designed boulevard can carry a very high flow of traffic without bisecting the pedestrian shed. Boulevards like the Diagonal in Barcelona, for example, can carry around 100 000 vehicles per day (Jacobs *et al*, 2002). Traffic-calming and street design techniques make it possible to solve the conflict between thoroughfares and dense activity centers, even in cases when the former take the form of heavily trafficked roads if one is willing to accept reduced speed (which does not necessarily mean much reduced capacity).

In what sense then does the proposed EMERGENT NEIGHBORHOOD MODEL (Figure 6) reduce the schism between the standpoints represented in Figures 2 and 3? Neighborhoods can be

quieter areas framed by local streets and nevertheless converge around some sort of community area placed more or less in the center of the neighborhood itself. Some services, like special kinds of retail shops or the lower grades of educational services, may take advantage of urban environments that put some distance from the hustle – and bustle of urban nuclei. The proposed scheme presents 'ripples' of denser neighborhood layers at the interstices of pedestrian sheds and away from dense activity centers on thoroughfares.

In this model, neighborhoods can still be quieter areas, but activities strongly need to stay close to channels of the movement economy, that is thoroughfares. On the one hand, neighborhoods do not rigidly respect the structure of centers and thoroughfares but flow in different ways over the substrate of this structure. On the other hand, pedestrian sheds 'abandon' any necessary reference to neighborhoods and remain anchored to the structure of urban nuclei and thoroughfares.

The solution to the placement and structure of the urban nucleus incorporates some sophisticated notions learned from biology. The center of our nucleus accommodates urban activity through flow, but only up to a certain carefully monitored threshold. This is analogous to having different systems of internal body flow that are necessary for the organism to function. There is always a very delicate balance, however, between the structural wholeness of the organs themselves and the requirements of the adjoining transportation system that is required to feed them. In addition, much of internal body flow is in fact capillary: that is diffusion rather than medium or fast flow. Our conception of human-scale urbanism shares this notion of capillarity. Human pedestrian movement being the most delicate form of movement (compared with vehicles) corresponds to capillary flow in the urban fabric (Salingaros, 2005, Chapter 6).

## Urban Nuclei, Main Streets and Sanctuary Areas: The '400-meter Rule'

Distinguishing between the concepts of pedestrian shed and neighborhood, as was discussed above, re-defines the concept of neighborhood. The conclusion that we draw is radical: we cannot design neighborhoods, because neighborhoods self-organize beyond any hierarchical top-down control. What then remains for urban designers to handle after the 'disappearance' of designable neighborhoods? Basically two things: (1) *pedestrian sheds*, and (2) *main streets and sanctuary areas*.

Conventionally, pedestrian sheds are determined by the location of mixed-use and transportation hubs (urban nuclei), and the type of street layout. Pedestrian sheds are simply a spatial range of accessibility to facilities. The pedestrian shed's form and extension depends upon the threshold of accessibility that we consider acceptable for that category of facility, and also on the types of facilities that we select for essential access. We can assume a threshold distance of the '5-minute walk', roughly equal to 400 m (1/4 mile), for basic services and light rail transit. This threshold can be less for local transit services like buses, more for underground metro and still higher for regional transit services like railways. Facilities that include mixed-use commerce/service activities and access to transit constitute what we term an 'urban nucleus'.

The type of street layout determines *actual* pedestrian sheds, with highly interconnected grids leading to higher permeability of the urban space, thus better approximating the *virtual* pedestrian shed circle. At the schematic level, however, we can represent local pedestrian sheds very roughly in the form of circles of 200 m radius (or, say, 400 m radius for longer-reach transit) surrounding the urban nuclei.

A pedestrian shed, therefore, has a fairly definite geographical shape so that we can indeed design it. Pedestrian sheds become a key tool in the hands of urban designers; their impact spans over major roads and local streets, residential quiet areas and intense activity centers, primary urban functions and ecological reserves like gardens and parks. The new Emergent Neighborhood Model addresses this complex relationship around two interrelated urban notions: 'main streets' and 'sanctuary areas'. This approach leads to an understanding of urbanization as a timeless process based on the '400-meter rule'; it also provides a conceptual framework for interpreting the greater part of urban fabrics, which are neither dense/active places (that is urban nuclei), nor appendages of thoroughfares.

With neighborhoods seen as flowing, evolving behavioral and socio-cultural formations rather than spatial entities, we use the term 'sanctuary area' to define those quieter urban areas, mostly residential, here and there punctuated by services or local retail, where most of us live. 'Sanctuary

AUTHOR COPY

area' refers to Donald Appleyard's distinction between busy streets full of people and activities from calm, local, mostly residential realms that he termed 'sanctuary streets' (Appleyard, 1981). He conceived these two distinct domains as being essential elements constituting the good city. We will explain how sanctuary areas are related to urban nuclei and thoroughfares.

A comparative study of many cities with different historical, cultural, geographic, climatic and economic characteristics reveals that *sanctuary areas* (that is those urban areas made of sanctuary streets) are one of the two building blocks of 'human' cities across all times and places; the second is *main streets*. We can see this dynamic in action in the paradigmatic case of the historical center of Bologna, Italy (Figure 7, plate a). The same dynamic applies to a case as culturally and historically different as Al Hofuf, Saudi Arabia (Figure 7, plate b). We observe that main streets in all living cities are those connecting the global to the local scales (in historic instances, they connect the city center with the ancient city gates), whereas sanctuary areas are quieter spatial entities bordered and defined by main streets. Such sanctuary areas are roughly quadrangular (or triangular in the case of converging streets); their size is determined by one edge that measures between 350–450 m. This measure of around 400 m on the side is surprisingly constant all over the world and across urban history. The rationale behind this '400-meter rule' is embedded in the general mechanism of the urban fabric's evolution that has been especially investigated by the Italian school of urban morphology (Caniggia & Maffei, 2001). We can extend those findings with a new focus on the interplay between main streets and sanctuary areas.

The process begins (Figure 8, plate a) with a densification around one major street at one point that is for some reason prominent (for example, an intersection with another important street). Buildings and lots directly abutting on the two main streets organize from both sides (here we represent just one side). A few small streets begin to grow from the two main streets inwards, showing a dead-end configuration; these streets are the seeds for the future development of the inner street network that will frame the sanctuary area at the end of the cycle. In a second step (Figure 8, plate b) a new main street stems orthogonally from the generator path somewhere around 400 m from the previous intersection, beginning here from both sides. What we have constitutes a first merged urban fabric, still not very dense, towards the original core of the city. It is framed by a complex but still not clearly hierarchical network of local service streets.

In a third step (Figure 8, plate c), the first 'sanctuary area' finally gets closed by another main street emerging parallel to the generator path. As the internal street network becomes more complex, a few routes emerge that provide direct shortcuts to the higher main streets network. Local service streets that evolve into through routes connecting main streets become *local* main streets; they assume some of the characteristics of main streets, that is density in built fronts and location of non-residential activities (especially at ground floor), though at a lower intensity. This type of street offers the best conditions for the 'spill-over effect' to happen, by which the mixed-use system of commerce and service gradually expands from main streets onto local main streets, and thus into sanctuary areas. The depth of this penetration dynamic depends upon local conditions, particularly on the grade of attractiveness exerted by the outer main street at its intersection with the local main street.

The dynamic relationship between sanctuary areas and main streets that we call the '400-meter rule' is a timeless pattern in city evolution that emerges whenever the urban fabric is the outcome of a historical self-organized process of formation. This rule has to do with several universal characteristics of the human body in relation to the environment, and correctly balances the need to navigate urban space effectively on foot, with the competing need to maximize the use of space for developing buildings and activities at a proper density. Interestingly enough, we find this rule not only in the 'spontaneous' formation of self-organized cities in history, but also everywhere in the rationally planned 'new foundation cities' before the industrial age, from ancient Roman colonies like *Augusta Taurinorum* (now Turin) to Renaissance ideal cities like Palmanova. It is only with modernism that city planning divorced itself from the 400 m rule of evolving cities applied during all preceding times, by introducing the concept of neighborhood as a geographic entity based around the population of an elementary school, and disconnecting adjacent units by high-speed inaccessible arterials (see our earlier discussion, above).

We conclude that sanctuary areas as building blocks of cities in history have always been sensibly smaller than the neighborhood as we

AUTHOR COPY

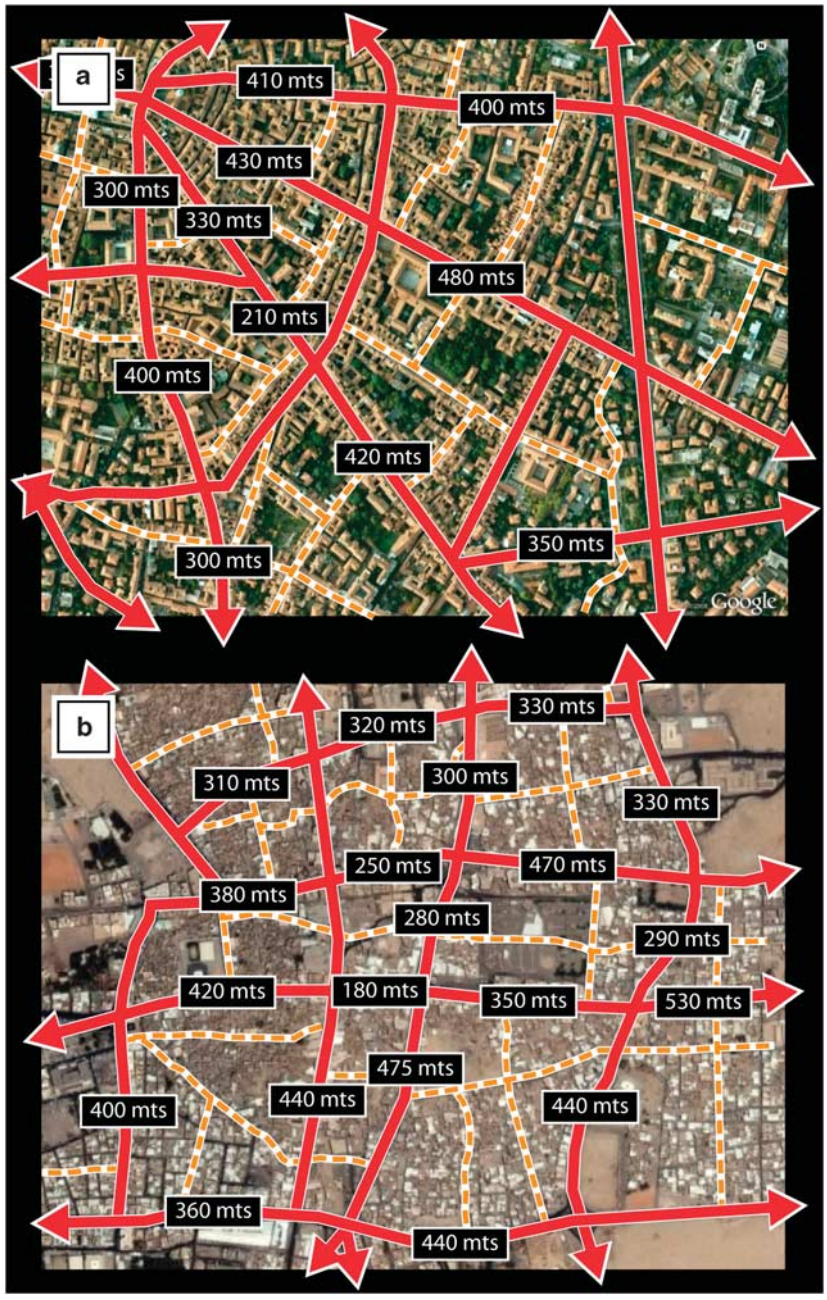


**Figure 7:** The timeless pattern of main streets (thick solid red) and sanctuary areas (on the background, defined by main streets) here at work in the cities of Bologna, Italy (plate a), and Al Hofuf, Saudi Arabia (plate b). Local main streets (dashed orange) emerge regularly within sanctuary areas as denser shortcuts connecting the higher network of main streets.

know it in literature and practice. This leads to a profound structural diversity in the scale of urban fabrics. The half-mile (800 m) 'Jeffersonian' grid, a measure that has persistently framed the 'neighborhood' literature in our modern disciplinary tradition (including some New Urbanist schemes), is simply out-of-scale. Other examples are Chandigarh in India and Beer-Sheva in Israel: both planned according to modernist city planning dogmas and based on an $800 \times 1200$ m grid, each cell of which was somehow meant to be an autonomous 'neighborhood' and is in fact separated from all others by major roads. This scheme is an abysmal failure based upon a complete misunderstanding of human nature and urban community.

 © 2010 Macmillan Publishers Ltd. 1357-5317 

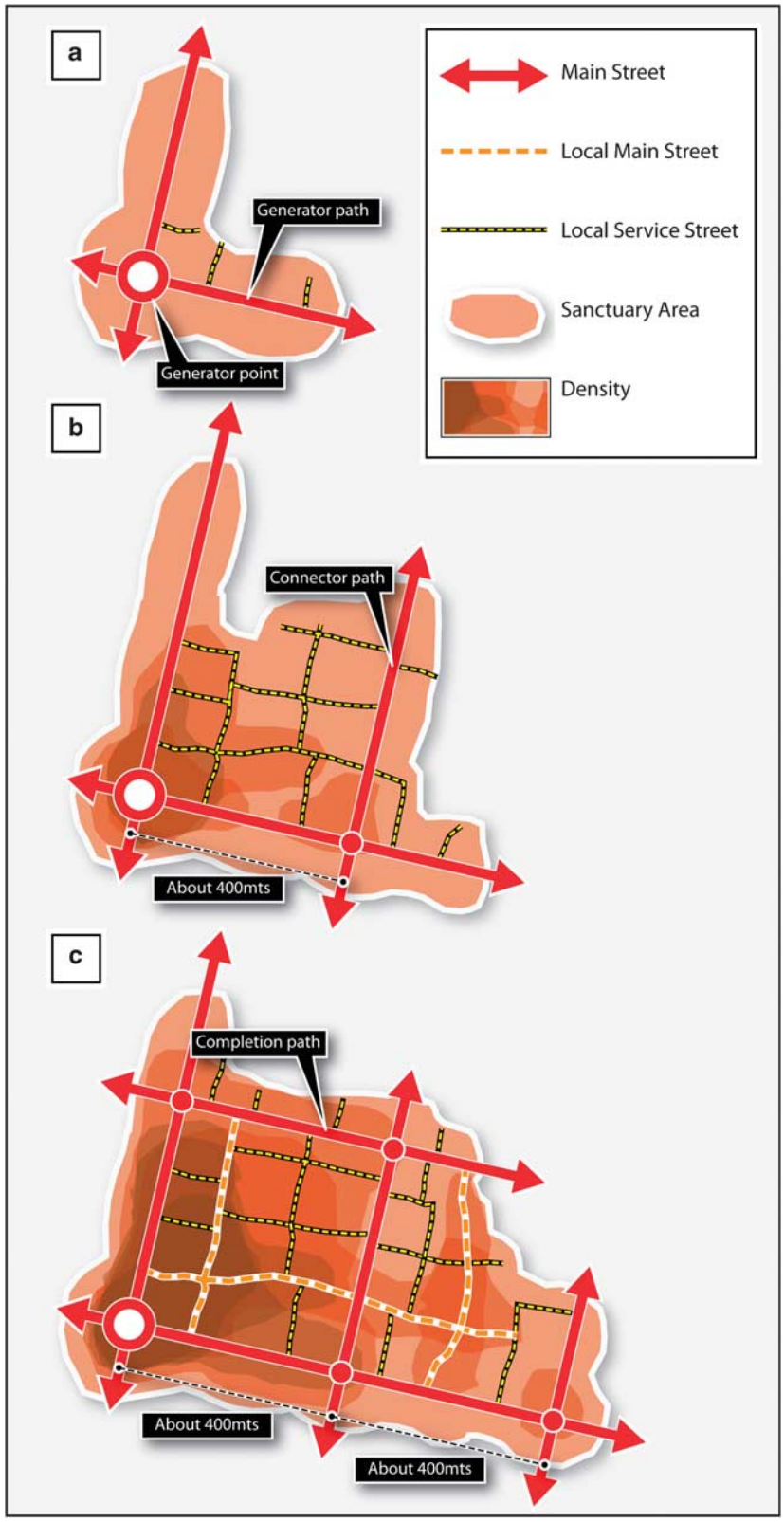


**Figure 8:** The '400-meter rule' as an outcome of the process of self-organized urban accretion that is conducive to the timeless pattern of main streets and sanctuary areas.

Given the human limits of pedestrian movement, all main streets must maintain connectivity on the order of 400 m maximum spacing, and the distance between transit-served and retail-supportive streets (as determined by their catchments) must be on the order of 400 m maximum separation. The 400 m rule establishes a diffuse, connected street structure containing the minimum spacing for continuous walkability, which ensures a close relationship between the sanctuary areas and the urban nuclei: close enough that you can actually walk to four different urban places from anywhere within the sanctuary areas.

## The Emergent Neighborhood Model in the Region: The Case for *Urban Seeding*

A taxonomic investigation (Figure 1) of the relational position of urban nuclei, pedestrian sheds and neighborhoods in the urban quarter space resulted in a formation that we termed the Emergent Neighborhood Model (Figure 6). In our proposal, traditional compact urban development finds a new synthesis based on the distinction between pedestrian shed and neighborhood, and the consequent reframing of neighborhoods as dynamic, social-spatial formations. Introducing the term 'sanctuary areas' and the '400-meter rule' as a metric for the self-organization of urban fabrics, we argued that this is a timeless metric of cities throughout urban history, regardless of culture, until the codification of the neighborhood concept in the early twentieth century. We now extend our proposed conceptual model (Figure 6) to a new vision that embeds the spatial dimension: the Emergent Neighborhood Model in urban and regional space (Figures 9 and 10 (a)–(e)).

At the urban scale (Figure 9) the model offers a finer hierarchy of nuclei and transit systems, which also implies an equally finer hierarchy of pedestrian sheds. The main points of this vision illustrate:

- The formation of denser developments in proximity to transit service of a higher rank (that is infrastructure-dependent mass transit).
- The generation of mixed-use corridors as an outcome of contiguous urban nuclei merging along such systems.
- The aggregation of local foci along *local* main streets within sanctuary areas as a result of the 'spill-over effect' from main streets.
- The continuity of a connected ecological network of linear and planar 'green' elements such as parks, tree lines, boulevards or rivers all over the urban fabric, with arrangements at intersections with main streets that maintain the critical connectivity of the system.

Compared with similar visions in the history of urban design, including recent New Urbanist schemes (Duany & Plater-Zyberk, 2002; Farr, 2008), the proposed scheme introduces several novel features:

- The lack of a tree-like hierarchy (in the sense of the large-scale dominating the small-scale) of neighborhoods around one neighborhood or nucleus of higher rank. That type of hierarchy of communities makes the small-scale dependent upon the large-scale, and would in fact be too rigid to allow any kind of self-organization and emergence of neighborhood to take place.
- The relinquishing of the neighborhood as a planning unit: the building block of urban fabric is no longer the fixed neighborhood unit, but is instead the network of pedestrian sheds connected by transit stops within urban nuclei.
- The 400 m rule defines quieter predominantly residential 'sanctuary areas', instead of regions of 800 m or more typical of twentieth century neighborhood unit-based models. Our proposal shows how the 400 m rule matches well with both the hierarchy of urban nuclei and that of transit systems.

As a result, our model stresses a continuous and permeable urban space, framed by an accessible transit infrastructure located within urban nuclei. The urban hierarchies are flexible and are constantly being reframed through a self-organizing process acting on a spatial substrate of places.

These characteristics are also legible in the extension of our vision to the larger regional space (Figure 10 (a)). Overlapping social and geographic units show up as emergent neighborhoods and pedestrian sheds of different sizes structured around urban nuclei. This evolution in turn reverses the top-down hierarchical structures proposed on the basis of a geographic notion of neighborhood in all post-traditional urbanism from the Garden City to the modern city (Alexander, 1965), down to the latest New Urbanism and Place-making schemes. A complex interlacing of social, cultural and economic layers emerges and evolves over a spatial substrate that includes features of mobility (private and public)

AUTHOR COPY

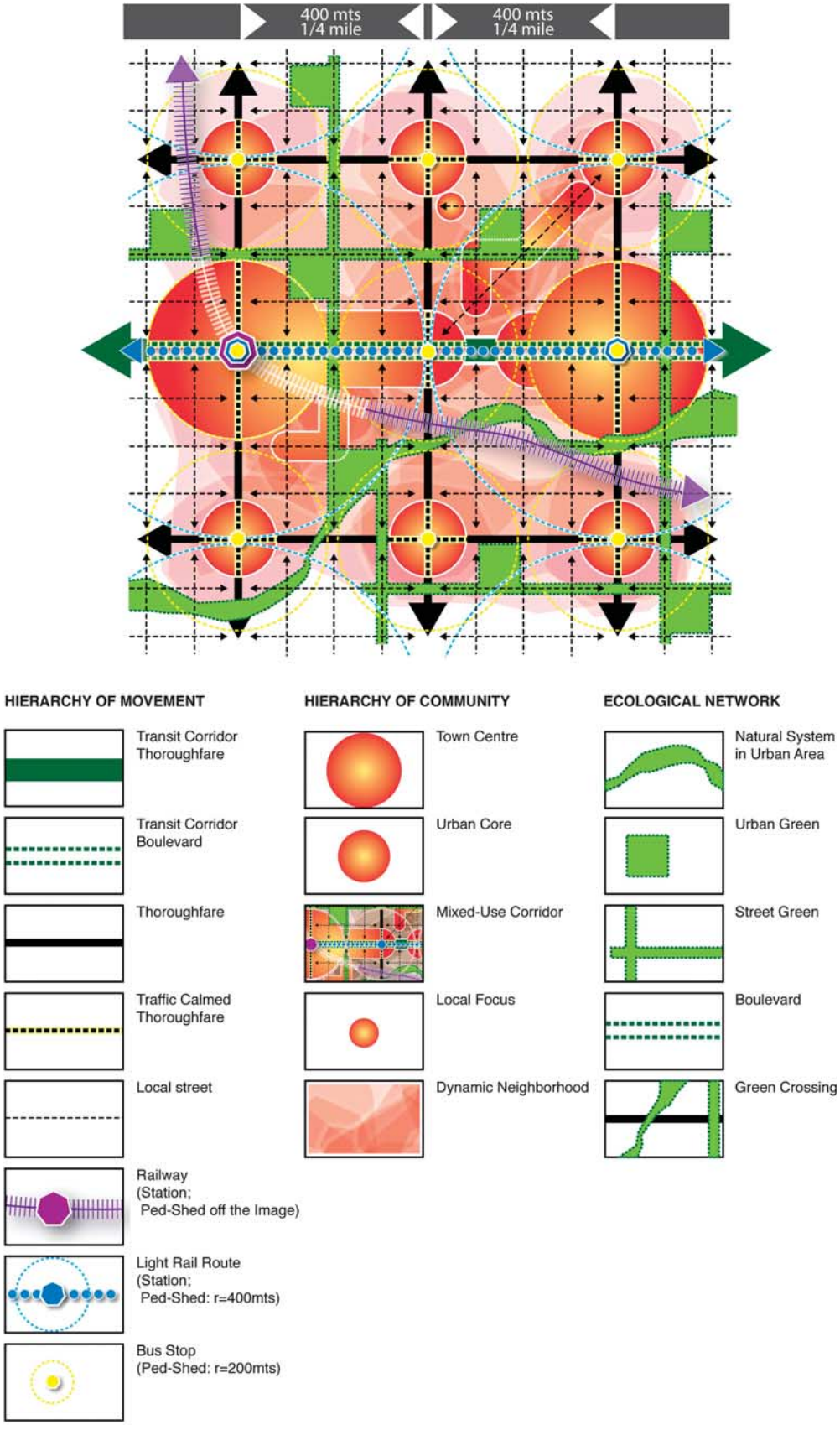


**Figure 9:** The proposed Emergent Neighborhood Model in urban space.

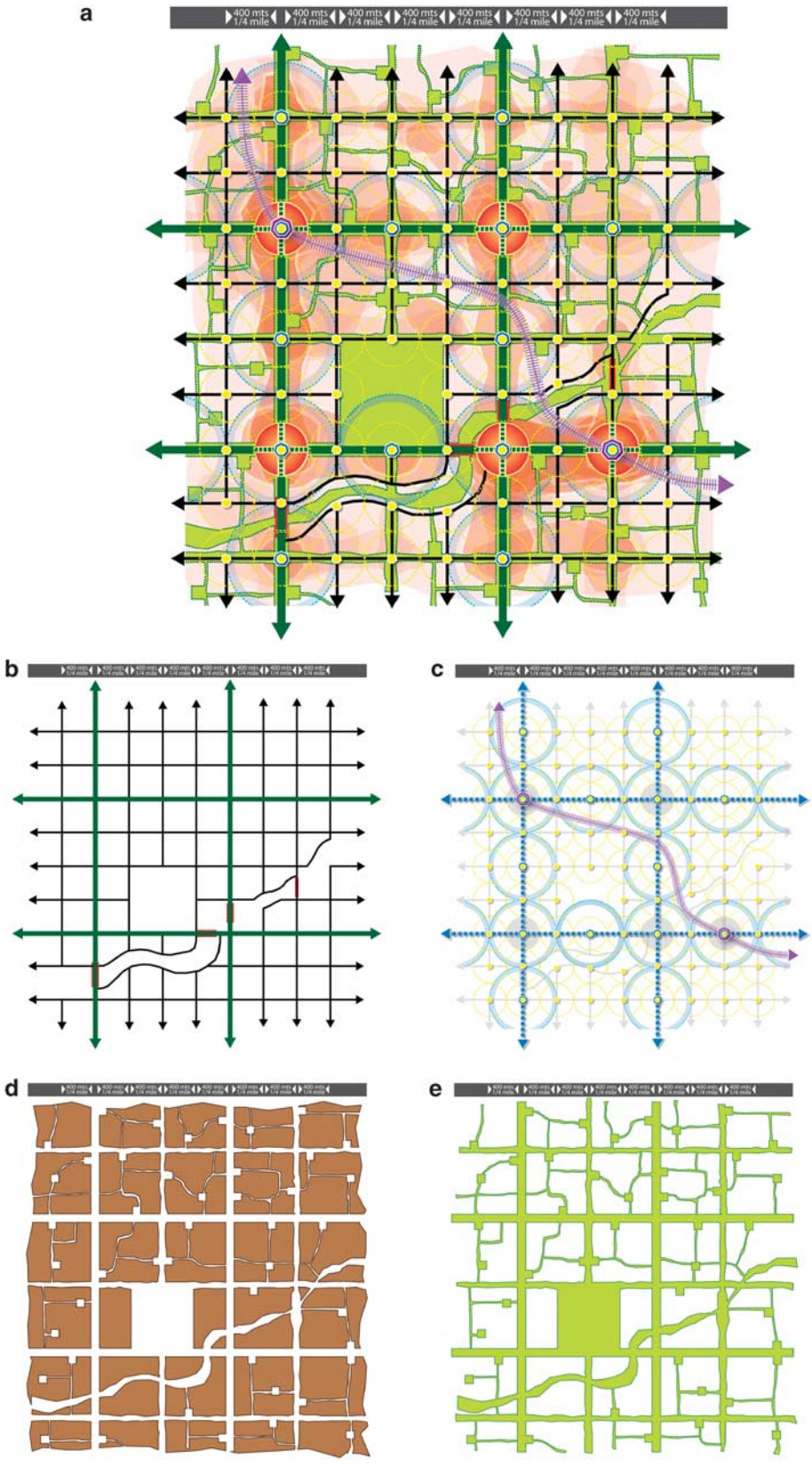


**Figure 10:** : The proposed Emergent Neighborhood Model in the regional space: (**a**) the complete picture; (**b**) the network of private mobility; (**c**) the network of public mobility; (**d**) the network of the built environment; (**e**) the network of the natural environment.

 © 2010 Macmillan Publishers Ltd. 1357-5317 

and the environment (built and natural). Although social, cultural and economic phenomena are rapidly changing, the spatial substrate (Figures 10 (b) –(e)) is relatively 'permanent' in the sense that it changes at a far slower pace. It lies indeed within the domain of urban designers, in the sense that its structure should be the matter of a renovated discipline of sustainable, human, adaptive urban design or, in short, of *urban seeding*.

In the proposed model, main streets (Figure 10 (b)) are the backbone of the ecological network. They provide the main linear natural features that make the whole ecological network connected. Nevertheless, main streets must not be conceived as parkways in a large green strip; in that case, they would split the built fabric of sanctuary areas (Figure 10 (c)) into visually and spatially disconnected regions. That would inhibit the self-organization of dynamic neighborhoods, pushing the system back again into a hierarchical top-down structure as in Chandigarh, Brasilia, Cambernauld, Milton Keynes and countless other modernist and post-modernist planned estates. This is because, as Kevin Lynch stated, *the good city is one in which the continuity of this complex ecology is maintained while progressive change is permitted* (Lynch, 1981, p. 116).

Linear natural features (Figure 10 (e)) should instead be interpreted as tree-lines, green storm-water medians, water streams, shrubs or hedges and the like, which do not fragment the built fabric into separate parts and do not interrupt the continuity of the city's complex ecology with spatial vacuums and barriers. Inserting these features as part of the design of main streets is a matter of innovation and research, creating a new urban component of the sustainable city of tomorrow. Local linear greens in the form of small public or private gardens, ponds and the like (what in short constitutes the ecological patrimony of a good residential realm) are to be considered part of the sanctuary areas structure, directly connected with the urban ecological network.

The overall structure of the main streets needs to be coordinated, designed and built at the scale of the city as a whole, or in the case of major thoroughfares, at the urban regional scale. However, the street and built-up fabric of sanctuary areas (Figure 10 (d)) can and should be structured such that a continuous process of adaptation and evolution takes place from the bottom up, through the personal initiatives of residents and citizens, outside of any formal process of participation. This form of grassroots contribution to the constitution of the urban fabric has always been the original and powerful form of citizens' involvement in the construction of their living urban environment, with the greatest advantage for the common good. In order for this participatory dynamic to emerge and flourish again, the proper spatial, proprietary and procedural prerequisites should be devised and established at the local scale.

There are by necessity discontinuities in the urban realm (Salingaros, 2005). These may be large elements of infrastructure, wildlife corridors and ecologically important areas: areas of heavy industry, or warehousing or areas of extreme concentrations of particular uses such as downtown commercial centers. How are these discontinuities to be negotiated within the new paradigm we are proposing?[1]

In fact, there is a very limited number of highly specialized activities that need proximity to expressways. The vast majority of economic activities and services, including all those that directly sustain the daily life of urban communities, need the kind of centrality that is based on how streets are positioned and mutually interconnected. This is pretty much independent from motor traffic flows. It is therefore crucial to avoid any confusion about the word 'thoroughfare', which in this article means 'a major channel of information/human/goods movement', but not necessarily anything like 'expressway' or even 'arterial road'. In our model thoroughfares are re-considered in a system of 'main streets'. In all cases where urban nuclei are to be centered on actual major traffic roads, an intensive use of traffic-calming techniques, including turning arterial roads into boulevards, are needed to resolve the conflicts.

## Urban Pathologies Interpreted Within the Urban Nucleus Framework

In the following three subsections, we describe three known urban pathologies in terms of the general urban nucleus framework introduced above. The first two cases describe conditions in which urban nuclei are either non-existent or extremely weak, mainly due to the lack of pedestrian sheds, or their misplacement relative to major movement corridors. The third case represents suburban sprawl's response to urban nuclei: a simulated nucleus that is divorced from

AUTHOR COPY

any pedestrian shed. The three pathologies are (1) strip development, characteristic of the early phases of suburbanization, (2) planned unit developments and (3) edge city and various 'campus'-like isolated developments, such as enclosed shopping malls, or their recent reincarnations as 'lifestyle centers'.

### Strip development

Of all suburban typologies, strip malls are perhaps the easiest to deal with. Their typology is EDGED/EXPOSED, but because of the very low densities of development, the pedestrian shed is relatively empty, and therefore the commercial life along the major arterial is completely dependent upon car access. Early strip malls may have developed in areas where the street grid was fairly dense, but the enforced segregation of uses and the completely different scale of the commercial development along the arterial, relative to the residential areas on streets perpendicular to it, separates the exposed world of the commercial street from the residential areas surrounding it. In later strip developments, this separation is exacerbated by the drastic reduction in the number of streets allowed to intersect with the arterial. Other factors that hinder the development of nuclei include: extensive parking lots fronting and sometimes completely surrounding the properties; the design of the street for capacity and speed of cars; a lack of shade; a lack of adequate sidewalks; and frequent curb cuts. All of these make pedestrian crossing and access difficult.

The strip mall configuration could be transformed rather easily into the Emergent Neighborhood Model by increasing residential densities around selected nuclei; improving public transport along the corridor; reducing speeds; improving the pedestrian environment and crossing ability; and removing front parking lots to a shielded position. The pedestrian scale connection of such nuclei with their residential hinterland has to be implemented according to the 400 m rule in conjunction with such improvement.

### Planned unit development: Cities without any urban nuclei

The second widespread urban pathology we find today results in the complete absence of any significant urban nuclei in expansive areas of residential suburbs. In merging the neighborhood unit idea together with the functional hierarchy of streets, neighborhood centers were envisaged combining commercial and civic facilities in the center of neighborhoods. This is the CENTERED/SHIELDED nucleus type described above (Figure 2). However, strict zoning codes, low densities and the lack of movement through the nucleus prevent an urban nucleus from actually forming inside a suburban pedestrian shed, even if those were designed, and so in recent years such attempts were abandoned (Steil *et al*, 2008). Many New Urbanist developments have tried to redress those problems by increasing density (particularly around the nucleus), improving internal walkability and inviting urban design. The lack of through movement and exposure to the outside, however, has meant that these 'neighborhood centers' have difficulty in succeeding commercially, and in generating more complex uses. When they do succeed, it is often through 'branding', where they become an attraction to drive to, even if not located on the main thoroughfares of the city.

### Edge cities, shopping malls, employment centers, and gated communities: Isolated concentration

Even areas of suburban sprawl need commercial and employment centers, and civic functions. The commercial 'edge city' we now see among dormitory suburbs is both spatially fragmented and not really dense. Each commercial node is isolated from the pedestrian shed, but it is also isolated from every other neighboring commercial node. These nodes exemplify the EDGED/SHIELDED nucleus option (Figure 5). As noted above, it would at first appear that this combination should never be experienced on the ground (but it is!), as it encourages severed communities, peripheral urban nuclei and inefficient pedestrian sheds.

In this category, we find high-density monofunctional clusters that are built in peripheral areas and are thus poorly connected to any urban nucleus. Significantly, they themselves do not define a very good urban nucleus. Even in extensive industrial estates, educational campuses or military bases that are isolated, attempts to mimic normal urban life are never entirely successful because of the lack of urban variety and restricted connectivity with the outside world. Characteristic examples include light industry that was

AUTHOR COPY

removed from the urban nucleus; high-rise apartment blocks built in the periphery and very poorly connected by roads to the rest of the city; schools and shopping malls built in the middle of nowhere and connected only by one road. In short, we see the typology of a highly concentrated mono-functional urban node, usually accessible by a single feeder road. Industrial estates and prison camps were also of this typology: these concentrated urban structures are intentionally isolated from other urban regions by difficult access (Kargon & Molella, 2008).

Many of these examples are further isolated by a perimeter fence (for security reasons), thus preventing diffuse connections from all sides. That is why they are nowhere inside a pedestrian shed. Entry and exit is usually via a single controlled road: not a through road but a dead-end feeder road. This restricted access is found also in residential developments of suburban sprawl, yet those do not follow exactly the same pathological pattern because, while also mono-functional, they are low-density. The constrained traffic flow is the same, however, as the feeder road to a residential subdivision in suburban sprawl becomes the only access to a very large area.

These various pathologies described above made temporary economic sense in the era of cheap oil, during a time while their external environmental and health costs could be ignored. The new economics increasingly makes these typologies unfeasible. We draw the analogy with a physical system that is artificially kept from nucleation (that is condensing into an ordered structure that includes a central core) by having constant energy input. That is precisely what it takes to prop up suburban sprawl, which is inherently unsustainable. Indeed, economists have argued persuasively that the faulty, unsustainable sprawl model was a major driver of the global financial crisis that began in 2008 (Leinberger, 2008). The economic dimension of this issue, though beyond the scope of this article, nonetheless parallels and reinforces these other trends. Thus it is critical to recognize the need for reform of sprawl-supporting economic processes just as much as correcting design issues.

## Balancing the Movement Economy With the Qualitative Factors of a Sanctuary Area

The model offered here is not a standard, but a type. There is a crucial difference between the two. A *standard* provides rigid outlines within which all variations must occur. A *type*, on the other hand, offers a set of relationships that can be varied greatly according to local conditions. It is a more generic version of what Alexander and colleagues have called a 'pattern' (Alexander *et al*, 1977). In our proposed type we offer the conditions under which the location of the nucleus will vary in relation to the thoroughfare. Moreover, we describe how variations in this spatial substrate occur so that the evolution of neighborhoods can be influenced to proceed in a more desirable direction. Some existing arterial roads may be impossible to change in the early stages, but can be planned to convert to boulevards over time. This is particularly true in the USA and other countries where auto-dominated planning is only slowly giving way to a more efficient multi-mode system.

Our Emergent Neighborhood Model accounts for the qualitative experience of a neighborhood: its beauty and vitality, and the kind of access it offers to various kinds of enriching urban experience such as parks and civic spaces. These were key motivations for the original City Beautiful concept that is one of the inspirations for New Urbanism.

Under the 400 m rule, the small scale of the sanctuary areas allows people living in them to be in a relatively quiet area, in which both pedestrian and car movement are restricted. This area may include neighborhood parks and small (not necessarily local) social institutions. Reduced movement is not a function of social limitation or lack of permeability, but of the reduced degree of centrality. Streets forming the edges of the sanctuary areas form active boundaries, not barriers, with denser functions and more mixed use, and of varying scale and intensity. Some may be through streets, but with relatively little commerce; some may be commercial streets; others may be residential avenues; some may be even wider urban parks, or larger urban squares or institutions. The details depend on density, the location of the sanctuary area within the city and region, its relationship to natural features and major urban uses.

One example of a planned urban area where these relationships hold is the northern part of central Tel-Aviv, known as the Geddes Plan (Figure 11). This area designed by Patrick Geddes for the Jewish Agency in 1926 guided the growth of Tel-Aviv in the 1930s, as Jews fleeing the ascendancy of Nazism and Fascism in Europe

AUTHOR COPY

**Figure 11:** The Geddes Plan of Tel-Aviv, showing the grid of main streets and 'home-block' sanctuary areas.

immigrated to British-controlled Palestine (Rofè, 2008). Geddes developed the idea of the 'home-block' that is similar in intention to our sanctuary area. An area of roughly $200 \times 300$ m, which included an internal public square and public institutions, is surrounded by through streets forming a larger scale grid. Each home block was adapted to its urban and natural context. This plan successfully negotiated the explosive growth of Tel-Aviv, and adapted to a density much higher than the garden suburb originally envisaged by Geddes. Even after becoming the central area of a thriving metropolis of 2.3 million people, its quiet residential streets within the sanctuary areas, with their little gardens and paths still allow for a quiet and at times even reclusive

 © 2010 Macmillan Publishers Ltd. 

residential experience, only steps away from the hustle and bustle of the major streets (Rofè & Schwartz, 2007).

Other examples stem from attempting to integrate natural beauty into the neighborhood, using patterns like *eccentric nucleus*, as part of a larger methodology for repairing sprawl (Steil *et al*, 2008). The integration coincides with, but is somewhat distinct from, the integration of nature *per se*, as wildlife corridors. As it happens, we believe the two can work together at the interface between main streets and sanctuary areas.

For example, a principal boulevard can surround a park-like natural area, with commercial and mixed use flanking the sides opposite the park. The connection across the boulevards to the open space occurs principally at the major nodes, where everything can be stopped and pedestrians can be given priority. Other connections could also be made with a series of bridges or traffic-calmed transverse crossings. Several real-world examples of similar structures, which are in fact beautiful and livable areas, can be found in Portland, Oregon and along Hyde Park in London (Figure 12).

Note that the neighborhoods illustrated here seem to have strong quiet centers along local main streets. In the case of Portland, there is a school and its play area, doubling as a public park. This is a very successful local neighborhood focus,


**Figure 12:** A principal boulevard can surround a park-like natural area, with commercial and mixed use flanking the sides opposite the park. Examples can be seen in Portland, Oregon, in the Northwest neighborhood and in London, UK, in the area surrounding Hyde Park.

though not so far from the edge that it becomes a disturbing segregation.

Once again, the optimum spacing of these connective nodes is surprisingly small: only about 400 m, which is about half of common twentieth century practice. This spacing would then define adjacent cells of the size of small pedestrian sheds, which would then also be about 400 m across (1/4 mile diameter), and can easily accommodate about 1500 dwelling units. All houses would be no more than 400 m or 1/4 mile, from a connecting node.

These estimates show that the sanctuary areas are getting close to about one-half of Christopher Alexander's theoretical pattern of 7000 people for a 'COMMUNITY OF 7000' (Alexander *et al*, 1977). As neighborhoods flow across sanctuary areas, all we need is two such cells to satisfy Alexander's criterion. Note that we need not preoccupy ourselves with a rigid definition of either the pedestrian sheds or the neighborhoods. Our 400 m spacing is used as a guide to make sure that activity nodes are within optimum walking distance. In this way, the different points of view in this debate are reconciled. Areas of retail not directly on main streets can still function, because of their proximity to the movement economy generated by the main streets. This is how the movement economy works on retail and services: the closer you are to people flows, the more likely is your business to succeed; it is this increased *likelihood* that makes all the difference in the long run.

Regardless of technology or urban context, study examples consistently remind us that there is one fundamental biological unit at work in any sanctuary area: the ability of a person to walk conveniently to many nearby destinations. This is what mathematicians term a 'structural attractor' (an essential and consistent geometrical solution to the problem) for the coherence of any sanctuary area. A person will need to walk to all destinations within or bordering the sanctuary area, not only public transit, or retail or any other single function. So it is very useful to start with this 'pedestrian shed' and work with the other structures – retail, transport and so on – as overlay patterns that may vary based upon conditions. Then the question becomes, how do the other overlaid patterns work in relation to such a fundamental biological unit? There is not a one-size-fits-all spatial configuration, but there is a spatial measure. This is one of the key points of confusion and controversy on this issue. We argue here that there *is* one scale for this fundamental unit, *and it is smaller than usually assumed*. This has important implications for the required connectivity of any scheme.

Those who think that a neighborhood needs an edge, and those who think that, more importantly, it needs close connectivity to the next neighborhood, are both likely to find a new synthesis in our proposed framework. Sanctuary areas, which follow the 400 m rule, between main streets, are likely to result in a permeable urban spatial continuum, over which social and cultural communities such as neighborhoods can layer, aggregate and change.

Yet another distinction comes from those who have focused upon transit-oriented development, as opposed to those who are more focused upon creating complete communities whose public transit connections to other communities may be limited. The former include urban infill planners, whereas the latter include planners of more peripheral and rural settlements. The debate over center versus edge has persisted, with some authors making dire warnings about putting too much at the center, and others arguing that at least some things (the corner grocery, a transit stop, perhaps more nodes) can and should go to the center. We suggest that in either case, the issue is not transit-oriented development *per se*, but the use of integrated multiple modes, starting with pedestrian movement.

## Conclusion

The Emergent Neighborhood Model (Figures 6, 9 and 10 (a)–(e)) proposes that urban nuclei should be located in close proximity to urban thoroughfares in order to benefit from the movement economy (Porta *et al*, 2009). Such thoroughfares should be conceived as a network of main streets shaped by a '400-meter rule', so that a spatial distance of roughly 350–450 m is left between two neighboring major intersections. The location of urban nuclei on or immediately adjacent to such a network of main streets ensures the best potential for retail and services to stabilize and grow, and to serve urban communities in the long run. The urban nuclei by definition shape the geography of pedestrian sheds, which are simply the areas surrounding them under the critical 400 m distance.

The urban fabric is, therefore, an interplay between main streets and quieter, mostly residential,

AUTHOR COPY

sanctuary areas. Neighborhoods, however, are inherently self-organizing and evolving social and cultural entities, whose dynamics of formation and change are simply too complex to be shaped top-down by spatial design. Pedestrian sheds and a complex of main streets and sanctuary areas create the geography from which neighborhoods may emerge from the interplay between the substrate of space and the social life of its inhabitants.

A high grade of attractiveness of the urban nucleus can enact dynamics of retail and service spillover towards the inner areas of the neighborhood. That regularly happens on *local* main streets, that is, shortcuts across sanctuary areas that connect to the higher network of urban main streets. Therefore, we can evaluate the potential of places to attract and stabilize a flourishing local retail and service system. People make places fit for running a business, and the more a place is central the more it is likely to be popular and used. The densest and most diverse variety of retail commerce and services is very likely to emerge and grow in central places. In order to be accessible to pedestrians, those central places full of shops and services must be reachable within walking distance, say about a 400 m radius. Finally, if in such central places, located at walking distance from home, one is able to jump onto a transit service, this will heavily enhance the popularity of the place. At the same time, easy access to transit ensures that a condition of equity is restored that frees residents from required ownership and extensive use of the private automobile, to enjoy the best of what their city offers.

Note that our discussion covered topics of urban design, social structure, economics, the mathematics of generativity and other topics. We believe this kind of inter-disciplinary investigation offers a key avenue for future research. Indeed, the lesson may be that the notion of urban design itself must undergo a transition, from a simple linear application of standards, schema or 'parti', to a complex process of facilitating beneficial pattern growth. This is a paradigm shift in the management of complex urban growth, towards a discipline that may be thought of as 'urban seeding'.

We recognize, however, that this is a shift that even traditional urban designers/reformers may find hard to make. Yet, we believe the looming challenges of resource depletion, habitat destruction, massive informal/illegal urbanization, climate change, social equity, political instability and other crises make such a transition mandatory and urgent. It is in urban settlements, and in their integration and their ultimate quality, that the principal struggles of the future will be won or lost.

## Note

1 A notable example is in our colleague Paul Murrain's design for Harlow New Town, an urban extension of one of the UK's struggling modernist towns built north of London after the war. The extension is connected over a wildlife corridor by only a single bridge flanked by retail, in a configuration not unlike the Ponte Vecchio in Florence. Yet, as Murrain has argued, the connectivity remains strong (Council Report III, CNU).

## References


Alexander, C. (1965) A city is not a tree. *Architectural Forum* 122(1): 58–62, (Part I); and 122(2): 58–62, (Part II).

Alexander, C. (2001–2005) *The Nature of Order*, Books 1–4 Berkeley, CA: Center for Environmental Structure, Book 1: *The Phenomenon of Life*, 2001; Book 2: *The Process of Creating Life*, 2002; Book 3: *A Vision of a Living World*, 2005 and Book 4: *The Luminous Ground*, 2004..

Alexander, C., Ishikawa, S., Silverstein, M., Jacobson, M., Fiksdahl-King, I. and Angel, S. (1977) *A Pattern Language*. New York: Oxford University Press.

Appleyard, D. (1981) *Livable Streets*. Berkeley, CA: University of California Press.

Badland, H. and Schofield, G. (2005) Transport, urban design, and physical activity: An evidence-based update. *Transportation Research Part D: Transport and Environment* 10(3) (5): 177–196.

Banerjee, T. and Baer, W.C. (1984) *Beyond the Neighborhood Unit: Residential Environments and Public Policy*. New York: Plenum Press.

Ben-Joseph, E. (2005) *The Code of the City: Standards and the Hidden Language of Place Making*. Cambridge, MA: MIT Press.

Bernick, M.S. and Cervero, R. (1997) *Transit Villages in the 21st Century*. New York: McGraw-Hill.

Biddulph, M. (2000) Villages don't make a city. *Journal of URBAN DESIGN* 5(1): 65–82.

Boarnet, M.G., Greenwald, M. and McMillan, T.E. (2008) Walking, urban design, and health: Toward a cost-benefit analysis framework. *Journal of Planning Education and Research* 27(3): 341–358.

Brindley, T. (2003) The social dimension of the urban village: A comparison of models for sustainable urban development. *URBAN DESIGN International* 8(1–2): 53–65.

Brower, S. (2000) *Good Neighborhoods: A Study of In-Town and Suburban Residential Environments*. Westport, Connecticut: Greenwood Publishing Group, Incorporated.

Calthorpe, P. (1993) *The Next American Metropolis*. New York: Princeton Architectural Press.


AUTHOR COPY

Caniggia, G. and Maffei, G.L. (2001) *Architectural Composition and Building Typology: Interpreting Basic Building*. Firenze, Italy: Alinea Editrice, First published in Italian in 1979.

Castells, M. (2000) *The Information Age: Economy, Society and Culture. The Rise of the Network Society*. Malden, MA: Wiley-Blackwell.

Cervero, R. and Duncan, M. (2003) Walking, bicycling and the urban landscape: Evidence from the San Francisco Bay Area. *American Journal of Public Health* 93(9): 1478–1483.

Conroy-Dalton, R. (2003) The secret is to follow your nose: Route path selection and angularity. *Environment and Behavior* 35(1): 107–131.

de Nazelle, A. and Rodríguez, D.A. (2009) Tradeoffs in incremental changes towards pedestrian-friendly environments: Physical activity and pollution exposure. *Transportation Research Part D: Transport and Environment* 14(4) (6): 255–263.

Duany, A. and Plater-Zyberk, E. (2002) *Lexicon of the New Urbanism (version 3.2)*. Miami: Duany Plater-Zyberk & Company, http://www.dpz.com/research.aspx.

Duany, A., Plater-Zyberk, E. and Speck, J. (2000) *Suburban Nation*. New York: North Point Press.

Ernst, M. and McCann, B. (2002) Mean streets 2002, surface transportation policy project report. http://www.transact.org.

Ewing, R. and Kreutzer, R. (2006) Understanding the relationship between public health and the built environment. Report prepared for the LEED-ND Core Committee. U.S. Green Building Council.

Farr, D. (2008) *Sustainable Urbanism, URBAN DESIGN with Nature*. Hoboken, NJ: John Wiley and Sons.

Forsyth, A.J., Oakes, M., Lee, B. and Schmitz, K.H. (2009) The built environment, walking, and physical activity: Is the environment more important to some people than others? *Transportation Research Part D: Transport and Environment* 14(1) (1): 42–49.

Frank, L.D., Sallis, J.F., Conway, T.L., Chapman, J.E., Saelens, B.E. and Bachman, W. (2006) Many pathways from land use to health: Associations between neighborhood walkability and active transportation, body mass index, and air quality. *Journal of the American Planning Association* 72(1): 75.

Franklin, B. (2002) Constructing an image: The urban village concept in the UK. *Planning Theory* 1(3): 250–272.

Gehl, J. (2002) *Life Between Buildings: Using Public Space*. Copenhagen, Denmark: Danish Architectural Press.

Hebbert, M. (2005) Engineering, urbanism and the struggle for street design. *Journal of URBAN DESIGN* 10(1): 39–59.

Hillier, B. (1996) Cities as movement economy. *URBAN DESIGN International* 1(1): 41–60.

Hillier, B. and Hanson, J. (1984) *The Social Logic of Space*. Cambridge, UK: Cambridge University Press.

Jacobs, A. (1993) *Great Streets*. Cambridge, MA: MIT Press.

Jacobs, A.B., Macdonald, E. and Rofè, Y. (2002) *The Boulevard Book*. Cambridge, MA: MIT Press.

Jacobs, J. (1961) *The Death and Life of Great American Cities*. New York: Vintage Books.

Jones, E. and Kauffman, C. (2009) Integrated urban structuring in Australia. Paper presented at Optimizing Urban Structure session, CNU 17; June, Denver, CO.

Kargon, R.H. and Molella, A.P. (2008) *Invented Edens: Techno-Cities of the Twentieth Century*. Cambridge, MA: MIT Press.

Krier, L. (1998) *Architecture: Choice or Fate*. Windsor: Andreas Papadakis.

Kulash, W. (1990) Will the traffic work? 11th Annual Pedestrian Conference; October, Bellevue WA.

Leinberger, C. (2008) Study from the metropolitan program of the Brookings Institution. http://blog.islandpress.org/author/Christopher.

Loukaitou-Sideris, A., Liggett, R. and Sung, H. (2007) Death on the crosswalk: A study of pedestrian-automobile collisions in Los Angeles. *Journal of Planning Education and Research* 26: 338–351.

Lynch, K. (1981) *A Theory of Good City Form*. Cambridge, MA: MIT Press.

Marshall, S. (2005) *Streets and Patterns*. London: Spon Press.

Murrain, P. (2002) Understand urbanism and get off its back. *URBAN DESIGN International* 7: 131–142.

Murrain, P. (2009) Beyond Perry: Learning from several thousand years of the social logic of the structure of settlements. Paper presented at Optimizing Urban Structure session, CNU 17; June, Denver, CO.

Newman, P. and Kenworthy, J. (1999) *Sustainability and Cities*. Washington DC: Island Press.

Perry, C. (1929) *The Neighborhood Unit. Regional New York and its Environs*. New York: Regional Plan Association.

Philibert-Petit, E. (2006) Connectivity-oriented urban projects. PhD Thesis available from Delft University of Technology, to be published as a monograph by Techne Press, Amsterdam, 2010.

Porta, S., Crucitti, P. and Latora, V. (2006) The network analysis of urban streets: A primal approach. *Environment and Planning B: Planning and Design* 33: 705–725.

Porta, S. *et al* (2009) Street centrality and densities of retail and services in Bologna, Italy. *Environment and Planning B: Planning and Design* 56: 450–465.

Porta, S. and Renne, J. (2005) Linking urban design to sustainability: Formal indicators of social urban sustainability field research in Perth. *URBAN DESIGN International* 10: 51–64.

Rofè, Y. (1995) Space and community: The spatial foundations of urban neighborhoods. *Berkeley Planning Journal* 10: 107–125.

Rofè, Y. (2008) The white city of Tel-Aviv. *Urbanistica – Journal of the Italian Institute of Planning* 136: 95–102.

Rofè, Y. and Schwartz, H. (2007) Vision, implementation and evolution of Patrick Geddes' urban block in Tel-Aviv. Proceedings of the Conference on Regional Architecture in the Euro-Mediterranean Area: IIIrd International Conference on Architecture and Building Technologies. Second University of Naples, Ischia, Italy.

Salingaros, N.A. (2005) *Principles of Urban Structure*. Amsterdam, The Netherlands: Techne Press.

Steil, L., Salingaros, N. and Mehaffy, M. (2008) Growing sustainable suburbs: An incremental strategy for reconstructing sprawl. In: T. Haas (ed.) *New Urbanism and Beyond: Designing Cities for the Future*. New York: Rizzoli International, pp. 262–274.

Sucher, D. (2003) *City Comforts*. Seattle, WA: City Comforts.

Talen, E. (2000) The problem with community in planning. *Journal of Planning Literature* 15(2): 171–183.

Townshend, T. and Lake, A.A. (2009) Obesogenic urban form: Theory, policy and practice. *Health & Place* 15(4): 909–916.

US Environmental Protection Agency (US-EPA). (2004) Characteristics and performance of regional transportation systems. Washington DC. http://www.epa.gov/smartgrowth.

AUTHOR COPY