A New Pattern Language
for Growing Regions:

Places, Networks, Processes

A Collection of 80 New Patterns for
a New Generation of Urban Challenges

A further contribution guided by the book
A Pattern Language: Towns, Buildings, Construction

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Note on referencing patterns

In the text, two distinct means of referring to other patterns are used: new patterns introduced in this book are referred to by name and number, for example, 4.4. The 80 new patterns are numbered in groups of four, so they range from 1.1 to 20.4. Those original patterns from the book *A Pattern Language* are referred to according to that numbering system, for example APL 89. The 253 Alexandrian patterns range from APL 1 to APL 253.

ACKNOWLEDGEMENTS

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Finally, we are grateful to all those who worked on and contributed to pattern language methodology, including the original authors of the 1977 book: Sara Ishikawa, Murray Silverstein, Ingrid Fiksdahl-King, Max Jacobson, Shlomo Angel, and especially, Christopher Alexander. May the work they started continue, as they expressed and intended.

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To Christopher, and to all those others who continue his fascinating and hopeful work.

INTRODUCTION:

Who is this book for?

One of the most pressing needs today is to improve the quality of urban development for growing regions around the world — to maximize the benefits that urbanization can bring, while minimizing the potential problems and negative impacts for the future. To that end, this volume presents a so-called "pattern language" of a number of urban development best practices that have been identified through research at Sustasis Press, and with partners at KTH University, the University of Strathclyde, and a number of other universities, research centers, and individual collaborators.

This book also represents a contribution to a five-year collaboration with UN-Habitat on implementation of the "New Urban Agenda," a framework document that seeks to maximize the human benefits of urban development at all scales over the period 2016-2036. The New Urban Agenda was adopted by consensus by all 193 countries of the United Nations in 2016, in an act of remarkable international unity. However, there remains an urgent need to implement its aspirations with effective, evidence-based tools and strategies. This volume is one contribution aimed at addressing that need.

This volume (and its on-line counterpart, npl.wiki) is also intended as only the start of a much wider international effort — not only applying the information herein, but seeking additions to it, and encouraging parallel efforts. Ultimately this and other projects may form a many-stranded network for sharing of the best available knowledge, tools and strategies for better-quality urbanization. In that spirit, this work is by no means a "final word" — but it is our best curated formulation of the current state of evidence-based urban design and architecture today, expressed as a representative and (we very much hope) useful collection, for active builders, designers, planners, businesses, governments, and NGOs.

Why pattern languages?

In many fields today, pattern languages have been used successfully to develop and share best practice design tools and strategies. Perhaps the widest usage is in computer science, where pattern languages of programming (also called design patterns) are used to develop many operating systems, most games, and many other kinds of programs. In a re-

markable spinoff, pattern languages also led to the development of wiki, which was created as a tool to share patterns of design, and later used (more famously) to create Wikipedia, as well as many other widely-used websites. Additional software spinoffs included Agile development, Extreme Programming, and Scrum methodology.*

Pattern languages have also been applied usefully in a surprisingly diverse number of other fields, including human-computer interaction, sociology, molecular biology, business management, manufacturing, and production engineering, to name a few. In fact, many thousands of patterns have been written, not only for software and computer architecture, but also for structural principles of organizations, education, social interaction, communication and information technology, even music, chess and poetry. Researchers in these disciplines have adopted the convenient pattern format to present their results, and were also encouraged to try and find links among their patterns. The pattern format is now embraced as a convenient standard in which to write new results in a variety of disciplines.

This diversity is all the more remarkable, considering that pattern languages had their origin in the built environment, and yet remarkably, the built environment remains one of the least well-developed fields for pattern languages. Therein lies a paradox — and an underdeveloped resource.

Pattern languages were introduced most famously in the 1977 book by the architect Christopher Alexander and his colleagues, *A Pattern Language: Towns, Buildings, Construction.* The book offered three remarkable achievements all at once. First, it gave the pattern format for expressing a discovered design result in compact and logical form for future reference and distribution as an evolving best practice. The presentation occurred normally in seven parts: *iconic name; representative (contextual) photo; links to previous patterns; problem-statement; discussion; conclusion ("therefore statement");* and *links to subsequent patterns*. Second was the idea of a pattern language in which the individual patterns link up using grammar-like rules. Importantly, this emphasized that design patterns are not isolated entities, but are embedded in an essential web-network. Third, the book presented the specific collection of 253 numbered patterns developed by Christopher Alexander and his associates at that time.

What accounts for the usefulness of pattern languages across such a diversity of fields? They are in essence a way of capturing useful knowledge

* See for example Cunningham, W. and Mehaffy, M.W. 2014. "Wiki as Pattern Language." In *Proceedings of the 20th Conference on Pattern Languages of Programs* (PLoP'13), Monticello, Illinois, USA (October 2013). 15 pages.

about the nature of a design problem, and expressing it in a way that can be easily shared and adapted to new contexts. However, the form of the knowledge is not rigid, but context-dependent and relational. This feature is especially useful for design problems that require very local and context-specific responses. Of course, this is very often the case for problems of urban design, architecture and building too.

What accounts for the comparatively limited development of pattern languages in the built environment — the very field for which they were originally developed? One explanation is that some architects and urban designers do not like what they see as the book's formulaic design guidance, which they believe constrains their creativity. That may be true for some, but by no means all. Another perhaps more relevant explanation is that, paradoxically, the very success of the 1977 book served to "freeze" the work in a seemingly immutable set of 253 patterns. The book became a best-seller, and an iconic work that some said must not be "tampered with."

But that is not what the book itself said. On the contrary, the introduction made its aim very clear (emphases added):

> *Let us finally explain the status of this language, why we have called it "A Pattern Language," with the emphasis on the word, "A," and how we imagine this pattern language might be related to the* ***countless thousands of other languages we hope that people will make for themselves, in the future****… The fact is, that* ***we have written this book as a first step*** *in the society-wide process by which people will gradually become conscious of their own pattern languages, and work to improve them…*
>
> *We hope, of course, that many of the people who read, and use this language,* ***will try to improve these patterns*** *— will put their energy to work, in this task of finding more true, more profound invariants — and we hope that gradually* ***these more true patterns,*** *which are slowly discovered, as time goes on, will enter a common language, which all of us can share...*
>
> *You see then that the patterns are very much* ***alive and evolving.*** *In fact, if you like, each pattern may be looked upon as a hypothesis like one of the hypotheses of science. In this sense,* ***each pattern represents our current best guess as to what arrangement of the physical environment will work...*** *But of course, no matter what the asterisks say,* ***the patterns are still hypotheses, all 253 of them — and are therefore all tentative, all***

> ***free to evolve*** *under the impact of new experience and observation. (Alexander et al., 1977, pages xv-xvii)*

Unfortunately, with the exception of a few pockets of practice, this continued evolution has been woefully absent in built environment fields. Instead, the very success of the book has served to freeze its contents, protected even by copyright as well as by the practical difficulty of modifying or adding to printed pages. Yet the text above makes clear the intention to launch a much larger and more ambitious open-source project to develop many more patterns, and to edit, adapt, share, and apply them all.

The proliferation of design patterns

This is precisely what has happened in computer science and other fields, with prodigious results. The comparatively weak results in environmental design fields are humbling — and instructive, for those who recognize the unmet potential of pattern languages to help to address new challenges for settlements.

For many years the kind of open-source exchange called for in the book was difficult to accomplish at any significant scale, since it required the cumbersome use of copier machines and the like. A few authors published compendia of new patterns, but without the ability to interact with and incorporate the original 253, they did not have a very large impact.

Of course, with the advent of the Internet, it became much more practical to share patterns, and even to turn the references that each pattern featured into "live" links that could be used to "click through" to other patterns. This is precisely what was done in 1987, not by environmental designers but by software engineers. In that year, Ward Cunningham created the "Portland Pattern Repository," advancing both pattern languages of programming and their more famous outgrowth, wikis.

Both design patterns and wikis were developed to address a fundamental problem in software: simply specifying new solutions to new problems in sequence leads to a cluttering of code, and an increased likelihood of malfunctions from unforeseeable and unintended interactions. In 1987, Cunningham and his colleague Kent Beck, working at Tektronix Corporation near Portland, Oregon, were seeking new forms of software that would display what mathematicians sometimes refer to as "elegance": the ability to do more with less. Cunningham embodied this principle in the question, "what is the simplest thing that could possibly work?" We enter

a process of exploration and adaptation, without assuming the need for detailed specifications in advance.

Cunningham was intrigued by the capacity of language, in its very ambiguity, versatility and economy, to serve more ably as a useful working model for problem-solving. A problem is, by definition, not pre-decomposed into simple functional units, but as Alexander noted, has many overlapping and ambiguous connections. Language mirrors this capacity, and therein lies its usefulness. Therefore, the goal is, in a sense, to achieve the same robustness of language, by endowing the model with its own set of powerful (but limited in number) generative components, much as language does.

Thus, the goal is not simply a matter of economy, but one of greater context-adaptive problem-solving power. In fact it goes back to the heart of Alexander's concept of language-like networking: a simple grammatical system, functioning generatively, can be far more powerful than a complex set of specification-based processes. As Cunningham put it, when asked by programmer Tom Munnecke to explain how "the generativity of a pattern is a way of expressing complexity:"

> *That was an idea that excited me, and that seemed more powerful than most... And that is, language is generative. And that idea that I can have a set of rules that generates something that I could value is really important. So the question was, why don't we do everything that way? And the answer was, well we pretty much did, until we let professionals get involved. …And they made it complex by trying to make it simpler, because they didn't understand how some system of rules could* ***generate*** *behaviors instead of* ***specifying*** *behaviors.*

This generation refers to the capacity to reproduce the essence of a functioning structure, without having to specify all of its characteristics. A simple example is the distinction between the way a genetic process generates the blue eyes, say, of a child, which recapitulates the blue eyes of the parent without having to specify them in minute detail — their intricate retinal flecking pattern, precise round shape, and so on. Instead, the genetic process is able to generate, and regenerate, an intricately complex structure from a relatively simple set of language-like (or recipe-like) instructions.

So it is with pattern languages and their patterns. The goal is to pick out the most salient features that are needed for regeneration *within a specific context*, and to establish a generative process that uses those patterns. This process is very much like the way older cities and buildings were tradi-

tionally generated using linguistic concepts, often without the need to state them explicitly. In the case of pattern languages, the process is only formalized, so that designers can be more articulate about the needed design aspects, and so that the result can be more successful, more durable, and more sustainable, responding to the best available evidence, and representing a best adaptation to human need.

The continuing need for pattern languages in many fields — including the built environment

Just now, by contrast, the human species is drowning in overly complicated and malfunctioning designs, from a human point of view. They may be exciting, they may be stimulating, they may be entertaining — indeed, they may not be malfunctioning in the short term, but instead, offer great power and allure. But we are like the fabled Sorcerer's Apprentice, unleashing a power we cannot control. Especially in comparison with the durable structures of nature, and of our own history, the results lack long-term resilience and sustainability. We can enjoy them, we can marvel at them, we can admire them — but we must also commit ourselves to deep reforms.

An apparent paradox is that today we are able to produce more *volume* of building than ever before in human history. Indeed, we are in an era of unprecedented urbanization, on course to build more sheer area of urbanization in the next fifty years than in all of human history. It is therefore a matter of highest urgency to address the nature of this urbanization, and its long-term impacts on economy, technology and quality of life — and to determine the levels at which reforms are needed in policy and practice.

It is a thesis of this book that those levels are very deep indeed. At the heart of the pattern language methodology is a recognition of changes needed in the very nature of technological methodologies, and the inadequate feedback capacities of our current linear systems — particularly as they impact the use and depletion of resources, the systems we use for developing and applying adaptive knowledge, and related challenges.

This is also the reform-minded insight behind the related movements of Agile, Scrum, wiki, and other innovative reforms in methodology of design, and technology more broadly. Pattern languages, as we have discussed, played a role in shaping these other movements. The stunning, if partial, success to date hints at more to come, and suggests that the full potential of pattern languages — especially in the built environment — has not been reached.

One of the great advantages of pattern languages is that they do contain within them the capacity to establish reciprocal feedback channels through their web-networks of hyperlinks. The implications of this capacity are broad, although a full discussion is beyond the scope of this book.

Why these patterns in particular?

This volume is not meant to provide an exhaustive library of patterns, but rather, to provide a representative curated compendium of relevant new patterns, suggesting the potential for many more. The book is divided into three sections representing places, networks and processes ("patterns of scale," "patterns of multiple scale," and "patterns of process") with a series of pattern groups under each, and four representative patterns in each group. The selection of four is not significant, except as a means of including a small but illustrative sample of each kind of pattern.

There is also an on-line companion "repository" that includes these patterns as, in effect "seed patterns," which can be edited, deleted, added to, and used in any other way desired. It can be found at npl.wiki. We hope very much that this on-line version will lead to the evolution and use of many more patterns.

The patterns curated herein are not the only ones that are possible, certainly — and indeed, many regions are using very different patterns today (for better or worse). But a key purpose of this book is to show with the patterns herein examples of a more reliable, evidence-based approach to sustainable, resource-efficient urban development, promoting a higher quality of life, and at the same time, a healthier and more sustainable form of economic development. We document this claim with numerous research citations within the patterns, and we further demonstrate this claim by showing some concluding examples of several contemporary cities that do incorporate these patterns very successfully, with measurable economic, social and ecological benefits.

Other users may assert other patterns, or dispute the patterns we propose — and that is fine. All that is required is that the preponderance of evidence over time shows which patterns succeed best on local human terms, including social, economic and environmental dimensions. We want to know not only which patterns seem to be universally more beneficial, but also locally more beneficial in many different contexts, and expressing many different adaptations and variations — and in some cases, wholly new patterns, that may prove useful elsewhere. In this way, the entire collection of patterns can grow more useful, and at the same time,

more diverse and extensive. This is, after all, how science works, and how knowledge works.

Ultimately, we may have many different collections of patterns, some sharing common patterns, some slightly different, and some altogether different, based on context. This is the core idea behind "federation," the concept that motivates the new "federated" generation of wiki, of which the new wiki is an example. This would deliver on the promise of the original book, to see "countless thousands of other languages we hope that people will make for themselves, in the future."

Why this particular format?

For the printed version, we have chosen to stay relatively close to the structure and appearance of the original pattern format introduced in 1977, for three related reasons. First, other versions of pattern language structure and appearance have been developed for the built environment, in part following the invitation of the book — yet no format has proven as user-friendly, as appealing, or as effective, as the original. This project is nothing if not evidence-based, and reliant on what has been shown to work — unless and until other, better practices are demonstrated to be more successful. Second, a consistent form of pattern is necessary so that the original goal of shared languages may be possible, and so that the patterns may be re-used in various customized project languages, working together. Third, the original book itself provides explicit direction (emphasis added):

> *…we have written this book* ***as a first step****… We have spent years trying to formulate this language, in the hope that when a person uses it, he will be so impressed by its power, and so joyful in its use, that he will understand again, what it means to* ***have a living language of this kind****. (A Pattern Language, pp. xvi-xvii)*

Echoing our second point, the book also makes clear that the format presented is intended as an essential characteristic of the project:

> *There are two essential purposes behind this format. First, to present each pattern connected to other patterns, so that you grasp the collection…as a whole, as a language, within which you can create an infinite variety of combinations. Second, to present the problem and solution of each pattern in such a way that you can judge it for yourself, and modify it, without losing the essence that is central to it. (A Pattern Language, p. xi)*

The success of the format is clear, and the invitation to use and modify is clear. This book is therefore one step in response, and an invitation to all those who are serious about further open-source development of pattern languages and related advances. Let us join with many others in a larger collaboration, now for the built environment as well — precisely as called for in the original book.

Patterns for a New Urban Agenda

Many of the patterns collected here are also suggested by the New Urban Agenda, the aforementioned 2016 international framework agreement on urbanization adopted by acclamation by all 193 countries of the United Nations. The document places heavy emphasis on the role of public spaces, including streets and sidewalks, as essential elements for healthy urbanization. It articulates this new priority for public spaces in no fewer than ten paragraphs.

For example, Article 37 promotes

> *... safe, inclusive, accessible, green and quality public spaces, including streets, sidewalks and cycling lanes, squares, waterfront areas, gardens and parks, that are multifunctional areas for social interaction and inclusion, human health and well-being, economic exchange and cultural expression and dialogue among a wide diversity of people and cultures…*

The New Urban Agenda also emphasizes the economic importance of public spaces, as in Article 53:

> *We commit ourselves to promoting safe, inclusive, accessible, green and quality public spaces as drivers of social and economic development, in order to sustainably leverage their potential to generate increased social and economic value, including property value, and to facilitate business and public and private investments and livelihood opportunities for all.*

The New Urban Agenda also emphasizes the interconnected "network" character of public spaces, with special emphasis on streets as public spaces, and the ways they and other public spaces connect to private edges. For example, Article 100 supports

> *...the provision of well-designed networks of safe, accessible, green and quality streets and other public spaces that are accessible to all and free from crime and violence, including sexual harassment and gender-based violence, considering the human scale, and measures that allow for the*

best possible commercial use of street-level floors, fostering both formal and informal local markets and commerce, as well as not-for-profit community initiatives, bringing people into public spaces and promoting walkability and cycling with the goal of improving health and well-being.

Finally, a number of other articles in the New Urban Agenda emphasize the integration of public spaces with other key characteristics of urban form, including "polycentrism" (many regional centers with a full mix of housing, employment and recreation). For example, Article 51 supports

...the development of urban spatial frameworks, including urban planning and design instruments that support... appropriate compactness and density, polycentrism and mixed uses, through infill or planned urban extension strategies, as applicable, to trigger economies of scale and agglomeration, strengthen food system planning and enhance resource efficiency, urban resilience and environmental sustainability.

An evolving theory of urban form, based on an evolving science of cities

This emphasis on public space frameworks organized around streets and their active edges, and around mixed use, polycentrism and compactness, reflects a notable shift from the dominant 20th century (mostly European and American) urban theories. These older theories, rooted in an earlier industrial model of cities, have given way to a more dynamic, more complex view of cities — one that also reflects new scientific insights from the biological sciences, and from other advancements in mathematics and other fields.*

The form of many cities around the world today is still dominated by these older models. It must be recognized that these models have proven effective in supporting rapid urbanization and economic growth, and in removing millions from poverty. That achievement should not be minimized. At the same time, the older models rely on unsustainably high rates of resource consumption and depletion, and related long-term consequences like pollution, greenhouse gas emissions, climate change and other potentially disastrous long-term impacts. We can also see that, for all its gains, the 20th century paradigm has also been socioeconomically costly, by segregating and essentially trapping many of the poor. The

* These topics are discussed in much greater detail in Mehaffy, M.W. and Salingaros, N.A. (2014), *Design for a Living Planet,* Portland: Sustasis Press.

evidence increasingly points to the need for a major transition to more resource-efficient forms of urbanization, and of technology — and to urbanization that also more efficiently delivers better long-term quality of life for human beings, without the many negative impacts of the older models.

Accordingly, the patterns herein reflect this new view of cities, and indeed the new understanding of the inter-connected, web-like patterns within cities — a view on which the technology of patterns itself is based. Therefore, in accordance with the New Urban Agenda, the patterns here describe compact, polycentric urban development, public space frameworks, a mix of uses, multi-modal forms of transportation over well-connected, walkable street systems, active street-level building edges, human-scale design, ample greenery and natural characteristics, and other related specifications. Again, these patterns are not the final word, but they do reflect our best current formulation of the state of the urban science, and the lessons for urban best practice.

New *kinds* of patterns

The sections of this book offer patterns at a number of different scales — as did the 1977 book — but addressed to new challenges, including rapid urbanization, new urban technologies (like autonomous vehicles), and the particular challenge of developing urban public spaces. (This is a key focus of the New Urban Agenda, and a particular focus of our own research work as well.)

Several sections also include new kinds of patterns as well — at least new by the standards of the 1977 book — including patterns devoted to retrofit processes (such as slum upgrading, and so-called "sprawl repair"), more detailed geometric patterns, and also implementation tool patterns (including community design and building processes, and financial tools). This focus on patterns of *process* represents an expansion of the earlier focus on patterns of configuration within human environments.

For this reason, the book is organized into three major sections: patterns of scale, patterns of multiple scale, and patterns of process. These correspond to the subtitle of the book: places, networks, processes. This structure reflects an awareness that we need new models of urbanism, and also new tool for successful implementation of urbanism, to confront new challenges.

In all these innovations, this volume represents one open-source project to expand the capacity of pattern languages — and it is far from the fi-

nal word. Like the first set of patterns, it amounts to a set of hypotheses based on our best assessment of available evidence. Like the hypotheses of science, these patterns are able to be challenged and revised, if and when truly better evidence for broader human benefit — as opposed to *ex cathedra* doctrines, or ideologically motivated rationalizations for narrow self-interests — becomes available.

Accordingly, the text herein is licensed under Creative Commons' "Attribution-ShareAlike"*. Those who would like to revise, extend, modify, or otherwise re-publish the text with their own (one hopes) proper evidence-based alterations, are welcome to do so, in whatever media they choose, with the only stipulation of attribution to this original source, and continued openness to peer review and challenge on evidence. In that spirit, as Christopher Alexander and his co-authors said in the original book, may we finally see "countless thousands of other languages… that people will make for themselves, in the future."

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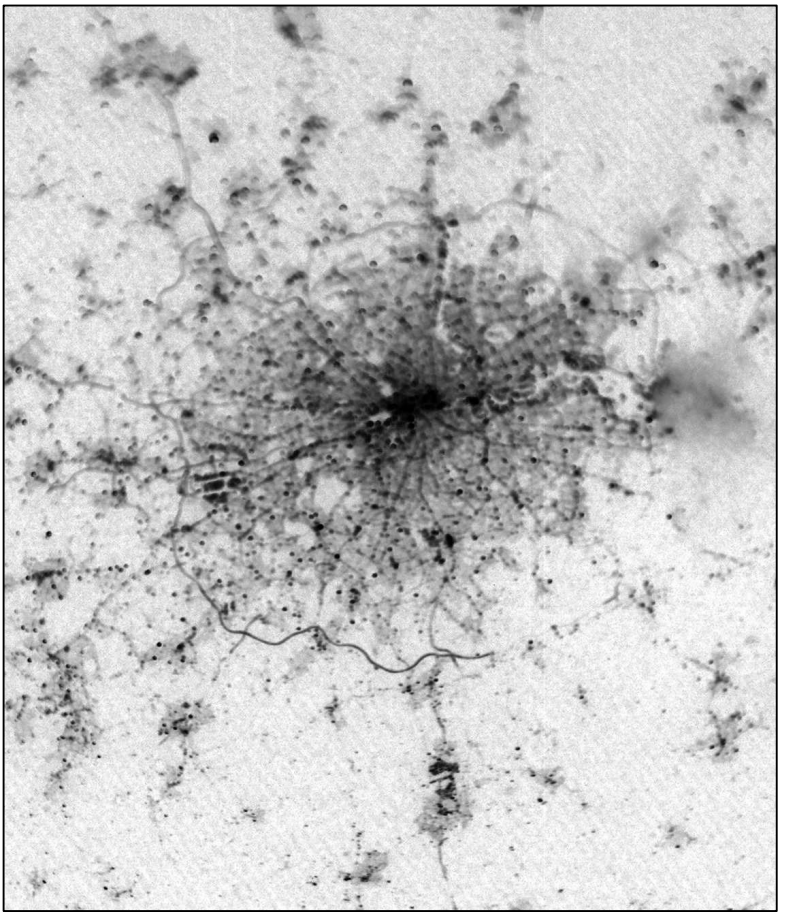
SECTION I:
PATTERNS OF SCALE

1. REGIONAL PATTERNS

Define the large-scale spatial organization…

1.1. Polycentric Region
1.2. Blue-Green Network
1.3. Mobility Corridor
1.4. 400m Through Street Network

1.1. POLYCENTRIC REGION



…We need to establish a settlement area as it relates to a wider regional structure. This pattern governs the relation of urban centers to their peripheries.

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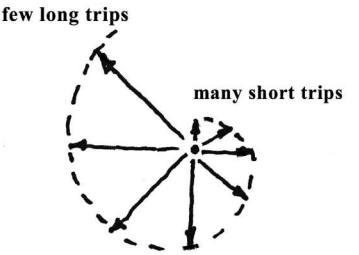
Problem-statement: Cities that are too centralized too often require excessive commuting from their edges, and their cores can become unhealthy monocultures.

Discussion: We can see that where cities and towns have developed in a more natural pattern — especially prior to the automobile — there has been a remarkably regular distribution of city sizes, with a few large urban centers, many smaller satellite towns, and a medium range of mid-size settlements, often suburban town centers. Similarly, most residents in these areas make a great many short trips — for example, daily trips to a nearby grocery store or to school — as well as a few long trips, perhaps to a major cultural event in another town. In between these extremes, they make a medium number of medium-size trips — for example, trips to work. This range of trip lengths could be illustrated this way:



But when a city is too centralized, even routine trips can become long commutes — for example, when the center is a monoculture of offices and workplaces, and the edges are primarily residential. By the same token, a city can also become too decentralized, with too many resources scattered across a large region, and requiring too much energy and cost for most people to access equitably.

A healthier pattern will include a more optimum distribution of activities and uses across settlements and scales, forming a "polycentric" region — a region with a range of diverse, mixed centers at a range of scales,

each of which offers most of the routine destinations, activities and amenities of urban life.[1]

This pattern can be seen clearly in the example of the London region (the photograph for this pattern). There a series of "urban villages" offers most of the needs for most residents to live, work and play within their own area, while they can also take longer trips less frequently. Some may make long frequent trips, but many do not.

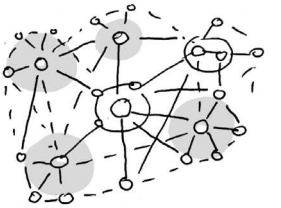
This pattern also extends to the smaller cities and towns of a larger region. Their residents also need to be connected to the same regional economy, with similar life opportunities and exchanges, but focused more on the activities that are best suited for their regional location — for example, industries needing regular access to rail, water-intensive industries, or other location-specific economic activities.

What we describe goes to the heart of stable sustainable systems, which as evidence suggests, obey "fractal" scaling properties.[2] That means there are a few big elements, many small elements, and a medium number of medium-sized elements. In the case of path lengths, the same is true: there must be many more short trips, and many fewer long trips, made possible by the geometry of the urban fabric and its distribution of uses. Unfortunately in the 20th century, we created urban forms that forced too many longer trips, largely by separating functions with zoning. That was not a stable or sustainable condition.

All of these nodes in the local, regional and even global network, need to be well-connected and well-developed to provide balanced life opportunities for all residents. Evidence shows that when some populations are cut off from genuine opportunity for growth and human development, there are political, economic and environmental impacts for all populations that are likely to become unsustainable over time.

Therefore:

Develop cities as nodes within polycentric regions, consisting of a range of sizes of mixed, diverse, well-connected "urban villages" that offer a full complement of daily and weekly needs, and good access to other parts of the region for less frequent trips.



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Establish a rough structure of a 400M THROUGH STREET NETWORK (1.4), creating continuous walkable and multi-modal urban areas. Where interruptions occur, such as natural geographic obstructions, connect the centers as much as possible with a continuous network, organized around the MOBILITY CORRIDOR (1.3) and MULTI-WAY BOULEVARD (3.2) patterns…

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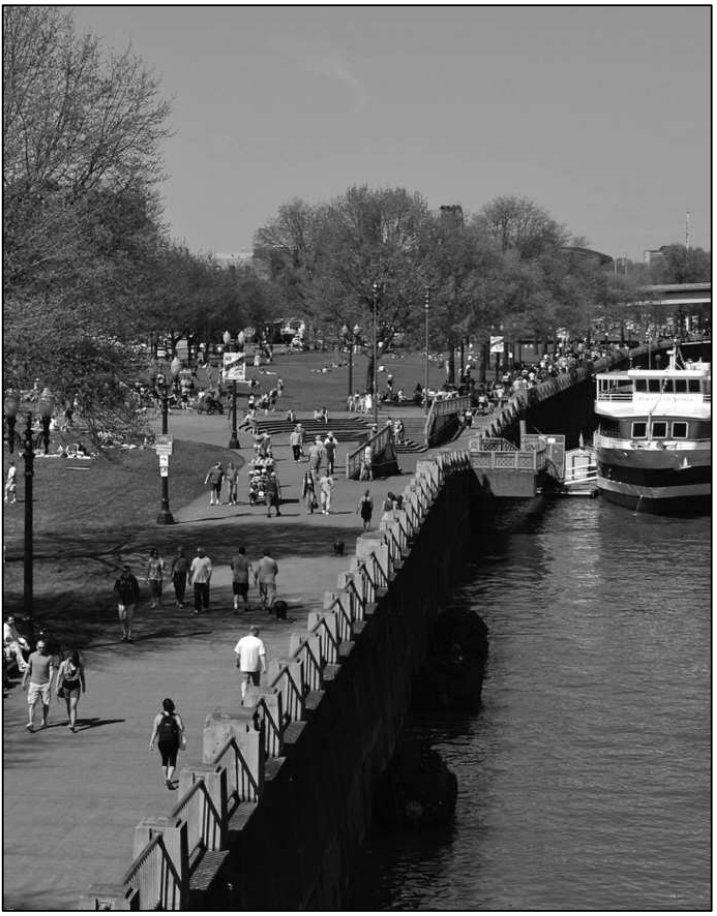
[1] See for example the special issue of *Urban Studies,* Vol. 38, No. 4, and in particular the introductory essay, Kloosterman, R. C., & Musterd, S. (2001). The polycentric urban region: towards a research agenda. *Urban Studies, 38*(4), 623-633. Available on the Web at https://journals.sagepub.com/doi/pdf/10.1080/00420980120035259?casa_token=UN34U0vU-JnMAAAAA:pIlcW55gb7HLO_J7IX8iPbyC3ASwQYp9oiBTjJtpcW1Hvyk7qu1s3r-jBJj8q6aTUrfof-OuStj-a

[2] See for example Salingaros, N. (2005) "Connecting the Fractal City," in *Principles of Urban Structure.* Amsterdam: Techne Press. Available online at http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.431.6038&rep=rep1&type=pdf

1.2. BLUE-GREEN NETWORK



…Settlements that follow the pattern of a POLYCENTRIC REGION (1.1) will also adapt to the terrain of the land, its watershed and vegetation patterns

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Problem-statement: A region that does not adapt its form to its watershed patterns cannot be sustainable.

Discussion: Every settlement area, no matter how arid, has a hydrology at some scale. In recent decades, it has been common to pipe over the natural system of hydrology, but this is doubly destructive. First, it fails to allow the natural systems to function as they can to clean the water, recharge the groundwater, and support vegetation with natural irrigation. Second, it deprives the human community of an important quality of life asset, and sense of connection to their own regional ecosystems.[1]

In order to work with a region's hydrology, it is vital to recognize its network connectivity through mapping, and then to lay out settlement patterns such as streets and infrastructure in response to its "blue-green network" — that is, its network of creeks, watersheds and vegetation corridors. These usually offer segments that can become important blue-green corridors for walking, cycling, recreation and vehicular transportation (with proper mitigation of danger, noise, emissions and other impacts) — see URBAN GREENWAY (3.1).

In the 20th century, we failed to understand the importance of these blue-green networks, and their potential role as a "cooperating network" with human movement networks. We failed also to understand the importance of blue-green networks in providing "ecosystem services," notably the improvement of water quality.[2] Rather than negotiate a co-existence between these two systems, we allowed human movement systems like streets to dominate and even replace blue-green networks with pipes and concrete ditches. Now we are paying the price for this short-sightedness. We have begun to change our policies and practices to create nested, interacting urban networks incorporating blue-green networks within them.

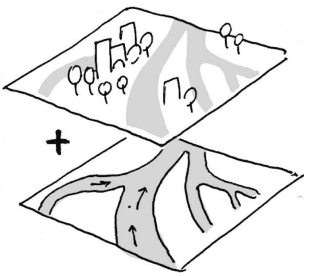
At the same time we must recognize that, while the blue-green network of an urbanized area must be ecologically functional with regard to its ecosystem services and its role in urban wildlife habitats, the primary function of urban regions is to be urban — that is, to establish a pattern that is sufficiently compact to avoid sprawl and to protect surrounding

ecologies. As the British Town Planner Thomas Sharp put it, "the true way to save the countryside is to build true sheerly urban towns."

The blue-green network of Portland, Oregon USA, located at the intersection of two major rivers and a number of creeks and watersheds. These have been fashioned into major corridors for infrastructure, movement, recreation and ecosystems services. Photo: Google Maps.

Therefore:

Lay out the settlement with the pattern of blue (water courses) and green (vegetation corridors and watersheds) networks.



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Identify key corridors of the Blue Green Network as potential locations for an URBAN GREENWAY (3.1) or MULTI-WAY BOULEVARD (3.2)…

[1] See for example De Vleeschauwer, K., Weustenraad, J., Nolf, C., Wolfs, V., De Meulder, B., Shannon, K., & Willems, P. (2014). Green–blue water in the city: Quantification of impact of source control versus end-of-pipe solutions on sewer and river floods. *Water Science and Technology, 70*(11), 1825-1837. Available on the Web at https://tinyurl.com/yxfb444j

[2] This pattern is closely related to Goal 6 of the Sustainable Development Goals on safe water and sanitation (adopted by all members of the UN General Assembly in 2015). There are a number of resources that can be consulted for additional information. See for example the World Bank report on water quality and the role of cities, *Quality Unknown*, available free for download at https://openknowledge.worldbank.org/bitstream/handle/10986/32245/9781464814594.pdf?sequence=8&isAllowed=y. As the report concludes, "The world faces an invisible crisis of water quality. Its impacts are wider, deeper, and more uncertain than previously thought and require urgent attention. While much attention has focused on water quantity — too much water, in the case of floods; too little water, in the case of droughts — water quality has attracted significantly less consideration… Water quality challenges are not unique to developing countries but universal across rich and poor countries alike. High-income status does not confer immunity - challenges with pollutants grow alongside GDP. And as countries develop, the cocktail of chemicals and vectors they contend with change — from fecal bacteria to nitrogen to pharmaceuticals and plastics, for example. What we think of as safe may be far from it." See also a report by the European Union: "Green infrastructure, as defined by the European Union Green Infrastructure Strategy 2013 is 'a strategically planned network of natural and semi-natural areas with other environmental features designed and managed to deliver a wide range of ecosystem services'." https://webgate.ec.europa.eu/greencitytool/resources/docs/guidance/nature.pdf

1.3. MOBILITY CORRIDOR

…In a POLYCENTRIC REGION (1.1), develop proper high-speed connections between the centers of the region as well as to other regions.

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Problem-statement: There is a need for corridors that allow high-speed vehicular movement within and between cities. This need extends into the hearts of the cities. But these structures must not be allowed to sever and destroy the tissue of the city.

Discussion: Few structures have been more damaging to modern cities than freeways. Yet the solution of creating freeway bypasses on the outskirts of cities is equally disastrous — sapping the centers of commercial movement and activity, and at the same time generating new sprawling zones at the edges.

This is not a unique problem of the automobile age. Railways can be no less destructive of urban areas, and so can canals, rivers and other structures — in fact, any structure that significantly interrupts the connectivity and flow of pedestrians is likely to be problematic. But there are excellent examples of cities that have managed this problem, by separating the grades of the mobility corridors, and by creating a continuous fabric of connections across them. Examples can be seen in London, Paris, and many other mature cities.

Grade-separated mobility corridor in Paris: Place de l'Europe over a railway line.

The issue is not whether a mobility corridor is present, but whether the urban fabric surrounding it remains intact. This must be done carefully, maintaining a continuous, tight fabric with minimal intrusion of noise, emissions, and visual disorder. Examples like Place

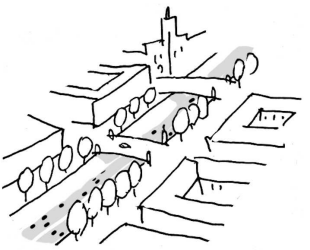
de l'Europe in Paris demonstrate the value of ample vegetation, fences and other screening devices. Some cities have simply taken their mobility corridors underground, like Oslo. Some cities bring buildings across the bridging structures, like the Ponte Vecchio in Florence.[1]

One problem for many cities is the cost of excavation and retaining structures. One strategy to minimize this cost is a "balanced cut and fill" grade change, rising gently in the urban fabric to the edge of the mobility corridor, and then cut more deeply to accommodate travel lanes at a lower grade. A related strategy is to utilize existing natural watershed grade changes, taking care to avoid water pollution from vehicle emissions and other toxic runoff. Because of the cost of excavation, many cities in recent decades have chosen the easier alternative, which is to raise highways and heavy transport tracks above the pedestrian urban fabric. But the evidence shows that there is a profoundly negative impact of such solutions on the urban life underneath them.[2]

Of course, it must be stressed that "mobility" is not just about high speed transportation, but about integrated mobility across multiple modes (see WALKABLE MULTI-MOBILITY, 2.1). A coordinated strategy is needed to keep a balanced and integrated approach to mobility.[3]

Therefore:

Do not push freeways, railways and other destructive activities to the edges of the city. Instead, find ways to integrate them into the urban fabric with minimal disruption, using careful grade-separating strategies. Assure that the streets above are continuous, walkable, and as protected as possible from negative impacts like noise and emissions. Plan for at least two major mobility corridors crossing each large urban area, and connecting to others.



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Integrate mobility corridors into the network, maintaining a 400M THROUGH STREET NETWORK (1.4) across all interruptions, providing bridges and other connections…

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[1] For a discussion of this concept in relation to urban mobility networks, see Mehaffy M.W., Porta, S., Rofè, Y. and Salingaros, N. (2010), Urban nuclei and the geometry of streets: The 'emergent neighbourhoods' model. *Urban Design International, 15*(1), 22-46. Available on the Web at https://tinyurl.com/yy98o68y

[2] The damaging effects of such structures has been discussed extensively, and perhaps most notably by Jane Jacobs in *The Death and Life of Great American Cities* (1961, New York: Random House). She referred to the consequences as "galloping gangrene."

[3] Additional resources on this point include the World Resources Institute Sustainable Mobility Strategies, http://wrirosscities.org/sites/default/files/WRR_Transport.pdf. Among their recommendations: 1) Optimize efficiency: Support planning and implementation of higher fuel and vehicle efficiency standards and lower energy consumption and emissions from the transport sector through engagement and research. 2) Electrify fuels: Support adoption of electric vehicles and the transition to electrified transport systems through localized research and direct engagement with stakeholders from multiple sectors. 3) Integrate systems: Support implementation and management of integrated transport systems through directly influencing the planning and implementation of urban transport systems and publishing high-quality research. 4) Shift and align funding and policy: Build capacity for sustainable transport through research, direct technical guidance, policy recommendations, and stakeholder engagement with the public, private, civil society, and donor communities.

An additional resource is the European Commission's "Green City Tool" on mobility: https://webgate.ec.europa.eu/greencitytool/topic/mobility/guidance.

1.4. 400M THROUGH STREET NETWORK