Christopher Alexander

A City is Not a Tree:

50th Anniversary Edition

with
new commentaries by

Mike Batty • Luís Bettencourt • Howard Davis
Jaap Dawson • Bin Jiang • Michael W Mehaffy
Hans Joachim Neis • Dellé Odeleye • Sergio Porta
Yodan Rofè • MariaPia Vidoli
and other contributors

edited by
Michael W Mehaffy

Sustasis Press
In Association with
Center for Environmental Structure

In 1965, the architect and design theorist Christopher Alexander published a landmark theoretical critique of modern urban design, and by extension, modern design in general. His critique was different from others of the day in that it was not based on a social or political argument, but on a structural analysis, rooted in then-emerging insights from the fields of mathematics and cognition.

Here, published again on its fiftieth anniversary, is Alexander's classic text, together with new interpretive commentaries and discussions by leading theorists and practitioners. This volume is destined to become an invaluable resource for a new generation of students and practitioners.

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"At a time of increasing concern over the adequacy of design methods, "A City is not a Tree" broke open and reoriented the debate."

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"It pointed clearly to a change in the way we need to think about cities – not as assemblies of one-off components that are hierarchically sorted, but as systems with global properties that manifest at local places. That, for me, is also the key insight and power of Space Syntax as a methodology."

— Bill Hillier, Chairman of the Bartlett School of Graduate Studies, University College London

"Seen from the distance of half a century, Christopher Alexander's "A city is not a tree" remains a landmark in our thinking about cities and design... It is a new beginning: The first step on a journey – for Alexander and for urbanism - to discover what the city really is. Its daring novelty is to place the problems of architecture and urban planning on the same level of those in physics or biology and to seek answers using the scientific method, expressed in mathematical language."

— Luís Bettencourt, Santa Fe Institute

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Editor's Preface

Michael W Mehaffy

“A City is Not a Tree” was first published in two parts in the American journal *Architectural Forum*, in April and May 1965. Later that year it won the prestigious Kauffman International Design Award, and the jurors noted that "the principles he [Dr Alexander] describes, and the analytical methods he adopts, are applicable at all levels of design". The paper was subsequently re-published in over a dozen journals and books, and later circulated endlessly on the Internet – but unfortunately, in formats of uneven quality and accessibility.

This seminal work has not, however, appeared in its own dedicated volume, a format where it might be studied and assessed more thoughtfully, by students, researchers, and practitioners. Given its seminal influence within the history of 20th Century design theory, my colleagues and I – part of a research coordination network called the Environmental Structure Research Network (ESRG) – felt that the occasion of the fiftieth anniversary of its first publication would be an appropriate time to meet that need. We present the original paper here along with a collection of newer reflections, exegeses and critical analyses by a number of leading scholars and practitioners.

The historical influence of this slight 7,500 word paper is difficult to overstate. Its author, Christopher Alexander, has some 15 books to his credit, many of them noted theoretical or philosophical works, and several that are landmarks in their own right – among them *Notes on the Synthesis of Form* and *A Pattern Language*. But “A City is Not a Tree” has been arguably as influential for many in the field of environmental design, and indeed in design more generally, as any of his books.

A representative example may be Robert Campbell, a prominent architecture critic for the Boston Globe, who said that Alexander had "an enormous critical influence on my life and work, and I think that's true of a whole generation of people" – and he singled out "A City is Not a Tree" as most influential for him.

Campbell recalled discovering the paper as a student in the library of Harvard's Graduate School of Design. "That was a *landmark* moment in my development as a thinker and as an architect," he said, speaking at the National Building Museum in 2009. "It really blew away what were the foundational principles of the education at Harvard in those days, and it established in me an interest in actually *looking* at the world – not looking at set of preconceived abstract mechanical ideas that were supposed to *replace* the existing world."

It is instructive that such a change of focus should be necessary – that a profession bewitched by its own abstractions should need to have its spell broken, as it were, by the blunt force of a clear and compelling argument. It may also be instructive that it took so long for such an argument even to appear. That it was Alexander who did so might be explained by his work at Harvard and MIT, not only in their design schools but perhaps more importantly (as he himself has said) in their psychology departments, where he worked with legendary pioneers of cognition like George A. Miller.

Much has been said about the mathematical argument that Alexander makes, the one derived from set theory, with a close relation to network theory. This subject was later to blossom within the field of complexity science, with contributions to urban studies (including the development of Space Syntax, as our co-contributor Bill Hillier notes). Perhaps more should be noted about Alexander's description, later in the paper, of cognitive biases and distortions, and the tendency of human minds to organize things in particular ways that are subtle but enormously consequential. In that sense, Alexander may have been an early contributor to the psychology of bounded rationality and cognitive bias, and their sometimes profound impacts on human life and social

organization. If this is true, then perhaps the modern professions of environmental design are, while not the only examples of such cognitive distortions, then perhaps, "Exhibit A" in the case for reform.

The accompanying essays by contemporary authors assess the paper, its legacy, and its relevance to contemporary challenges. They do not, as a rule, attack the paper, or its author, by presenting critical dismissals or revisionist history, or even detailed critiques of technical aspects of Alexander's argument.

There are two reasons why we have refrained from including such critical texts. One is that the reader can find quite a few of them elsewhere; indeed, Alexander is a popular target in some quarters, including many corners of architectural academia. The other is that, speaking quite frankly, we believe the time has come to look for the forest and not the trees. The latter may be a fond habit – but it may also be a major reason that architectural academia is in crisis, while its relevance is challenged as never before.

At present, the world is urbanizing at an unprecedented rate: on track to produce more urban fabric in the first third of the Twenty-first Century than in *all of human history.* In that light, whatever else we may say about the strengths and weaknesses of this historic paper, we will say this: the insightful connections it developed could not be more relevant and even urgent, forming a provocative and compelling argument for reform today. In one way or another, most of the essays by the other contributors revolve around the question of what we have learned in the half-century since publication – and perhaps, in too many cases, what we still have to learn.

Acknowledgements

First and foremost, the authors and publishers are greatly indebted to Christopher Alexander for writing the original paper included herein, and to him and his wife Maggie Alexander for graciously supporting this project, and giving their permission for the paper to be re-published. We are also indebted to Chris and Maggie for supporting the creation of the Environmental Structure Research Network (ESRG), a number of whose members contributed to this volume.

Secondly, we are indebted to those co-authors, who have contributed their own thoughtful exegeses on this text. They have provided an invaluable mix of perspectives from the half-century point since publication.

Thanks to fellow board members of Sustasis Foundation, Ward Cunningham and Bernard Franceschi, for supporting this project with their ideas and suggestions, and with their own generous funds.

Thanks also to other donors to Sustasis Foundation in support of this project and related initiatives, notably Besim Hakim of Albuquerque, and Susan and Fred Ingham of Seattle. We are most grateful to you and to other supporters, past and future, who make this work possible.

Thanks to my colleague Nikos Salingaros, who gave his time, assistance and ideas to this and other related projects of Sustasis Press.

Special thanks to Yulia Kryazhneva of Yulia Ink in Amsterdam for cover design, copy-setting and formatting, and to Levellers Press in Boston for printing and fulfillment.

- Michael Mehaffy, Sustasis Press

I THE ORIGINAL 1965 TEXT


EKSOTISKE FRUKT
GRØNNSAKER
Helgensens gate
Deli de Luca
Deli de Luca
VIDEO
MINIBANK
DØGNÅPENT
Victory

Chapter 1

A City is Not a Tree

Christopher Alexander

The tree of my title is not a green tree with leaves. It is the name of an abstract structure. I shall contrast it with another, more complex abstract structure called a semilattice. In order to relate these abstract structures to the nature of the city, I must first make a simple distinction.

I want to call those cities which have arisen more or less spontaneously over many, many years natural cities. And I shall call those cities and parts of cities which have been deliberately created by designers and planners artificial cities. Siena, Liverpool, Kyoto, Manhattan are examples of natural cities. Levittown, Chandigarh and the British New Towns are examples of artificial cities.

It is more and more widely recognized today that there is some essential ingredient missing from artificial cities. When compared with ancient cities that have acquired the patina of life, our modern attempts to create cities artificially are, from a human point of view, entirely unsuccessful.

Architects themselves admit more and more freely that they really like living in old buildings more than new ones. The non-art-loving public at large, instead of being grateful to architects for what they do, regards the onset of modern buildings and modern cities everywhere as an inevitable, rather sad piece of the larger fact that the world is going to the dogs.

It is much too easy to say that these opinions represent only people's unwillingness to forget the past, and their determination to be traditional. For myself, I trust this conservatism. People are usually willing to move with the times. Their growing reluctance to accept the modern city evidently expresses a longing for some real thing, something which for the moment escapes our grasp.

The prospect that we may be turning the world into a place peopled only by little glass and concrete boxes has alarmed many architects, too. To combat the glass box future, many valiant protests and designs have been put forward, all hoping to recreate in modern form the various characteristics of the natural city which seem to give it life. But so far these designs have only remade the old. They have not been able to create the new.

Outrage, the Architectural Review's campaign against the way in which new construction and telegraph poles are wrecking the English town, based its remedies, essentially, on the idea that the spatial sequence of buildings and open spaces must be controlled if scale is to be preserved - an idea that really derives from Camillo Sitte's book about ancient squares and piazzas.

Another kind of remedy, in protest against the monotony of Levittown, tries to recapture the richness of shape found in the houses of a natural old town. Llewelyn Davies' village at Rushbrooke in England is an example - each cottage is slightly different from its neighbour, the roofs jut in and out at picturesque angles, the shapes are 'interesting' and cute.

A third suggested remedy is to get high density back into the city. The seems to be that if the whole metropolis could only be like Grand Central Station, with lots and lots of layers and tunnels all over the place, and enough people milling around in them, maybe it would be human again. The artificial urbanity of Victor Gruen's schemes and of the LCC's scheme for Hook New Town, both betray this thought at work.

Another very brilliant critic of the deadness which is everywhere is Jane Jacobs. Her criticisms are excellent. But when you read her concrete proposals for what we should do instead, you get the idea that she wants the great modern city to be a sort of mixture between Greenwich Village and some Italian hill town, full of short blocks and people sitting in the street.

The problem these designers have tried to face is real. It is vital that we discover the property of old towns which gave them life, and get it back into our own artificial cities. But we cannot do this merely by remaking English villages, Italian piazzas and Grand Central Stations. Too many designers today seem to be yearning for the physical and plastic characteristics of the past, instead of searching for the abstract ordering principle which the towns of the past happened to have, and which our modern conceptions of the city have not yet found. These designers fail to put new life into the city, because they merely imitate the appearance of the old, its concrete substance: they fail to unearth its inner nature.

What is the inner nature, the ordering principle, which distinguishes the artificial city from the natural city? You will have guessed from the first paragraph what I believe this ordering principle to be. I believe that a natural city has the organisation of a semilattice; but that when we organise a city artificially, we organise it as a tree.

Trees and semilattices

Both the tree and the semilattice are ways of thinking about how a large collection of many small systems goes to make up a large and complex system. More generally, they are both names for structures of sets.

In order to define such structures, let me first define the concept of a set. A set is a collection of elements which for some reason we think of as belonging together. Since, as designers, we are concerned with the physical living city and its physical backbone, we must naturally

restrict ourselves to considering sets which are collections of material elements such as people, blades of grass, cars, molecules, houses, gardens, water pipes, the water molecules in them etc.

When the elements of a set belong together because they co-operate or work together somehow, we call the set of elements a system.

Here is an example (photo below). In Berkeley at the corner of Hearst and Euclid, there is a drugstore, and outside the drugstore a traffic light. In the entrance to the drugstore there is a newsrack where the day's papers are displayed. When the light is red, people who are waiting to cross the street stand idly by the light; and since they have nothing to do, they look at the papers displayed on the newsrack which they can see from where they stand. Some of them just read the headlines, others actually buy a paper while they wait.

The corner of Hearst and Euclid as it appeared in 2015. Photo courtesy Google.

This effect makes the newsrack and the traffic light interactive; the newsrack, the newspapers on it, the money going from people's pockets to the dime slot, the people who stop at the light and read papers, the traffic light, the electric impulses which make the lights change, and the

sidewalk which the people stand on form a system - they all work together.

From the designer's point of view, the physically unchanging part of this system is of special interest. The newsrack, the traffic light and the pavement between them, related as they are, form the fixed part of the system. It is the unchanging receptacle in which the changing parts of the system – people, newspapers, money and electrical impulses - can work together. I define this fixed part as a unit of the city. It derives its coherence as a unit both from the forces which hold its own elements together and from the dynamic coherence of the larger living system which includes it as a fixed invariant part.

Other examples of systems in the city are: the set of particles which go to make up a building; the set of particles which go to make up a human body; the cars on the freeway, plus the people in them, plus the freeway they are driving on; two friends on the phone, plus the telephones they hold, plus the telephone line connecting them; Telegraph Hill with all its buildings, services and inhabitants; the chain of Rexall drug stores; the physical elements of San Francisco that fall under the administrative authority of City Hall; everything within the physical boundary of San Francisco, plus all the people who visit the city regularly and contribute to its development (like Bob Hope or the president of Arthur D. Little), plus all the major sources of economic welfare which supply the city with its wealth; the dog next door, plus my garbage can, plus the garbage out of my garbage can which he lives on; the San Francisco chapter of the John Birch Society.

Each one of these is a set of elements made coherent and co-operative by some sort of inner binding forces. And each one, just like the traffic light - newsrack system, has a physically fixed part which we think of as a unit of the city.

Of the many, many fixed concrete subsets of the city which are the receptacles for its systems and can therefore be thought of as significant

physical units, we usually single out a few for special consideration. In fact, I claim that whatever picture of the city someone has is defined precisely by the subsets he sees as units.

Now, a collection of subsets which goes to make up such a picture is not merely an amorphous collection. Automatically, merely because relationships are established among the subsets once the subsets are chosen, the collection has a definite structure.

To understand this structure, let us think abstractly for a moment, using numbers as symbols. Instead of talking about the real sets of millions of real particles which occur in the city, let us consider a simpler structure made of just half a dozen elements. Label these elements 1,2,3,4,5,6. Not including the full set [1,2,3,4,5,6], the empty set [-], and the one-element sets [1],[2],[3],[4],[5],[6], there are 56 different subsets we can pick from six elements.

Suppose we now pick out certain of these 56 sets (just as we pick out certain sets and call them units when we form our picture of the city). Let us say, for example, that we pick the following subsets: [123], [34], [45], [234], [345], [12345], [3456].

What are the possible relationships among these sets? Some sets will be entirely part of larger sets, as [34] is part of [345] and [3456]. Some of the sets will overlap, like [123] and [234]. Some of the sets will be disjoint - that is, contain no elements in common like [123] and [45].

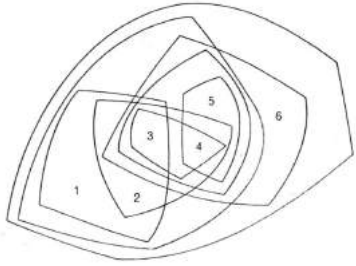


Diagram A

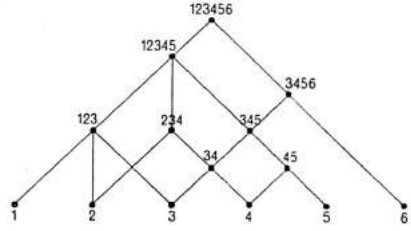


Diagram B

We can see these relationships displayed in two ways. In diagram A (above) each set chosen to be a unit has a line drawn round it. In diagram B the chosen sets are arranged in order of ascending magnitude, so that whenever one set contains another (as [345] contains [34], there is a vertical path leading from one to the other. For the sake of clarity and visual economy, it is usual to draw lines only between sets which have no further sets and lines between them; thus the line between [34] and [345] and the line between [345] and [3456] make it unnecessary to draw a line between [34] and [3456].

As we see from these two representations, the choice of subsets alone endows the collection of subsets as a whole with an overall structure. This is the structure which we are concerned with here. When the structure meets certain conditions it is called a semilattice. When it meets other more restrictive conditions, it is called a tree.

The semilattice axiom goes like this: *A collection of sets forms a semilattice if and only if, when two overlapping sets belong to the collection, the set of elements common to both also belongs to the collection.*

The structure illustrated in diagrams A and B is a semilattice. It satisfies the axiom since, for instance, [234] and [345] both belong to the collection and their common part, [34], also belongs to it. (As far as the city is concerned, this axiom states merely that wherever two units overlap, the area of overlap is itself a recognizable entity and hence a unit also. In the case of the drugstore example, one unit consists of newsrack, sidewalk and traffic light. Another unit consists of the drugstore itself, with its entry and the newsrack. The two units overlap in the newsrack. Clearly this area of overlap is itself a recognizable unit and so satisfies the axiom above which defines the characteristics of a semilattice.)

The tree axiom states: *A collection of sets forms a tree if and only if, for any two sets that belong to the collection either one is wholly contained in the other, or else they are wholly disjoint.*

The structure illustrated in diagrams C and D (below) is a tree. Since this axiom excludes the possibility of overlapping sets, there is no way in which the semilattice axiom can be violated, so that every tree is a trivially simple semilattice.

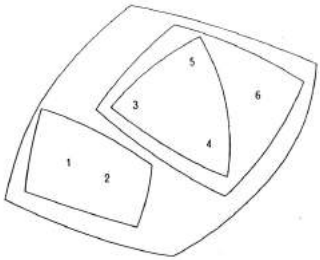


Diagram C

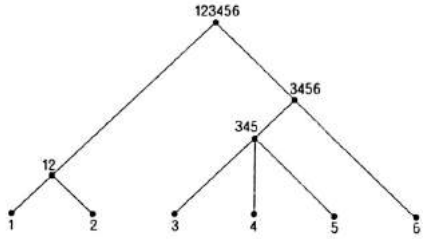


Diagram D

However, in this paper we are not so much concerned with the fact that a tree happens to be a semilattice, but with the difference between trees and those more general semilattices which are not trees because they do contain overlapping units. We are concerned with the difference between structures in which no overlap occurs, and those structures in which overlap does occur.

It is not merely the overlap which makes the distinction between the two important. Still more important is the fact that the semilattice is potentially a much more complex and subtle structure than a tree. We may see just how much more complex a semilattice can be than a tree in the following fact: a tree based on 20 elements can contain at most 19 further subsets of the 20, while a semilattice based on the same 20 elements can contain more than 1,000,000 different subsets.

This enormously greater variety is an index of the great structural complexity a semilattice can have when compared with the structural simplicity of a tree. It is this lack of structural complexity, characteristic of trees, which is crippling our conceptions of the city.

Artificial cities which are trees

To demonstrate, let us look at some modern conceptions of the city, each of which I shall show to be essentially a tree. It will perhaps be useful, while we look at these plans, to have a little ditty in our minds:

> "Big fleas have little fleas
> Upon their backs to bite 'em;
> Little fleas have lesser fleas,
> And so ad infinitum."

This rhyme expresses perfectly and succinctly the structural principle of the tree.

Examples

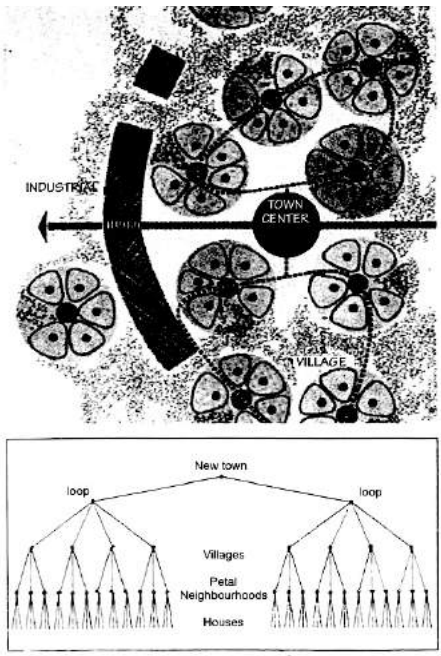


Figure 1. Columbia, Maryland, Community Research and Development, Inc.: Neighbourhoods, in clusters of five, form 'villages'. Transportation joins the villages into a new town. The organization is a tree.

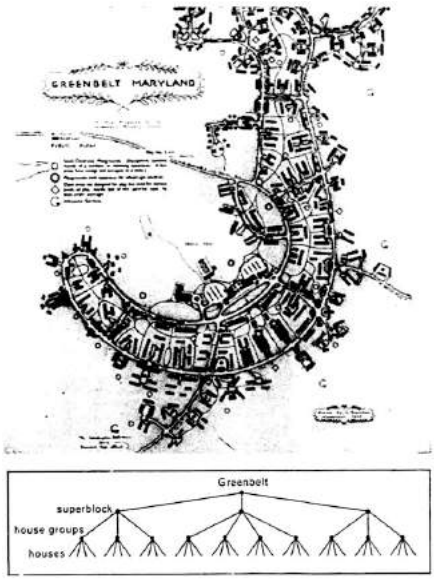


Figure 2. Greenbelt, Maryland, Clarence Stein: This 'garden city' has been broken down into superblocks. Each super-block contains schools, parks and a number of subsidiary groups of houses built around parking lots. The organization is a tree.

Figure 3. Greater London plan (1943), Abercrombie and Forshaw: The drawing depicts the structure conceived by Abercrombie for London. It is made of a large number of communities, each sharply separated from all adjacent communities. Abercrombie writes, 'The proposal is to emphasize the identity of the existing communities, to increase their degree of segregation, and where necessary to recognize them as separate and definite entities.' And again, 'The communities themselves consist of a series of sub-units, generally with their own shops and schools, corresponding to the neighbourhood units.' The city is conceived as a tree with two principal levels. The

communities are the larger units of the structure; the smaller sub-units are neighbourhoods. There are no overlapping units. The structure is a tree.

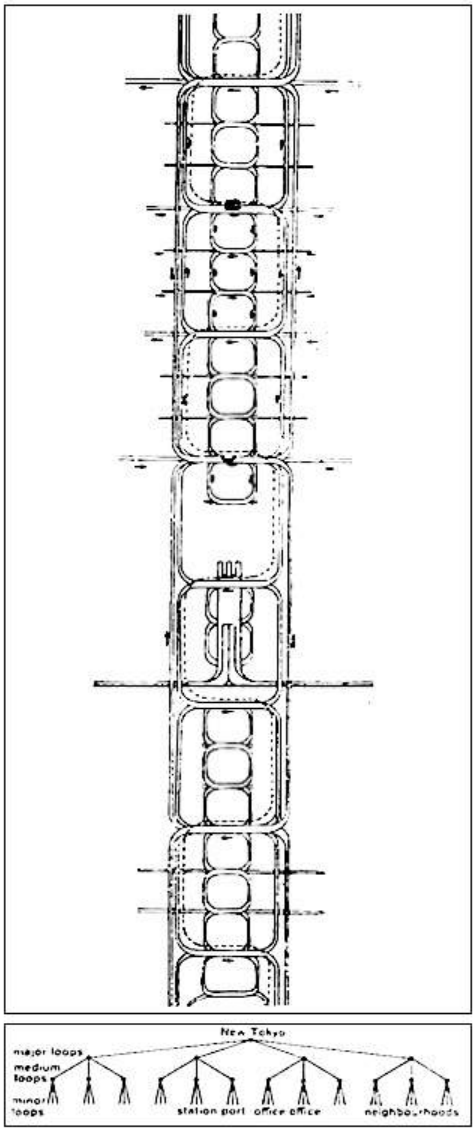
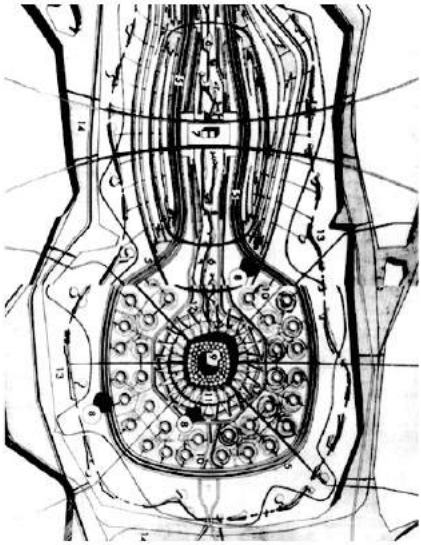


Figure 4. Tokyo plan, Kenzo Tange: This is a beautiful example. The plan consists of a series of loops stretched across Tokyo Bay. There are four major loops, each of which contains three medium loops. In the second major loop, one medium loop is the railway station and another is the port. Otherwise, each medium loop contains three minor loops which are residential neighbourhoods, except in the third major loop where one contains government offices and another industrial offices.



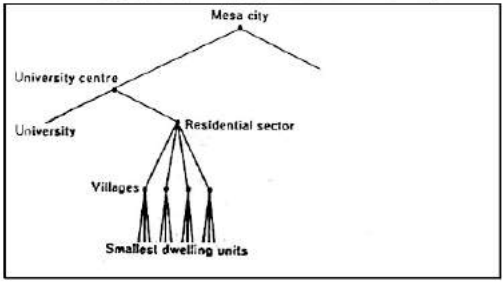


Figure 5. Mesa City, Paolo Soleri: The organic shapes of Mesa City lead us, at a careless glance, to believe that it is a richer structure than our more obviously rigid examples. But when we look at it in detail we find precisely the same principle of organi-zation. Take, particularly, the university centre. Here we find the centre of the city divided into a uni-versity and a residential quarter, which is itself divided into a number of villages (actually apart-ment towers) for 4000 inhabitants, each again subdivided further and surrounded by groups of still smaller dwelling units.

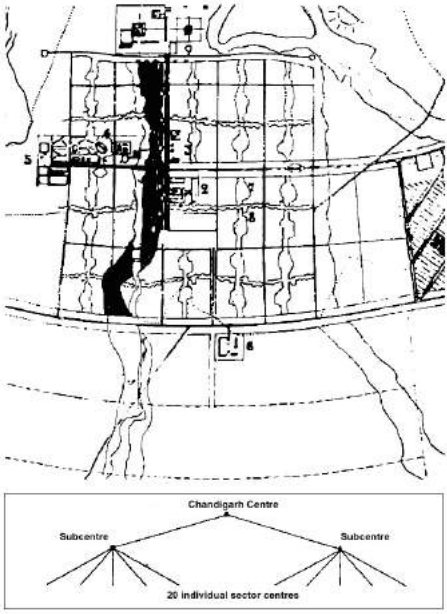


Figure 6. Chandigarh (1951), Le Corbusier: The whole city is served by a commercial centre in the middle, linked to the administrative centre at the head. Two subsidiary elongated commercial cores are strung out along the major arterial roads, running north-south. Subsidiary to these are further administrative, community and commercial centres, one for each of the city's 20 sectors.

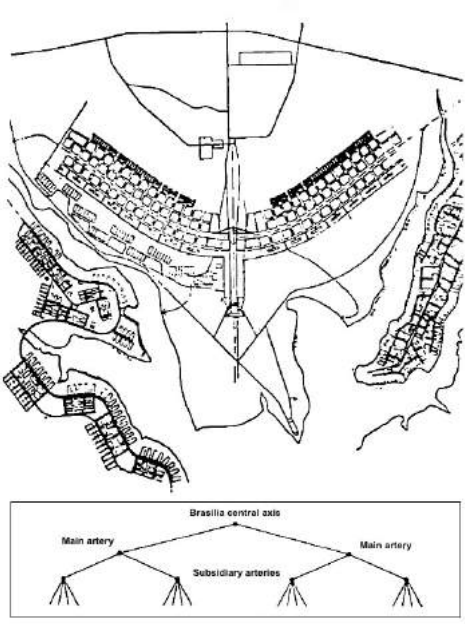


Figure 7. Brasilia, Lucio Costa: The entire form pivots about the central axis, and each of the two halves is served by a single main artery. This main artery is in turn fed by subsidiary arteries parallel to it. Finally, these are fed by the roads which surround the superblocks themselves. The structure is a tree.

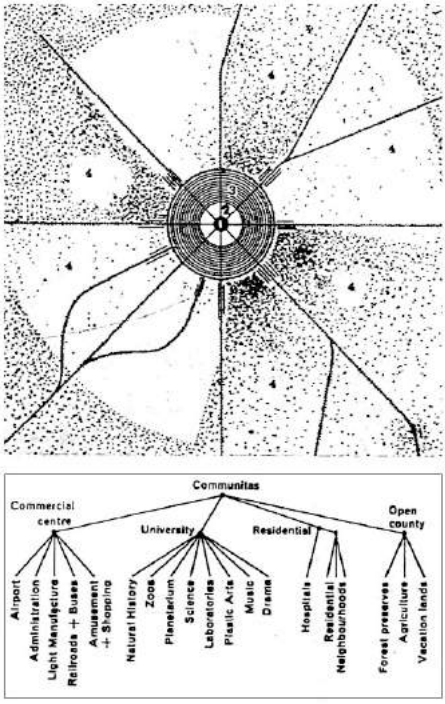


Figure 8. Communitas, Percival and Paul Goodman: Communitas is explicitly organized as a tree: it is first divided into four concentric major zones, the innermost being a commercial centre, the next a university, the third residential and medical, and the fourth open country. Each of these is further subdivided: the commercial centre is represented as a great cylindrical skyscraper, containing five layers: airport, administration, light manufacture, shopping and amusement; and, at the bottom, railroads, buses and mechanical services. The university is divided into eight sectors comprising natural history, zoos and aquariums, planetarium, science laboratories, plastic arts, music and drama. The third concentric ring is divided into neighbourhoods of 4000 people each, not consisting of individual houses, but of apartment blocks, each of these containing individual dwelling units. Finally, the open country is divided into three segments: forest preserves, agriculture and vacation lands. The overall organization is a tree.

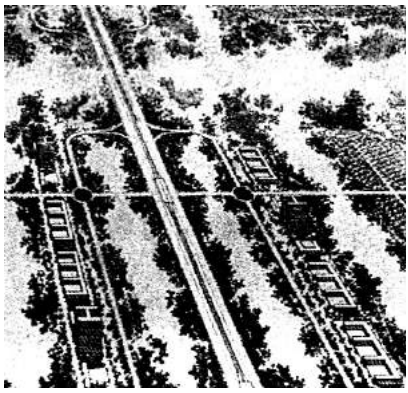


Figure 9. The most beautiful example of all I have kept until last, because it symbolizes the problem perfectly. It appears in Hilberseimer's book *The Nature of Cities*. He describes the fact that certain Roman towns had their origin as military camps, and then shows a picture of a modern military encampment as a kind of archetypal form for the city. It is not possible to have a structure which is a clearer tree. The symbol is apt, for, of course, the organization of the army was designed precisely in order to create discipline and rigidity. The photograph on the [left] is Hilberseimer's own scheme for the commercial area of a city based on the army camp archetype.

Each of these structures is a tree.

The units of which an artificial city is made up are always organised to form a tree. So that we get a really clear understanding of what this means, let us define a tree again:

Whenever we have a tree structure, it means that within this structure no piece of any unit is ever connected to other units, except through the medium of that unit as a whole.

The enormity of this restriction is difficult to grasp. It is a little as though the members of a family were not free to make friends outside the family, except when the family as a whole made a friendship.

The structural simplicity of trees is like the compulsive desire for neatness and order that insists that the candlesticks on a mantelpiece be perfectly straight and perfectly symmetrical about the centre. The semilattice, by comparison, is the structure of a complex fabric; it is the structure of living things - of great paintings and symphonies.

It must be emphasised, lest the orderly mind shrink in horror from anything that is not clearly articulated and categorised in tree form, that the ideas of overlap, ambiguity, multiplicity of aspect, and the semilattice, are not less orderly than the rigid tree, but more so. They represent a thicker, tougher, more subtle and more complex view of structure.

Let us now look at the ways in which the natural city, when unconstrained by artificial conceptions, shows itself to be a semilattice.

A living city is and needs to be a semilattice

Each unit in each tree that I have described is the fixed, unchanging residue of some system in the living city. A house , for example, is the residue of the interactions between the members of a family, their emotions and their belongings. A freeway is the residue of movement and commercial exchange. But a tree contains only very few such units – so that in a tree-like city only a very few of its systems can have a physical counterpart. Thousands of important systems have no physical counterpart.

In the worst trees, the units which do appear fail to correspond to any living reality; and the real systems, whose existence actually makes the city live, have been provided with no physical receptacle.

Neither the Columbia plan nor the Stein plan for example, corresponds to social realities. The physical layout of the plans, and the way they function suggests a hierarchy of stronger and stronger closed social

groups, ranging from the whole city down to the family, each formed by associational ties of different strength.

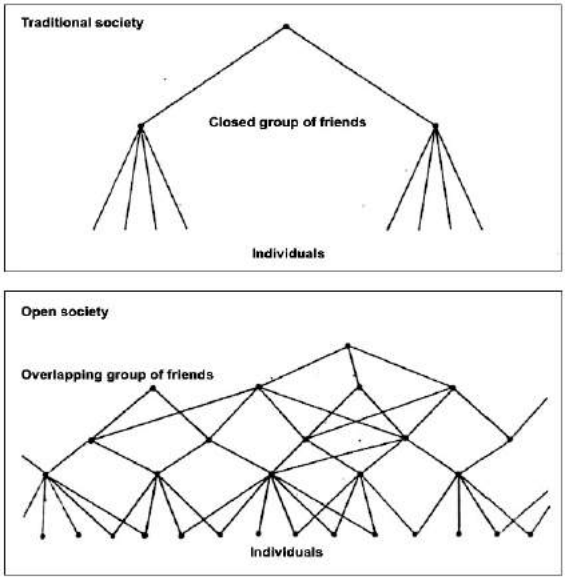


Figure 10

In a traditional society, if we ask a man to name his best friends and then ask each of these in turn to name their best friends, they will all name each other so that they form a closed group. A village is made up of a number of separate closed groups of this kind. (Upper drawing, Fig. 10.)

But today's social structure is utterly different. If we ask a man to name his friends and then ask them in turn to name their friends, they will all name different people, very likely unknown to the first person; these people would again name others, and so on outwards. There are virtually no closed groups of people in modern society. The reality of today's social structure is thick with overlap - the systems of friends and acquaintances form a semilattice, not a tree. (Lower drawing, Fig. 10.)

In the natural city, even the house on a long street (not in some little cluster) is a more accurate acknowledgement of the fact that your friends live not next door, but far away, and can only be reached by bus or car. In this respect Manhattan has more overlap in it than Greenbelt. And though one can argue that in Greenbelt, too, friends are only minutes away by car, one must then ask: since certain groups have been

emphasized by the physical units of the physical structure, why are just these the most irrelevant ones?

Another aspect of the city's social structure which a tree can never mirror properly is illustrated by Ruth Glass's redevelopment plan for Middlesbrough, England, a city of 200,000 which she recommends be broken down into 29 separate neighbourhoods. After picking her 29 neighbourhoods by determining where the sharpest discontinuities of building type, income and job type occur, she asks herself the question: 'If we examine some of the social systems which actually exist for the people in such a neighbourhood, do the physical units defined by these various social systems all define the same spatial neighbourhood?' Her own answer to this question is no.

Each of the social systems she examines is a nodal system. It is made of some sort of central node, plus the people who use this centre. Specifically she takes elementary schools, secondary schools, youth clubs, adult clubs, post offices, greengrocers and grocers selling sugar. Each of these centres draws its users from a certain spatial area or spatial unit. This spatial unit is the physical residue of the social system as a whole, and is therefore a unit in the terms of this discussion. The units corresponding to different kinds of centres for the single neighbourhood of Waterloo Road are shown in Figure 11.

Figure 11

The hard outline is the boundary of the so-called neighbourhood itself. The white circle stands for the youth club, and the small solid rings stand for areas where its members live. The ringed spot is the adult club, and the homes of its members form the unit marked by dashed boundaries. The white square is the post office, and the dotted

line marks the unit which contains its users. The secondary school is marked by the spot with a white triangle in it. Together with its pupils, it forms the system marked by the dot-dashed line.

As you can see at once, the different units do not coincide. Yet neither are they disjoint. They overlap.

We cannot get an adequate picture of what Middlesbrough is, or of what it ought to be, in terms of 29 large and conveniently integral Chunks called neighbourhoods. When we describe the city in terms of neighbourhoods, we implicitly assume that the smaller elements within any one of these neighbourhoods belong together so tightly that they only interact with elements in other neighbourhoods through the medium of the neighbourhoods to which they themselves belong. Ruth Glass herself shows clearly that this is not the case.

On the following page are two representations of the Waterloo neighbourhood. For the sake of argument I have broken it into a number of small areas. Figure 12 (following page) shows how these pieces stick together in fact, and Figure 13 shows how the redevelopment plan pretends they stick together.

There is nothing in the nature of the various centres which says that their catchment areas should be the same. Their natures are different. Therefore the units they define are different. The natural city of Middlesbrough was faithful to the semilattice structure of the units. Only in the artificial-tree conception of the city are their natural, proper and necessary overlaps destroyed.

The same thing happens on a smaller scale. Take the separation of pedestrians from moving vehicles, a tree concept proposed by Le Corbusier, Louis Kahn and many others. At a very crude level of thought this is obviously a good idea. It is dangerous to have 60 mph cars in contact with little children toddling. But it is not always a good

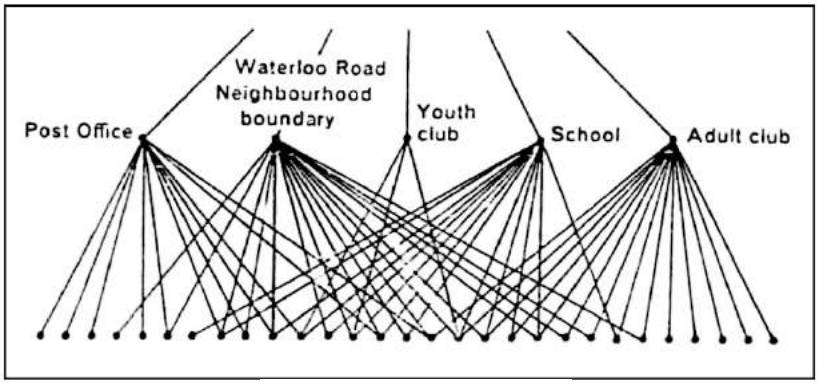


Figure 12

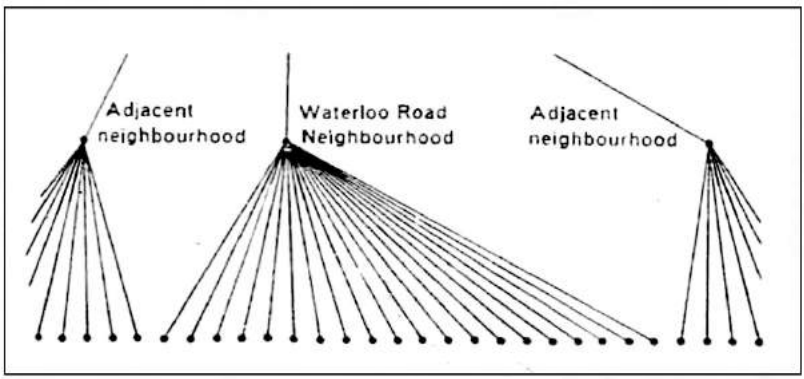


Figure 13

idea. There are times when the ecology of a situation actually demands the opposite. Imagine yourself coming out of a Fifth Avenue store: you have been shopping all afternoon; your arms are full of parcels; you need a drink; your wife is limping. Thank God for taxis!

Yet the urban taxi can function only because pedestrians and vehicles are not strictly separated. The cruising taxi needs a fast stream of traffic so that it can cover a large area to be sure of finding a passenger. The pedestrian needs to be able to hail the taxi from any point in the pedestrian world, and to be able to get out to any part of the pedestrian world to which he wants to go. The system which contains the taxicabs needs to overlap both the fast vehicular traffic system and the system of

pedestrian circulation. In Manhattan pedestrians and vehicles do share certain parts of the city, and the necessary overlap is guaranteed (Figure 14).

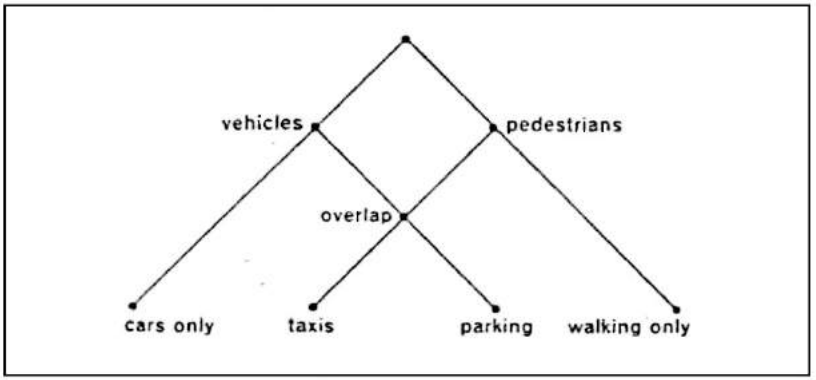


Figure 14

Another favourite concept of the CIAM theorists and others is the separation of recreation from everything else. This has crystallized in our real cities in the form of playgrounds. The playground, asphalted and fenced in, is nothing but a pictorial acknowledgment of the fact that 'play' exists as an isolated concept in our minds. It has nothing to do with the life of play itself. Few self-respecting children will even play in a playground.

Play itself, the play that children practise, goes on somewhere different every day. One day it may be indoors, another day in a friendly gas station, another day down by the river, another day in a derelict building, another day on a construction site which has been abandoned for the weekend. Each of these play activities, and the objects it requires, forms a system. It is not true that these systems exist in isolation, cut off from the other systems of the city. The different systems overlap one another, and they overlap many other systems besides. The units, the physical places recognized as play places, must do the same.

In a natural city this is what happens. Play takes place in a thousand places it fills the interstices of adult life. As they play, children become full of their surroundings. How can children become filled with their surroundings in a fenced enclosure! They cannot.

A similar kind of mistake occurs in trees like that of Goodman's Communitas or Soleri's Mesa City, which separate the university from the rest of the city. Again, this has actually been realized in the common American form of the isolated campus.

What is the reason for drawing a line in the city so that everything within the boundary is university, and everything outside is nonuniversity? It is conceptually clear. But does it correspond to the realities of university life? Certainly it is not the structure which occurs in nonartificial university cities.

Take Cambridge University, for instance. At certain points, Trinity Street is physically almost indistinguishable from Trinity College. One pedestrian crossover in the street is literally part of the college. The buildings on the street, though they contain stores and coffee shops and banks at ground level, contain undergraduates' rooms in their upper stories. In many cases the actual fabric of the street buildings melts into the fabric of the old college buildings so that one cannot be altered without the other.

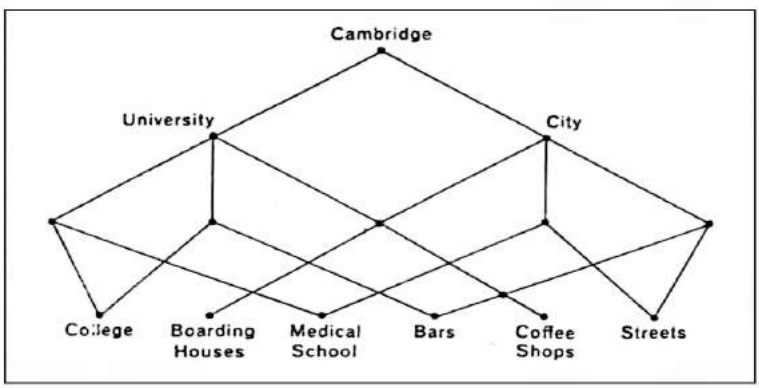


Figure 15

There will always be many systems of activity where university life and city life overlap: pub-crawling, coffee-drinking, the movies, walking from place to place. In some cases whole departments may be actively involved in the life of the city's inhabitants (the hospital-cum-medical school is an example). In Cambridge, a natural city where university and city have grown together gradually, the physical units overlap because they are the physical residues of city systems and university systems which overlap (Figure 15, previous page).

Let us look next at the hierarchy of urban cores realized in Brasilia, Chandigarh, the MARS plan for London and, most recently, in the Manhattan Lincoln Center, where various performing arts serving the population of greater New York have been gathered together to form just one core.

Does a concert hall ask to be next to an opera house? Can the two feed on one another? Will anybody ever visit them both, gluttonously, in a single evening, or even buy tickets from one after going to a performance in the other? In Vienna, London, Paris, each of the performing arts has found its own place, because all are not mixed randomly. Each has created its own familiar section of the city. In Manhattan itself, Carnegie Hall and the Metropolitan Opera House were not built side by side. Each found its own place, and now creates its own atmosphere. The influence of each overlaps the parts of the city which have been made unique to it.

The only reason that these functions have all been brought together in Lincoln Center is that the concept of performing art links them to one another.

But this tree, and the idea of a single hierarchy of urban cores which is its parent, do not illuminate the relations between art and city life. They are merely born of the mania every simple-minded person has for putting things with the same name into the same basket.

The total separation of work from housing, started by Tony Garnier in his industrial city, then incorporated in the 1929 Athens Charter, is now found in every artificial city and accepted everywhere where zoning is enforced. Is this a sound principle? It is easy to see how bad conditions at the beginning of the century prompted planners to try to get the dirty factories out of residential areas. But the separation misses a variety of systems which require, for their sustenance, little parts of both.

Jane Jacobs describes the growth of backyard industries in Brooklyn. A man who wants to start a small business needs space, which he is very likely to have in his own backyard. He also needs to establish connections with larger going enterprises and with their customers. This means that the system of backyard industry needs to belong to both the residential zone, and to the industrial zone – these zones need to overlap. In Brooklyn they do (Figure 16, below). In a city which is a tree, they don't.

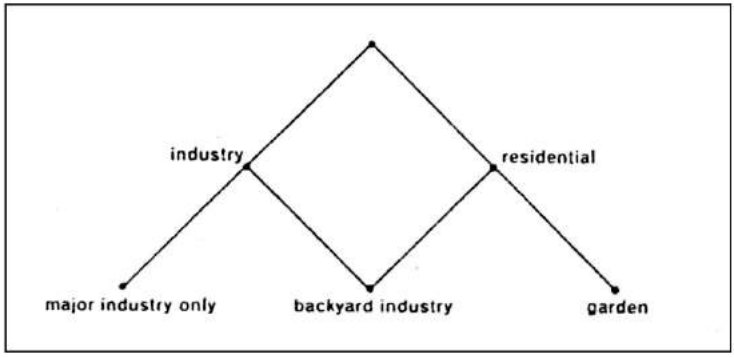


Figure 16

Finally, let us examine the subdivision of the city into isolated communities. As we have seen in the Abercrombie plan for London, this is itself a tree structure. The individual community in a greater city has no reality as a functioning unit. In London, as in any great city, almost no one manages to find work which suits him near his home. People in one community work in a factory which is very likely to be in another community.

There are, therefore, many hundreds of thousands of worker-workplace systems, each consisting of individuals plus the factory they work in, which cut across the boundaries defined by Abercrombie's tree. The existence of these units, and their overlapping nature, indicates that the living systems of London form a semilattice. Only in the planner's mind has it become a tree.

The fact that we have so far failed to give this any physical expression has a vital consequence. As things are, whenever the worker and his workplace belong to separately administered municipalities, the community which contains the workplace collects huge taxes and has relatively little on which to spend the tax revenue. The community where the worker lives, if it is mainly residential, collects only little in the way of taxes and yet has great additional burdens on its purse in the form of schools, hospitals, etc. Clearly, to resolve this inequity, the worker-workplace systems must be anchored in physically recognizable units of the city which can then be taxed.

It might be argued that, even though the individual communities of a great city have no functional significance in the lives of their inhabitants, they are still the most convenient administrative units, and should therefore be left in their present tree organization.

However, in the political complexity of a modern city, even this is suspect.

Edward Banfield, in his book *Political Influence*, gives a detailed account of the patterns of influence and control that have actually led to decisions in Chicago. He shows that, although the lines of administrative and executive control have a formal structure which is a tree, these formal chains of influence and authority are entirely overshadowed by the ad hoc lines of control which arise naturally as each new city problem presents itself. These ad hoc lines depend on who is interested in the matter, who has what at stake, who has what favours to trade with whom.

This second structure, which is informal, working within the framework of the first, is what really controls public action. It varies from week to week, even from hour to hour, as one problem replaces another. Nobody's sphere of influence is entirely under the control of any one superior; each person is under different influences as the problems change. Although the organization chart in the Mayor's office is a tree, the actual control and exercise of authority is semilattice-like.

The origin of tree-like thought

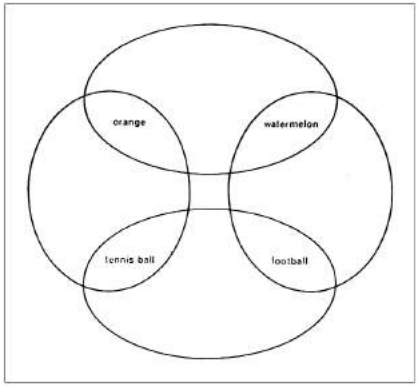
The tree - though so neat and beautiful as a mental device, though it offers such a simple and clear way of dividing a complex entity into units - does not describe correctly the actual structure of naturally occurring cities, and does not describe the structure of the cities which we need.

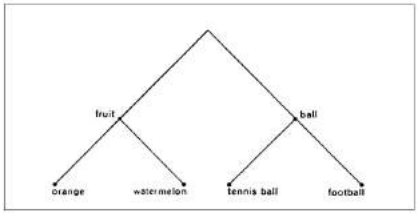
Now, why is it that so many designers have conceived cities as trees when the natural structure is in every case a semilattice? Have they done so deliberately, in the belief that a tree structure will serve the people of the city better? Or have they done it because they cannot help it, because they are trapped by a mental habit, perhaps even trapped by the way the mind works - because they cannot encompass the complexity of a semilattice in any convenient mental form, because the mind has an overwhelming predisposition to see trees wherever it looks and cannot escape the tree conception?

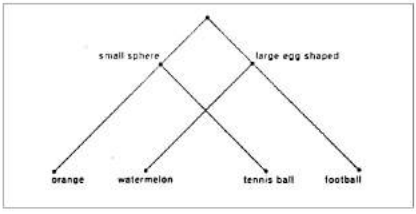
I shall try to convince you that it is for this second reason that trees are being proposed and built as cities - that is, because designers, limited as they must be by the capacity of the mind to form intuitively accessible structures, cannot achieve the complexity of the semilattice in a single mental act.

Let me begin with an example. Suppose I ask you to remember the following four objects: an orange, a watermelon, an American football,

and a tennis ball. How will you keep them in your mind, in your mind's eye? However you do it, you will do it by grouping them.







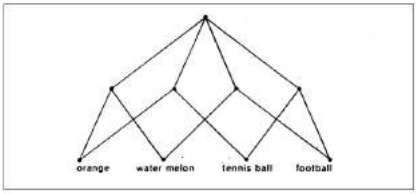


Figure 17

Some of you will take the two fruits together, the orange and the watermelon, and the two sports balls together, the football and the tennis ball. Those of you who tend to think in terms of physical shape may group them differently, taking the two small spheres together - the orange and the tennis ball and the two large and more egg-shaped objects – the watermelon and the football. Some of you will be aware of both.

Either grouping taken by itself is a tree structure. The two together are a semilattice (see Figure 17).

Now let us try and visualize these groupings in the mind's eye. I think you will find that you cannot visualize all four sets simultaneously – because they overlap. You can visualize one pair of sets and then the other, and you can alternate between the two pairs extremely fast, so that you may deceive yourself into thinking you

can visualize them all together. But in truth, you cannot conceive all four sets at once in a single mental act.

You cannot bring the semilattice structure into a visualizable form for a single mental act. In a single mental act you can only visualize a tree.

This is the problem we face as designers. While we are not, perhaps, necessarily occupied with the problem of total visualization in a single mental act, the principle is still the same. The tree is accessible mentally and easy to deal with. The semilattice is hard to keep before the mind's eye and therefore hard to deal with.

It is known today that grouping and categorization are among the most primitive psychological processes. Modern psychology treats thought as a process of fitting new situations into existing slots and pigeonholes in the mind. Just as you cannot put a physical thing into more than one physical pigeonhole at once, so, by analogy, the processes of thought prevent you from putting a mental construct into more than one mental category at once. Study of the origin of these processes suggests that they stem essentially from the organism's need to reduce the complexity of its environment by establishing barriers between the different events that it encounters.

It is for this reason - because the mind's first function is to reduce the ambiguity and overlap in a confusing situation and because, to this end, it is endowed with a basic intolerance for ambiguity - that structures like the city, which do require overlapping sets within them, are nevertheless persistently conceived as trees.

The same rigidity dogs even perception of physical patterns. In experiments by Huggins and myself at Harvard, we showed people patterns whose internal units overlapped, and found that they almost always invent a way of seeing the patterns as a tree - even when the semilattice view of the patterns would have helped them perform the task of experimentation which was before them.

The most startling proof that people tend to conceive even physical patterns as trees is found in some experiments of Sir Frederick Bartlett. He showed people a pattern for about a quarter of a second and then asked them to draw what they had seen. Many people, unable to grasp the full complexity of the pattern they had seen, simplified the patterns by cutting out the overlap.

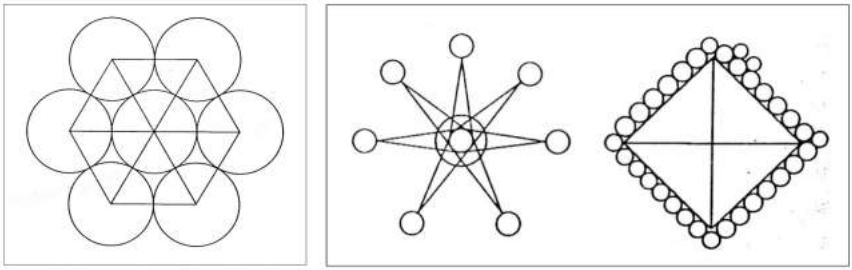


Figure 18

In Figure 18 (above), the original is shown at left, with two fairly typical re-drawn versions to the right. In the redrawn versions the circles are separated from the rest; the overlap between triangles and circles disappears.

These experiments suggest strongly that people have an underlying tendency, when faced by a complex organization, to reorganize it mentally in terms of non-overlapping units. The complexity of the semilattice is replaced by the simpler and more easily grasped tree form.

You are no doubt wondering by now what a city looks like which is a semilattice, but not a tree. I must confess that I cannot yet show you plans or sketches. It is not enough merely to make a demonstration of overlap – the overlap must be the right overlap. This is doubly important because it is so tempting to make plans in which overlap occurs for its own sake. This is essentially what the high- density 'life-

filled' city plans of recent years do. But overlap alone does not give structure. It can also give chaos. A garbage can is full of overlap. To have structure, you must have the right overlap, and this is for us almost certainly different from the old overlap which we observe in historic cities. As the relationships between functions change, so the systems which need to overlap in order to receive these relationships must also change. The recreation of old kinds of overlap will be inappropriate, and chaotic instead of structured.

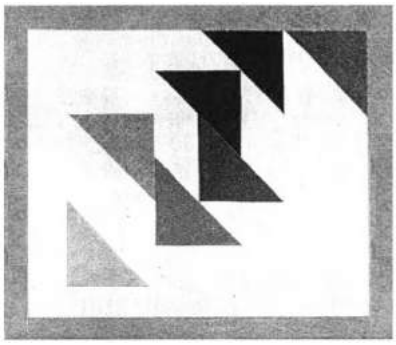


Figure 19a

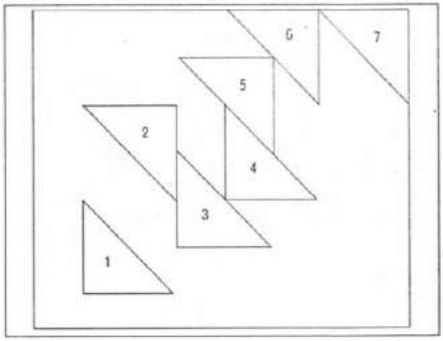


Figure 19b

One can perhaps make the physical consequences of overlap more com-prehensible by means of an image. The painting illustrated at left is a work by Simon Nicholson (Figure 19a). The fascination of this painting lies in the fact that, although constructed of rather few simple triangular elements, these elements unite in many different ways to form the large units of the painting - in such a way indeed that, if we make a complete inventory of the perceived units in the painting, we find that each triangle enters into four or five completely different kinds of unit, none contained in the others, yet all overlapping in that triangle.

Thus, if we number the triangles and pick out the sets of triangles which appear as strong visual units (Figure 19b, above), we get the semilattice shown in Figure 20 (below).

Triangles 3 and 5 form a unit because they work together as a rectangle; 2 and 4 because they form a parallelogram; 5 and 6 because they are both dark and pointing the same way; 6 and 7 because one is the ghost of the other shifted sideways; 4 and 7 because they are symmetrical with one another; 4 and 6 because they form another rectangle; 4 and 5 because they form a sort of Z; 2 and 3 because they form a rather thinner kind of Z; 1 and 7 because they are at opposite corners; 1 and 2 because they are a rectangle; 3 and 4 because they point the same way as 5 and 6, and form a sort of off-centre reflection; 3 and 6 because they enclose 4 and 5; 1 and S because they enclose 2, 3 and 4. I have only listed the units of two triangles. The larger units are even more complex. The white is more complex still and is not even included in the diagram because it is harder to be sure of its elementary pieces.

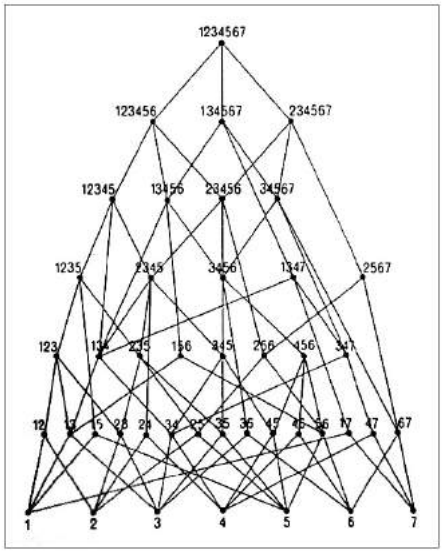


Figure 20

The painting is significant, not so much because it has overlap in it (many paintings have overlap in them), but rather because this painting has nothing else in it except overlap. It is only the fact of the overlap, and the resulting multiplicity of aspects which the forms present, that makes the painting fascinating. It seems almost as though the painter had made an explicit attempt, as I have done, to single out overlap as a vital generator of structure.

All the artificial cities I have described have the structure of a tree rather than the semilattice structure of the Nicholson painting. Yet it is the painting, and other images like it, which must be our vehicles for thought. And when we wish to be precise, the semilattice, being part of

a large branch of modern mathematics, is a powerfu1 way of exploring the structure of these images. It is the semilattice we must look for, not the tree.

When we think in terms of trees we are trading the humanity and richness of the living city for a conceptual simplicity which benefits only designers, planners, admini-strators and developers. Every time a piece of a city is torn out, and a tree made to replace the semilattice that was there before, the city takes a further step toward dissociation.

In any organized object, extreme compartmentalization and the dissociation of internal elements are the first signs of coming destruction. In a society, dissociation is anarchy. In a Person, dissociation is the mark of schizophrenia and impending suicide. An ominous example of city-wide dissociation is the separation of retired people from the rest of urban life, caused by the growth of desert cities for the old like Sun City, Arizona. This separation is only possible under the influence of treelike thought.

It not only takes from the young the company of those who have lived long, but worse, it causes the same rift inside each individual life. As you pass into Sun City, and into old age, your ties with your own past will be unacknowledged, and therefore broken. Your youth will no longer be alive in your old age - the two will be dissociated; your own life will be cut in two.

For the human mind, the tree is the easiest vehicle for complex thoughts. But the city is not, cannot and must not be a tree. The city is a receptacle for life. If the receptacle severs the overlap of the strands of life within it, because it is a tree, it will be like a bowl full of razor blades on edge, ready to cut up whatever is entrusted to it. In such a receptacle life will be cut to pieces. If we make cities which are trees, they will cut our life within to pieces.

II CONTEMPORARY COMMENTARIES

Chapter 2

Alexander's Challenge: Beyond Hierarchy In City Systems and Systems of Cities

Michael Batty[1]

It is very hard to really grasp the notion that any object can belong with the same importance to more than one set. As a species we seem destined to simplify the world by defining groups and categories that are aggregations of simple units, perhaps units that at one level are indivisible like ourselves. In our theorising about the biological world, we have imposed a hierarchy of classification from Linnaeus onwards that tries to neatly allocate the basic units that we define into relatively unambiguous categories and this principle of order still lies at the basis of modern science. In fact things are not so ordered in the social world, for our everyday experience makes obvious that we can belong to more than one social group and indeed the remarkable interest in network science in the last 20 years is testament to this notion that the groups we define overlap and interrelate. Yet our intuition provokes us to search for the simplest and least ambiguous groupings we can find, to minimise overlap and to this end, we tend to impose hierarchy on much of what we observe in the effort to make sense of the world. We remain uncomfortable with ambiguity.

One thing however does seem clear. The more abstract our thinking, particularly about how we achieve an understanding of the world ourselves, the harder it is to put our ideas into separate categories. The

[1] *Centre for Advanced Spatial Analysis (CASA), University College London (UCL), 90 Tottenham Court Road, London W1N 6TR m.batty@ucl.ac.uk www.complexity.info & t @jmichaelbatty*

very best examples of this involve the kinds of abstractions that are associated with structuring a series of tasks to solve a problem. There appear to be countless different ways of partition and grouping, and this is especially the case in software engineering. There is little guidance at all in writing software, how we should order the key concepts, whether or not they should be sequenced hierarchically, and this is made all the more problematic in the present day as everything can, in principle, be related to everything else in a completely networked world. This is the principle underlying hypertext of course where you can connect with anyone anywhere and trace links between one another almost indefinitely as one web link enables another in recursive fashion. In 1974, Ted Nelson in his hugely influential book *Computer Lib/Dream Machines* wrote: "Everything is deeply intertwingled. In an important sense there are no 'subjects' at all; there is only knowledge since the cross-connections among the myriad topics of this world simply cannot be divided up neatly.". In a later edition (Nelson, 1987), he said: "Hierarchical and sequential structures, especially popular since Gutenberg, are usually forced and artificial. Intertwingularity is not generally acknowledged – people think they can make things hierarchical, categorizable and sequential when they can't". In short, Nelson in exploiting Hegel's dictum that 'everything is connected to everything else', argued that putting things into categories is well-nigh impossible particularly in an ever more abstract world. And it is in terms of abstraction that we build our understanding of cities

Many people of course have said this many times before but in our own domain, it was Christopher Alexander (1965) who so brilliantly posed the question of how we might classify the components that make up our cities – neighbourhoods, primarily – in his notion that "A City is Not a Tree". One of the reasons why his argument was so resonant was due to the fact that at the time he was writing, systems approaches to architecture, planning and much of social science, not to say biology and some engineering, were being rapidly developed. The key notion was that systems were and are composed of subsystems that interrelate – as a network – but that many systems are organised hierarchically,

indeed that the building blocks of any system generate a hierarchy of levels as the system grows and evolves. In many mechanical systems which were used as exemplars, the idea that structure could be well-articulated in a hierarchy of subsystems became a kind of null hypothesis from which to explore its applicability to cities, societies, economies as well as biologies and related systems in the human and natural sciences. The notion that this hierarchy might not be strict, that the neatly nested order whose greatest natural exemplar is the 'tree', came as a shock and a revelation to those who were just getting used to the idea that cities might be understood as hierarchical in structure. Yet at the same time, what Alexander was saying was also intuitively very satisfying as our everyday experiences bore out the notion that the world of cities was in fact not a strict hierarchy. Alexander did not go as far as Nelson in saying that everything was intertwingled, impossible to produce as any form of hierarchy. He stopped well short of this, suggesting that the way a system might be ordered into its hierarchy of subsystems, sub-subsystems, and eventually component parts, might admit a form of tree-like structure whose branches overlapped like a lattice; in short, what he called a semilattice. All of this made perfect sense while showing that the top-down systems model of the world was not the ultimate explanation that most others were pursuing. Moreover both the idea of hierarchy and its weakening in terms of a lattice structure was consistent with the often quoted mantra of systems theory half a century ago that "the whole is more and greater than the sum of its parts".

Alexander challenged the idea of hierarchy in cities and city systems. The hierarchical model was in fact at the time deeply embedded as a construct around which neighbourhoods, cities and systems of cities were assumed to function. Many knew the limits of these constructs but they were a convenient fiction on which to begin. In the 1930s, the idea that cities were nested according to their functions and their sizes was developed by Christaller (1933) as central place theory, with bigger cities forming the hinterland in which smaller cities depended upon them for more specialised functions, this model being replicated over

many levels to form a hierarchy of cities as the basis for a system of cities. At about the same time, the notion that there was a sequence of cities with few big and many small came to be enshrined in Zipf's (1949) Law, a rank-size rule that in its purest form implied that the number and hierarchy of cities by size could be determined from a simple formula where the population of a city at rank in the hierarchy could be calculated from the formula where was the largest city in the system. If you start with say the largest city of say 10 million and compute a few terms in the series, then you get cities of 10m, 5m, 3.3m, 2.5m, 2m, and so on down the hierarchy. If we compare these to the biggest cities in the US with New York at about 10m, LA at 5m and Chicago at 3.3m and so on, then this casual comparison shows the power of Zipf's Law and the ascendency of the hierarchical idea. In fact a rather nice relaxation of Zipf's Law where cities do overlap, which is entirely consistent with Alexander's idea of the hierarchy being a semilattice, produces a set of city sizes in the US which is a good deal closer to what we might observe (Cristelli, Batty and Pietronero, 2012). This is Alexander's lesson from his paper: that the variety of interconnections in the world is such that overlap is necessary and inevitable – that is, it creates diversity which should not be taken as noise – and we can see this everywhere where the hierarchical idea is present. In fact Alexander was also making the point that badly designed cities did not admit diversity and if one were to impose the strict hierarchical model on the way neighbourhoods of cities were configured and related, this was a recipe for disaster as in many new towns and cities planned from the top down such as Brasilia. In other words, cities that evolved naturally from the bottom up inevitably generated variety and diversity that came from the overlap of social groups and communities. This, of course, is the essential message of complexity theory.

What is perhaps slightly curious about Alexander's 'A City is Not a Tree' paper was its timing. Alexander himself first wrote about a model for design in his PhD which suggested that the various components of design could always be linked as a network. He then argued that such a

network of components – or rather the elements that needed to be fashioned into a design – might be grouped into sub-problems. If the components were strongly linked in either a negative or positive sense meaning that in the design they either reinforce each other or contradict one another, they could be grouped according to this density of interaction, and then these should form the sub-problems that needed to be resolved first. In fact if a hierarchy based on the intensity of interactions with the most intense involving the smallest numbers of components in subsystems at the bottom of the hierarchy, could be formed, this would provide an order in which to resolve the sub-problems. The design would get easier to evolve as the designer proceeded sequentially to solve the sub-problems as s/he progressed to a final design following the order of the tree, from bottom to top. All of this was developed in his thesis which was published in 1964 as *Notes on the Synthesis of Form*, a wonderful, lucid book that had an enormous impact on architecture from the time it was published until now, a book that has outlasted the century and may well continue to outlast this one.

Alexander in fact suggested that the concept of the hierarchy or the design tree as he called it, provided a procedural structure for good design. To an extent, he did not and could not demonstrate that this protocol would generate better designs but his argument that good design in less self-conscious societies than our own did evolve from the bottom to the top, slowly and incrementally, provided a very convincing story. Alexander in many senses was way ahead of his time. He did in fact draw from much of what was going on in the development of systems theory citing one of the most influential papers on hierarchy ever written: Herbert A. Simon's (1962) 'Architecture of Complexity' which was yet another lucid statement of the importance of evolving designs for complex systems from the bottom up but according to a hierarchy. Indeed as I will recount below, the concept of hierarchy, notwithstanding Alexander, is enduring for many reasons and it is still a cornerstone in the complexity sciences.

But we are getting ahead of ourselves. What was rather odd about Alexander's argument that the structures we should deal with should be lattice-like and not strict hierarchies is that this was written just after his book had been published and was convincing us all that hierarchy was the way forward. In fact a careful reader, would have realised that his denial of the strict hierarchy and its generalisation as a semilattice was entirely consistent with his early thesis on design protocols and method. In fact it was rather easier to see how his method could be improved by considering overlapping subsystems in a hierarchy and how the networks which underlay such systems were proof in themselves of the difficulty of breaking the bonding into strict subsystems. I remember as a student working with methods for decomposing hierarchies as well as building them from the bottom up – from components of their graphs – and realising that semilattice like forms were a much more natural consequence of this style of thinking. Indeed I lay these kinds of structure bare in my recent book *The New Science of Cities* (Batty, 2013) and these remain consistent with systems that can be designed from the top down or evolved from the bottom up, that is with systems theory or its modern incarnation as complexity science.

When Alexander published his paper, several people reacted. An unusual paper with the title "Who Ever Said the City was a Tree?" was published by Mort and Eleanor Karp (1967) in the journal *Landscape* 20 months after Alexander's publication. This paper never referred explicitly to Alexander which is somewhat strange in that anyone reading it who did not know of the paper "A City is Not a Tree" would be somewhat mystified by what the Mort's were saying, at least in their title. In essence, their commentary was really a paper not about hierarchies but about morphologies. They essentially argued that cities could not be trees because their circulation systems were continuous and in fact, this reinforced what Alexander was saying which in effect was the idea that the networks which defined a city could not be simplified to the point where a strict hierarchical representation was

useful. In a sense, they anticipated the world of cities where the biological analogy is now dominant in saying that "A city and an organism are not identical, only analogous", although their comments that cities do not grow as biological systems do, adjusting their shape and mass as they get bigger does not accord with our contemporary thinking about urban allometry.

A decade or so after Alexander, the eminent graph theorist Frank Harary and his colleague James Rockey (1976) published a paper in *Environment and Planning A* called "A City is not a semilattice Either". In this, they objected to Alexander's use of the term semilattice arguing that what he was proposing was not the topological structure known formally as a semilattice; and they followed this up with a double whammy that the structures he called hierarchies were not trees either in formal graph-theoretic terms. These points are all contentious of course for it depends on the level of formality adopted. Their article however was more generous than it seemed because they also said that cities were considerably more complex than hierarchies or semilattices which is some respects was Alexander's point. In a third article (and this is the last I will single out from many), John Minett (1975) wrote a polemical response entitled "If the City is not a Tree, nor is it a System" arguing that as hierarchies are the essence of systems, then cities can hardly be systems: the implication is that they are more complex and to an extent this also reinforces Alexander's point.

In short, both Alexander and those who followed up his argument, all tended to agree that cities were eminently more complex structures than strict trees or hierarchies could ever represent in more abstract terms. Hierarchies with respect to how communities are defined and nested within one another are defined from networks of relationships between their elemental parts, with clusters (sub-systems) being identified at successive levels as groups of ever more intense interactions as one proceeds down the tree from top to bottom. In fact many conceptions of systems whose relations defining the interactions between their elemental components often do not require any simplification of their

structure through clustering. Models of such systems – and central place systems are the archetypal example in the geography of cities – define processes of exchange and interaction that take place directly on network links and in this way, the natural clustering of interactions is taken account of. Before such models were developed, central place systems were defined in terms of retail hinterlands at different levels using methods of defining breakpoints between clusters of nodes to define catchment areas associated with the patronage of and interaction with each of these places. However once spatial interaction modelling developed there was never any need to define hinterlands and their breakpoints for it was widely recognised that there could be flows from any place to any other and that defining a hierarchy of clusters from which hinterlands could be derived was a simplification too far. Instead, one could work the models directly on these networks.

This is the case for models of design akin to Alexander's (1964) approach where instead of defining design as the averaging of conflicts according to the hierarchy of interactions between the component parts, the averaging and resolution of conflicting factors relevant to solving the problem could be operated directly on the network. A host of models which resolve conflict and produce consensus through opinion pooling can thus be used to solve such problems directly (see Batty, 2013) and in this way the intricacies of the underlying network from which a hierarchy is merely a representational summary, are taken account of directly. There is thus no need for overlapping sets or lattice-like structures to define the problem as the network is operated upon directly. In fact network science which has emerged very rapidly in the last 20 years, is still stuck in the paradigm of simplification in that a major set of methods known collectively as community detection algorithms have been devised to extract hierarchies and partitions of networks into their densest parts which are assumed to reflect some underlying social grouping. In one sense, all the arguments advanced by Alexander for relaxing the strict hierarchy are still directly applicable to this modern practice (Lancichinetti and Fortunato, 2009).

To an extent, there are still many problems in spatial and city systems that require hierarchies to be extracted as summaries of clusters defining groups of elements in cities. Countless multivariate, data mining, neural net and evolutionary search processes yield strict hierarchies. Hierarchies are simplifications and like all simplifications, they are only useful for specific purposes. Denise Pumain (2006) in her edited collection entitled *Hierarchy in the Natural and Social Sciences* draws together many contributions that illustrate the important of hierarchies and their limits, particularly in city systems. Alexander (1965) in drawing attention to the limits of hierarchy and the need for thinking of neighbourhoods and communities as overlapping in cities, did not imply that the hierarchical idea was of no relevance but that in using it to understand cities, one should be wary of continuing on to use it to design cities. His argument was that if cities are designed as strict hierarchies, they lead to sterile neighbourhoods, divorced and separated from each other as in many British new towns and new capital cities such as Brasilia. Fifty years on from his path-breaking article, there is now recognition that the kind of complexity and diversity he was alluding to is an essential feature of urban living. We have rediscovered what Jane Jacobs (1961) was saying at much the same time as Alexander was writing and there is a conscious movement to steer clear of pattern book top-down recipes that introduce an artificial order into new developments. This is still a danger of course and in rapidly developing urban situations, there are still many examples of such top down use of the blunt instruments of strict hierarchy. Nevertheless the message that Alexander first promoted lives on in our embrace of complexity theory as the appropriate paradigm for understanding existing cities and designing future cities in the 21st century (Batty, 2005).

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Chapter 3

The Complexity of Cities and the Problem of Urban Design

Luís M.A. Bettencourt[1]

1. Introduction

"The purpose of a scientific view of architecture is to enable us to create deeper structure – and that means more satisfying design, more eternal forms, more valuable places, more beautiful buildings." - Christopher Alexander (2)

Seen from the distance of half a century Christopher Alexander's "A city is not a tree" (1) remains a landmark in our thinking about cities and design.

Superficially, its main achievement was to produce a systematic argument about what the city *is not*. In many ways this was a product of its time, a reaction against the modernist view of the "city as a machine" (3, 4). The logic and conceptual clarity of Alexander's argument and its lucid use of mathematical concepts in complex but real circumstances wins the day any day against the then prevailing forces in architecture, who saw the problem of the city as a technical issue of design to produce health, efficiency and order (5).

But the article is much more than that. It is a new beginning: The first step on a journey – for Alexander and for urbanism - to discover what the city really *is*. Its daring novelty is to place the problems of

[1] *Santa Fe Institute, 1399 Hyde Park Road, Santa Fe NM, 87501, USA. bettencourt@santafe.edu @BettencourtLuis*

architecture and urban planning on the same level of those in physics or biology and to seek answers using the scientific method, expressed in mathematical language (1, 2). This was new and radical, especially at a time when formal mathematical thinking, empiricism and the search for fundamental theory were shunned across many of the social sciences. By setting a new course for architecture, Alexander almost single-handedly placed its questions among the great mysteries of the universe and offered its perspectives as new starting points for scientific enquiry. Thus, "A city is not a tree" is the beginning of a unified science of cities and of a dialogue between the city as a natural phenomenon and other complex systems.

What this would require -- and the shape that it would take -- was only vaguely apparent in 1965. Alexander was, first and foremost interested in identifying necessary concepts and processes for a new theory of (urban) design (6, 7). This included the issue of mixing and overlap of urban functions in space, the importance of incremental adaptation and the need for multi-layered generative processes (8). In his own search for concepts and solutions, Alexander looked to other natural systems and – much like Jane Jacobs (9,10) –became one of the founders of the emerging science of complex systems.

In the following decades, architects have adopted methods and concepts from complex systems, while complex systems researchers started to approach the problem of the city as one of their key paradigms. Ever since, the study of cities has been fertile ground for both disciplines. As a result, a new scientific synthesis of diverse concepts and methods has now also emerged.

In this piece, I rethread some of Alexander's ideas in light of what we have learned since the publication of "A city is not a tree" about cities as complex systems. As any journey of discovery, mine too is personal and my thoughts will no doubt imperfectly relate to some of Alexander's original conceptions. I will focus on how several of the ideas in "A city is not a tree" have been immensely generative of

modern formal models of cities, and how such work has also come to embody ideas of information, economics, and sociology, among other disciplines. I will end with some of the remaining challenges for urban design as we continue to transform observations into syntheses and theory into practice not only in cities but also across several other related complex systems.

2. The Pursuit of a Science of Architecture and Design

The most important aspect of "A city is not a tree" is that it needed to make a point that was true, rigorous and general – it needed to make a scientific statement about the fundamental nature of all cities.

While urbanists are no strangers to grand conceptualizations, Alexander's approach was radical and new in that it used the methods of several established scientific disciplines (1, 6, 8) and – like Jane Jacobs' (9)– was rooted in extensive empirical observations of existing cities and their careful formal analysis.

Once Alexander showed how cities, like other natural systems, could be analyzed and described by scientific methods there was no going back.

Thus, "A city is not a tree" marks a point of no return because it shows that a science of cities that unifies observations and concepts from many disciplines can be constructed. This implied that a universal body of knowledge about all cities – past and present – could be built and brought to bear on the design of new places. And, most provocatively, it implied that such knowledge could be used to distinguish between bad design and good; "life-expanding" concepts from life-crushing master plans (4, 7, 9).

But, of course, there was a rub. In 1965, nobody knew how to create a science of cities true to this vision, let alone a practical approach to architecture and design able to create complex, evolving and vital urban spaces.

What followed was, by necessity, a search for general principles of cities and for a theory of design that could be true to their nature as complex adaptive systems. Alexander and collaborators played a crucial role in this search and construction, but the syntheses that would be needed was to be even wider and broader than he seems to have imagined. It would require knowledge that had been developing in parallel in architecture, sociology, economics, geography and social psychology along with methods from complex systems and from the natural sciences.

How then have our concepts for the general nature of cities changed over the last 50 years? We can trace this progress along many of the ideas Alexander started out with in the 1960s (6, 8). I single out three concepts, which I will focus on below: The problem of mixing and interactions in cities, the problem of open-ended urban design and the problem of evolution and adaptation of spatial forms to socioeconomic life and vice-versa. These three problems are clearly interconnected, but they also bring different perspectives on what the city *is*.

2.1 The Problem of Mixing

The concepts of mixing and of the networked structure of cities are the main focus of the arguments in "A city is not a tree". The problem is: How do the myriads of elements in a city – people, places, activities – interact with each other over built space? Do they do so in an organized and sequential manner? Or in a more haphazard, accidental, mutually overlapping way? How can we describe these different modes of organization mathematically and what are their consequences?

To synthesize his observations, Alexander used the mathematical language of sets and their organization and relationships in terms of graphs (1). Graphs are "networks" made up of nodes and the links that connect them, often known as edges (11). Graphs can map concrete physical objects, such as the network of streets or of pipes in a city, but

they may also be more abstract and account for social interactions or other relationships (12)[2].

Among all possible networks with a given number of nodes, the tree graph is the simplest (13). It is defined by the property that it has no cycles (loops). Because of this property, it also has the smallest number of connections that keep all elements in the graph linked. This apparent efficiency comes at a cost: to interact with each other distant nodes must go through a large number of other nodes, much like leaves of different branches of a tree can only "communicate" through the trunk. For this reason, tree graphs are models of hierarchal organizations.

The organization of a tree means that, in effect, interactions between nodes have no local recurrences or overlaps. The tree represents instead a gradual encapsulation of smaller sets into successively larger ones. For small local sets -- such as a place in the city, or a person -- to interact with each other they must do so through their mutual inclusion into larger sets. This is much like two factory workers in different divisions of a firm only being able to communicate via their CEO; Or two cells in an organism only sharing information through the circulatory system flowing through the heart. Thus, if a city is not a tree it is also not like a classical firm, or a multi-cellular biological organism.

So to describe a city in terms of more general networks one must go beyond tree graphs. In "A city is not a tree" Alexander proposed a semi-lattice as a graph structure that allows mutual inclusion between sets (1). This goes in the right direction qualitatively, but it is not particularly predictive. How much overlap may we expect? What are the consequences of such overlaps?

It turns out that much progress can be made by describing cities primarily as networks of socioeconomic interactions, embedded in

[2] *Alexander's goal was rather abstract (functional): he asks for example how people, a street corner, a newspaper stand and a traffic light on a Berkeley street intersection are connected.*

space and accounting for the cost-benefit tradeoffs that result in terms of rents and transportation (14). This builds on models of cities in geography and economics, due to von Thünen, Alonso and many others (15–17), but also goes beyond them by decentralizing space and emphasizing the primacy of social connections (14), as had been done by decades of urban sociology (18, 19).

That cities are, at their most essential, socioeconomic networks between people follows from considering what characteristics are conserved across the history of a city (20, 21) and places with very different levels of development (13): While infrastructure and economic activities, for example, change radically, the fact that people need to interact over space remains. These ideas instantiate Alexander's thinking in the more concrete sense that it is people who, through their movement and multiplicity of functions, create overlaps between places in the city. By looking at the city through the perspective of the trade-offs presented to individuals we can then derive the structure of overlaps that are possible in a city (14).

The key observation that follows from this "city as a network" approach is that cities are primarily sets of interactions. Because the number of edges in a graph can increase faster than the number of nodes and because the productivity of cities is set by the latter[3], cities can increase their socioeconomic productivity per capita the larger they are (12, 14, 22). This is a fundamental urban phenomenon known to economists as *increasing returns to scale* (23, 24). The increase in socioeconomic connectivity with city size is in turn the mechanism by which people can produce deeper divisions of labor and more knowledge, which creates the principal function of cities as places where new functions and new ideas tend to be created and translate into

[3] *This is a phenomenon known as Metcalfe's law. It states that the value of a network is proportional to its number of edges, not nodes. This idea was developed to describe telecommunication networks, and seems to be implicit in the reasoning for why "A city is not a tree".*

greater economic "value added" relevant within the city and as the basis of its relations to other urban areas (22).

These general properties of cities are derived from mathematical theory of interactions in the city that elaborate on Alexander's ideas of the *city as a graph that is not a tree* (14). Such networks relate people and their activities over built urban spaces, which are constrained to operate under the tradeoff between costs and benefits of living, interacting and moving in the city.

2.2 The Problem of Open-Ended Urban Design

Tree graphs may be appropriate models for "control and command" situations and as such are absurd models for a city. The tree limits the bottom-up, self-organizing information flows and economic interactions that create the city in the first place.

Thus, from the point of view of design, the tree sacrifices the functions of the city to the forms convenient to the designer (4, 7). It assumes that the city is infinitely malleable and can be organized in any (simple) way a designer sees fit. Modernist conceptions of the city went further to assume that the "city as a tree", built on industrial scales and emphasizing the circulation of people and goods using automobiles, would be *better* than cities of the past (3), which had developed gradually over centuries or even millennia of adaptation.

It is extraordinary to experience the consequences of the failure of such ideas first hand. I remember thinking about Alexander's arguments during a recent visit to Brasilia. I was staying in the "hotel sector" and was to have a meeting at the "bank sector". I was told that pharmacies were to be found only in the "pharmacy sector" across town, which in turn was some distance away from the "restaurant sector". Nevertheless, Brasilia has since its conception "as a tree" changed much. It is much more "mixed up", at least in terms of small businesses and services, and that is a good thing: It has adapted to being a real city

and become less like a tree. I was happy to find a busy new American-style mall by my hotel, which (in its own artificial way) contained most basic functions under the same roof.

So how does one design for cities that are not trees? The challenge is that while the tree is static, the city is dynamic; while the tree is unique, the city can exist in many spatial forms and configurations; and while the tree is well organized; the city will always be a work in progress.

To understand what kind of design may be appropriate for real cities Alexander turned to their history. The city that is not a tree is perhaps best summarized in one of Alexander's other memorable early titles: "The timeless way of building" (25). By looking at cities over longer periods of time, one could analyze their transformations, elaborations and adaptations to create spaces – like St Mark's Square in Venice or modern Tokyo – that work well.

This was not an entirely new idea: The earliest clear conceptualization of this evolving, complex system that is the city is perhaps to be found in Patrick Geddes' writings (26). Such ideas echo through the fringes of 20th century architecture in powerful voices such as Geddes (26, 27), Lewis Mumford (28), Jane Jacobs (9), Kevin Lynch (4) and others, and proliferated in our own time.

What is interesting about Alexander's approach was the intentional effort to distill principles of design from historic observations. He emphasized recursive, nested processes that create functional overlaps and meaningful articulations between elements - much like grammars in natural and computer languages. He also emphasized the type of multi-scale composition of networked elements that creates synergies between "wholes", their parts and elements beyond. As in natural languages or in music, such recursive, patterned compositions can always be extended, elaborated and sometimes simplified without loosing meaning, and thus provide a template for open-ended urban design (7, 8).

As a non-designer, it is hard for me to judge how useful such solutions are in practice and to what extent they transcend metaphors from other complex systems with desirable properties.

But there is much that have learnt over the last decades from analyzing urban data on how the built spaces of the city grow and adapt to the existing context of the city. These observations follow from natural, gradual processes of urban growth (by "natural design" as it were) without requiring a pre-set master plan[4]. They support the general observations of how cities operate, as described in "A city is not a tree".

The linkages between the structure of socioeconomic networks of the city, its built environment and their mutual co-evolution turn out to be the crucial elements for urban design. On large scales and over averages encompassing entire cities these are now reasonably well understood quantitatively. They relate and elaborate on older ideas of cities as spatial equilibria (bound states, in the language of physics), which form the basis of urban theory in geography and economics (14, 23).

As such we may have thought that, much like models of self-organization in other complex systems, cities would extent their build spaces as they grow based on purely local rules (29). This is only partially true. Understanding such rules reveals some of the mechanisms that maintain the character of the city as a coherent whole.

[4] *Master plans that are not excessively prescriptive are useful and may be positive elements in the development of real cities. An often-cited example is New York City's Commissioner's Plan of 1811. Though controversial because of its geometric monotony and artificial order, it opened up functional freedom as it did not set up strict land uses. Unlike the master plan for Brasilia with its strong assignment of functions in space, this provided spatial clarity of possible land uses and facilitated real estate transactions, while opening up a combinatorially large number of possibilities for social and economic development over space.*

In developed cities, new built places (buildings, public spaces) grow in tandem with their connecting infrastructure (streets, pipes, cables) (13, 14, 20). Quantitatively they take typical physical dimensions in tune with existing city density. This creates a density dependent growth process that is open-ended but that also relates every built element to the context of the city. A macroscopic consequence of these rules is that the built area of cities grows more slowly than its population size in a quantitatively predictable way. The area of the city also responds to increases in wealth and changes on the relative cost and speed of transportation, as it has been well-know to planners (14-17). These interconnections have curious consequences for the nature of the built environment of cities, such as that we can read the size of a city, its wealth and the speed of its social life from the three dimensional structure of its skyline, for example.

However, the problem that Alexander wanted to solve: how to create good urban design in detail, in specific places of the city, remains open, as relationships between places, people and functions within the city are not purely local. Interesting work on how to design public spaces has explored many of Alexander's ideas and new forms of gathering data (30, 31). The design of neighborhoods has also been inspired by many of the ideas in "A city is not a tree", specifically in "New Urbanism" designs that seek local mixed uses and modes of transportation (32). But the criticism to some of these approaches has been that they tend to re-create solutions that have worked in the past rather than create new city forms, based on fundamental new understanding of cities.

The greatest tests to our ability to understand and design cities will come from transformations already under way. Many cities in developed nations are (or will be) loosing population and ageing. They will require transforming their built forms and infrastructure to become desirable environments again. Most importantly, most developing cities have vast slum neighborhoods, which must change in ways that respect

existing socioeconomic networks without creating zones of exclusion or ghettos typical of many “solutions” of the past.

2.3 The Problem of Adaptation and Evolution in Cities

Connected to the problem of open-ended design is the issue of adaptation and evolution in cities. Understanding and creating good dynamical change in urban environments is perhaps the greatest challenge to urban science and design. The topic is important not only for architectural but also for policy. Much hope is currently being placed on the fact that more urban data may expand our ability to create radically better solutions to a host of urban problems (33).

The model of a city as a tree and its antithesis provide again important insights into the nature of the problem, several of which were discussed by Alexander in later publications (2).

The city as a tree is meant to be ideally organized and, as such, would stay the same forever as any change would be detrimental. It is unclear how the most important features of any real city: new people, business entrepreneurship, new technologies leading to improved services and infrastructure and human socioeconomic development fit into such a picture. It follows that any city that wishes to improve cannot be a tree.

But the problem is that once we stray away from the tree model many configurations of the city become possible. In fact, it can be shown that a combinatorially large number of possible designs is possible, larger than the number of particles in the universe (33). This makes discovering good designs by exhaustive search impossible in practice, doesn't matter how much data one may have.

This property of combinatorially large search spaces is common to most complex adaptive systems, such as living organisms (the space of all genomes), or brains (the space of all synaptic connections). Such systems change via processes of evolution and learning. These

processes are different in detail in distinct complex systems but rely on certain common mechanisms, such as accidental or proposed variation, and (de)amplification of (un)successful changes, via selection. In this way, complex systems can evolve and learn in open-ended ways by successively following small variations on already working designs.

In this light, the problem of change and adaptation in cities takes a very interesting meaning: by what mechanisms is variation produced in cities and how is it deemed successful and selected? Can this logic be intentionally used in the process of urban design?

The answer, I think, echoes processes at play in the history of any city and is clearly stated by Alexander many times, especially in his appreciation of vernacular architecture and planning as containing the elements necessary for more powerful and more systematic urban design.

The diversity and heterogeneity so typical of urban environments, but so absent in the tree, become a feature, not a bug (6, 22). The intentionality and agency of each person and socioeconomic organization to improve their own lot in the context of the city become a force for evolution and, in turn, also a source of selection. The dynamics of the overlaps and interactions between them become the elements along which the city not only exists but can also change and improve.

The result is a process of change and design that may seem, at first sight, to be more parochial, less ambitious and more gradual that a classical master plan. The power of such processes is to ensure a systematic sequence of improvements by staying close to solutions that already work for people in the city. But, by rendering such processes open-ended, a succession of modest steps can achieve arbitrarily large improvements.

In this picture, the role of the designer is to understand these processes of urban adaptation and evolution and to be able to propose and implement steps adequate to local environments that can create virtuous cycles of positive change by harnessing the natural dynamics of their city. To design in this way, requires the relentless study of real cities, inspired guesses for improvements, the humility to be found wrong, and great stamina. But the rewards over the long run are unlimited

3. Future Challenges: Design and Creation

"A City is Not a Tree" was written at a time of great need for cities. Concepts of what a city should be had been hijacked, particularly in the US during *urban renewal*, and in Europe during post-war reconstruction. Much of what happened to Detroit or Baltimore; Manchester or the poor outskirts of Paris and London was the result of wrong ideas about what a city is and how urban designers should intervene in times of crises.

Fifty years later, many of these issues recur globally, over a massively larger scale and with an unprecedented urgency (34).

How should Beijing or Mumbai be built to accommodate their growth and ensure their future economic prosperity and creativity? Should the slums of Jakarta or Lagos, or of countless other cities in Asia, Africa and Latin America, be razed to the ground and their people relocated, "urban renewal style"? Or should these neighborhoods be evolved and improved gradually and steadily? If the latter is the right answer, how to do it well, quickly and effectively?

The backdrop to these challenges is positive, on balance. The generative and creative potential of urban environments is now part of the lives of most people on Earth. Latin America has become an urban continent since "A city is not a tree" was written and Asia and Africa are now urbanizing at a fast pace, creating new forms of built environment and novel opportunities for their residents. New

technologies, in transportation and particularly in telecommunications, information and computing are making it possible to measure many aspects of the city in new ways, increasingly in real-time and affecting the choices and behaviors of billions of people. New energy technologies are starting to turn the tide on the destructive impact of urban lifestyles and, if used properly, could come to create a new synergistic relationship between human societies, their built environments and nature beyond our cities.

For all these reasons we now experience a new wave of change and, potentially, a latent new crisis for cities, reminiscent of that of the 1960s. Can we use our new powers of measurement and analysis to study and change cities in positive ways? Or are we destined to repeat the errors of building cities "as trees", only in new and more potent ways?

The lessons from "A city is not a tree" and the scientific and practical knowledge that accumulated in its wake over the last 50 years make me optimistic. We now understand, in quantitative and scientific ways much about the nature of cities at least in broad terms. We also understand the kind of design that can improve cities in gradual but limitless ways.

What we still lack is the finer understanding of how to best harness the natural processes of cities in each neighborhood, for each household, to recognize and amplify processes that generate prosperity, health, and creativity and distinguish them from often well-intentioned interventions that render the city disconnected, lifeless and poor. As we continue on our journey to understand and redesign cities in this way, we may finally meet the challenges posed in "A city is not a tree". We will discover much more about our own humanity and the nature of other complex systems in the process.

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Chapter 4

A Building Culture is Not a Tree

Howard Davis[1]

Author's note: When the editor of this volume suggested that this piece be included as a chapter, I initially resisted, since it does not deal explicitly with the issues of urban structure that were analyzed in "The City Is Not a Tree." But I then realized that there is, arguably, a strong analogy between a city of multiple and redundant connections, and a building culture, or building production process, in which multiple players, with diverse views and ways of working, coming at issues and problems from different points of view, together contribute to the success, robustness and beauty of the built environment.

This chapter is the text of a presentation delivered at the 2009 PUARL conference in Portland, Oregon. The presentation used a personal history—my long-time association with Christopher Alexander and my subsequent work—to make a point about the need for architectural practice and architectural theory to be open to differing ideas and approaches, even while respecting the very specific goals of a built environment of humanity and beauty. From one point of view the article is a criticism of overly doctrinaire interpretations of Alexander's work. Some of these interpretations insist on rigidly-defined procedures and techniques, or claim that contemporary architectural and urban practice are altogether incapable of producing built environments of quality and deep feeling. I reject many of those interpretations, while at the same time continue to be guided by the vision of a world that has a fundamental respect for basic humanity and the often-lost sensibilities of the human heart.

[1] *Professor of Architecture, University of Oregon; Co-director, Collaborative for Inclusive Urbanism*

The city and the building culture are metaphors for each other. When they are working well, they both act as networks rather than "trees," non-hierarchical, with redundancies of functions and players. My own experience, in which I moved from the intense and highly focused cauldron of Chris Alexander's Center for Environmental Structure into the much more messy "real world" of contemporary architectural education and practice, and in which I experienced the realities of contemporary buildings and cities, could have led to an irreconcilable conflict. But it is precisely the openness, the messiness, the diversity, the intellectual and professional opportunity that is lodged in our present building culture that provides the fertile ground for progress. In the same way that the city is not a tree, our present systems of building, and the accepted structures of architectural knowledge, may contain the material with which we can move toward a better built world. Not all of it is helpful—but it is also critical not to reject it out of hand.

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I'd like to talk about how the work I did with Chris Alexander affected my subsequent work and views on architecture—and about how that subsequent work affects my view of the work I did with Chris. I worked with Chris beginning as a student, when we did a planning project for Berkeley neighborhoods, and then continuing for several years afterwards when the major projects were a housing project in Mexico, a book about that project (*The Production of Houses*), a planning project in Omaha, a housing project in Israel, and various smaller projects in California. It was also during this period that I began to teach, beginning with a year when I took over Chris's courses when he was on sabbatical, continuing with a remarkable year-long project for San Francisco (subsequently published as *A New Theory of Urban Design*)—and then teaching with Ray Lifchez before I finally left Berkeley and moved to Texas.

Those were formative years for me. They helped to solidify a number of ideas, including perhaps most significantly the power of reality in

shared decision-making about buildings, and the importance of process in the production of the built environment. When I left Berkeley I brought along a way of thinking and working that was coherent and useful. But I was bringing it into an academic world and a professional world that also demanded respect by themselves.

My own stance has evolved to one in which the work I did with Chris remains central—but within a viewpoint from which I don't see the world in black and white terms, but much more in shades of gray. This is a viewpoint from which I see value in many buildings and many aspects of the profession to which I once had serious objections. This may sound contradictory—but I think that progress will be made by working within and through those contradictions. The fundamental goal that Chris set —to figure out how to develop a way of building that results in an architecture and urbanism of deep humanity—remains central, along with many of his conclusions. But many people with the same goals are working in ways that need to be seen as compatible, within a shared building culture.

One of the reasons I studied architecture in the first place came out of a fascination with New York City. My view of the city was one that came from the bottom up, whether it was exploring the basement of the three story apartment house in Brooklyn that I grew up in, or accompanying my father on his visits to jobs rewiring restaurant kitchens or factory lofts or apartment-house basements. My view of the city was not only a view of its vernacular buildings, but also one in which I developed a down-home respect for the people who built it. It was only much later that I started looking at monumental buildings with the same interest that I was looking at the ordinary everyday building.

This was the history that I brought to Berkeley when I finally decided to study architecture, and that along with my physics background made me an ideal candidate to be attracted to an empiricist like Chris Alexander, who was also deeply affected by his own childhood

environment in Oxford and Chichester. My first course on the pattern language was from Max Jacobson—this was about four years before the book was published—and in that course I began to see the possibility of two ideas:

- first, the idea that architectural knowledge might be commonly shared and improved
- and second, the idea that shared architectural knowledge might be applied toward the support of everyday life, considered most simply and most straightforwardly

That sounds easy enough.

The project in Mexicali was something of a turning point for me. Even in school I was interested in what later became my book on building cultures, and I took a seminar from Spiro Kostof on the history of the architectural profession in which I wrote something about the idea that the architect is only one of many influences in the production of the built environment. Kostof had a series of visiting lecturers in that seminar, and turned those lectures into a book that I later referred to in my own research on building cultures.

In Mexicali, we were working to develop a new system of housing production, that would include new ways of design, of construction, of financing, of zoning, of participation. But of course, our innovations were happening within the existing building culture of Mexicali, in which there were *already* ways of design, of construction, of financing, of zoning and of participation. The only way we could do what we were doing, which was in opposition to most established standards and procedures, was through the direct authority of the governor of the state of Baja California, who himself saw a political advantage in supporting the work of a notable architect from abroad, and who forced various agencies that were under his control to suspend their rules for our project.

So our project was surrounded by but in direct opposition to the existing building culture. The project itself has been analyzed by Peter Bosselmann and others. There were two small ripples beyond the project, into the local building culture. A few concrete vaults were built in the immediate neighborhood, and a local block manufacturer began to manufacture a simplified version of our interlocking blocks, using a standard concrete mix instead of our soil-cement concoction.

So Mexicali was not only about the production of low-cost houses. One of the things I've often said about that project is that if we had more understanding and respect for the local building culture, and introduced innovations much more gradually in the context of it, we might still be building houses there, or an outgrowth of the project would still be in place.

The Culture of Building is a book that I began thinking about soon after Mexicali. My original title was *The Culture of Buildings*, and Chris suggested changing it to *The Culture of Building*—properly so, and helping to ensure that the work would reflect our common interest in the importance of process. It did take another twenty years, however, to write the book.

The book is strongly connected to the pattern language work in a number of ways.

One is the emphasis on process itself, and the idea that we ultimately can't make wholesale improvement in the shape of the built environment without changing the underlying processes in the way things get done. Where I differ somewhat from Chris about this, is in identifying the sources of these changes. In my concluding chapter, "Cracks in the concrete pavement," I argue that architects, planners, clients, and builders all over the place – even people who never heard the name of Chris Alexander or the words "pattern language"—are doing innovative things that may have a positive long-term effect, and

their initiatives and efforts need to be nurtured and watered, like flowers growing through those cracks.

Another is a recognition that historical processes involved a very different relationship between the architect and builder from what often exist today.

The Metropolitan Club's building (in New York) was designed by one of the most important Beaux-Arts architecture firms. The Beaux-Arts was of course the antithesis of Arts and Crafts, and in it one might not expect that much of a dynamic relationship existed between the different players in the building process. Yet in combing through about 6000 documents regarding the construction of this building, I found a different story. When the building was first being set out on the ground, for example, a temporary platform was erected on the site so the clients could adjust the height of the ground floor, which contained the main public lounge, in relationship to the view of Central Park. Other documents of this building and others of the firm show very rough sketches of details being provided to fabricators, because control of the final form of the detail lay with the craftsmen.

Practice in the late nineteenth century is near the end of the time when design and building were part of one integrated process. In Renaissance Florence, the architect was in the middle of the hierarchy of organization of a construction site, with the *soprastante*, or site supervisor, at the top. In the book I documented this change more precisely by looking at the evidence of building contracts in London. In the late seventeenth century legally-binding contracts might have been half a page long and included minimal drawings and specifications; by the late nineteenth century contracts would have been many pages long and included detailed drawings and specifications. The gradual change over two hundred years, in which implicit understandings were replaced by explicit contract statements, mirrored the emergence of a building culture that was characterized by the emergence of the separate institutions of architecture and general contracting, all

supported of course by more and more lawyers. And this was accompanied by new regulatory mechanisms, in which common law doctrine was eventually supplanted by explicit and numerically-based statute.

And third, is the idea of a healthy building culture. With this idea I tried to generalize from Chris's insistence that the architect and the builder necessarily had to be the same person, and postulate some general features of a building culture that produces good results. This all represents an extension of the pattern-language ideas about process, judgment based on on-the-ground reality, and the proper sequence of things in design and construction. And within these ideas there are a lot of things happening in the contemporary building culture, coming from different places, that are promising. These include so called "integrated practice," advanced visualization and modeling techniques, and new concerns about urban and social sustainability.

In the course of writing this book I worked on a few projects that were helpful in one way or another. This included work I did with David Week in south India. In this project we developed a pattern language based on local villages, informal settlements and the old part of the city of Vellore; worked with community leaders to lay out the site; and worked with families to lay out their own houses on the ground. They were small, simple houses, in which tiny decisions like the exact position of a door or window had a lot of impact. David brought his Powerbook 160 to India—to local building officials in the early 1990s that was like a flying saucer landing—and this project was probably the first in south Asia to use digital graphics programs in conjunction with on-site layout procedures.

For me one of the values of the project was the collaboration I had with David, who was writing his PhD dissertation at the time. We wrote several papers that were really about the transfer of expertise and knowledge, and about the idea that foreign aid needs to be a two-way street. An extreme position is that taken by organizations that are

skeptical of ANY kind of outside professional expertise, seeing knowledge as needing to develop from within the community itself.

I'm talking in detail about this because it underscores the very delicate position in which the pattern language work may find itself, and has found itself in a variety of projects. On one hand the patterns and the techniques that go along with them should be liberating. They are after all resolutions to conflicts in the environment, and expressions of what people may think when image and prejudice are stripped away. But on the other the process of identifying a valid pattern, the process of ensuring agreement among a diverse group, and the need to go only so far and no more with a process within an established culture, are all critical. At the end of a chapter on architectural education that I wrote for a book about vernacular architecture, I wrote about the importance of separating expertise from power. Communities and their cultures deserve total respect at the same time new ideas are introduced.

I'll briefly mention another project that reminded me of the importance of acting with this respect, and of the pleasures of working in this way. Along with John Rowell and Don Corner, I worked on a pattern language for a Benedictine abbey and monastery about forty miles south of here. This place is known among architects as the site of one of the two buildings in this country designed by Alvar Aalto. But it is also an abbey with a hundred and thirty-year history, with a mother house in Switzerland, with ninety monks and two hundred seminarians, on a beautiful hilltop site in the Willamette Valley, and with a community that can trace itself back to St Benedict and his Rule, in the fifth century. In other words, a place with a deeply-felt culture that is lived and contemplated every day.

We worked closely with the monks, and one of them, Father Jeremy, is also a published poet with wonderful insights about life in the Abbey. I felt privileged to be a frequent guest in their community, and we found that this is not a quick process—our own insights came as much from

the time we spent there as from the questions we asked. We read the Rule of St Benedict, which talks a lot about daily life and the conduct of hospitality, and with the help of the monks we interpreted the Rule in terms of the settings of the Hilltop and the way people live on it. The pattern language contributed to ongoing building projects at the Abbey, but its real value may have been what it taught the monks and what it taught us. The monks became aware of their own place in a way that they had not done before, and I had the pleasure of talking to people about their houses and how they live in them.

Talking to people about their own houses is an activity—whether I'm doing it at Mount Angel or in a shophouse in Bangkok—I always find real, energizing and humbling. And it always brings me back to a central value of the pattern language approach, that many architects often forget, and that is the reality and value of people's lives and the importance of the buildings in which they live them.

My current book*, Living Over the Store: Architecture and Local Urban Life*, which is now in press, is in one sense the story of a single pattern. It is not an explicit pattern in APL, but the idea is mentioned or strongly implied in one or two of the patterns in that book, including CORNER GROCERY and INDIVIDUALLY-OWNED SHOPS. *Living Over the Store* is not so much about process but more about the structure of the urban environment. It owes a lot to Chris but perhaps even more to Jane Jacobs, and is intended to combine an historical and cross-cultural understanding with many modern and contemporary initiatives that are themselves reinstalling this idea in practice.

The book has four features:

First, it takes seriously the importance of everyday life, in its economic and social aspects. This everyday life is supported both inside these buildings and on the street, so that buildings in which independent families live and work, are aspects of the same phenomenon as buildings in which the same family lives and works.

Second, it identifies common architectural and urban ways in which everyday life is manifested across different cultures and through history. All these buildings give emphasis to the commercial frontage and maintain strategies for the privacy of domestic life at the same time. All of these urban districts, some irregular and some grid-like put shop/houses in positions in between all-residential streets and much busier streets, where they funnel pedestrian traffic toward much busier places.

Third, it questions the modern boundaries between functions, in both buildings and cities, and sees those boundaries as dynamic over time. Within shop/houses, there is often a fluid relationship between functions, as there is in these buildings in Bangkok, one a photo studio and one a tailor shop. In both of them domestic life and economic life strongly overlap. That is also seen on this sidewalk in Guangzhou and inside this shophouse in Taiwan.

And fourth, it respects different contemporary projects, ranging from single proprietors to developers to grassroots efforts, to changes to the building culture that might allow these buildings to happen on a large scale again in this country. My examples range from slum replacement projects in Bangkok and Port Elizabeth, South Africa, to building on greenfield sites in the US, to an elegant mixed-use building in Berlin. I also write about different strategies for financing and for zoning for new mixed use—not only form-based zoning but also straightforward changes to standard Euclidean codes.

So even though the pattern LIVING OVER THE STORE is a simple idea, it suggests a complex web of disciplinary sources ranging from social history to urban geography and an equally complex web of professionals ranging from community groups in Bangkok to architects in Germany. Within a world that is as diverse as ours, these all have to be taken seriously, and have to be respected for their intentions, within their own orbits, to reinforce the practice of urban diversity.

I'd like to conclude by saying that the diversity of my interests is supported by my connection to five academic and professional communities. These have influenced my views and combined with the school of thought that came out of my work with Chris and the Center. I see all of these communities as strongly connected with the pattern language work, and have helped me take that work out of its academic and professional marginalization.

1. First is the community of scholars who study vernacular architecture. This community has helped advance some critical connections, such as the social forces in their influence on architectural history, the strong relationship between vernacular buildings and those designed by architects, and the idea that buildings cannot be separated from their cultural contexts. Scholars in vernacular architecture understand that as a collective phenomenon, the vernacular is made up of buildings with repeating characteristics – these characteristics are usually described as types rather than patterns – and that they are shared within a culture, like patterns are.

2. Second is the community of people who study urban history and urban form. These scholars deal with the morphology and spatial structure of cities, and relate urban form not only to cultural ideas but also to the economics of production and exchange.

They have mapped towns and cities on a parcel-by-parcel basis and have found confirmation not only of the intuitive idea that the complexity of cities is made up of a relatively few repeating configurational ideas, but also of variations in urban form that point to a structure of centers, and to the idea that the piecemeal growth of cities is connected strongly to economic and social conditions.

3. Third, is the community of people who are working on housing and urban issues in the third world. I've already talked about this a little. I would just reiterate that there is a lot to learn about the ideals

of participation, about coherent piecemeal growth, and about the sensitivity of community needs from both good and bad experiences in world cities that are experiencing very rapid urbanization.

4. Fourth is the architectural profession, and particularly those architects in the last eighty years or so who have resisted the homogenizing and abstracting tendencies of modernism. The architectural profession is not necessarily at odds with an architecture that is humane and that can elevate the human spirit in a profound way. The worst examples—and there are many of them—are not the *only* examples. The sensitive and humane work moves me into a position in which I believe there must be an accommodation between theoretical precision and the messy realities of our contemporary cultures of architecture and building. And that accommodation is not an unfortunate compromise, but may itself serve to modify the theory.

5. And finally is the Department of Architecture at the University of Oregon. The department has a reputation for being hospitable to the pattern language approach, and indeed it is. But by the time I came to teach here in 1986, it was no longer central. At the same time however, many of the people on the faculty who I respected a lot—even though they might not have embraced the idea of the pattern language with wholehearted enthusiasm (and that is an understatement)—were teaching principles that were absolutely consistent with it, and having their students design buildings that were beautiful and contextual. As a faculty we tend to agree more about buildings than about the curriculum. Oregon has been another force in my career that has caused me to look outward, from my roots in Etna Street (site of the office of the Center for Environmental Structure when I worked for it) and Mexicali and the eighth floor of Wurster Hall in Berkeley.

Within my worldview the pattern language work has a critical and central role. The idea that the built world is important, the idea that

buildings can move us deeply, the idea of generative processes in the formation of the built environment, the idea that we may share not only knowledge but value—all of those things continue to shape my thinking and my teaching.

At the same time I am part of a world in which people have their own realities that I did not form, but which I need to deeply respect. The contemporary built environment needs a lot of help, but at the same time the answers are and have to be all around us. What I'm interested in is a building culture that is resilient and that welcomes good ideas no matter what their provenance.

A long time ago, Chris Alexander wrote a highly influential article on city planning, "A city is not a tree," in which he argued that a healthy modern city, instead of being organized in a way that has an overall hierarchical order, like a tree, is organized instead in the form of a semilattice. This allows for fluidity of associations, for resilience, and for overlaps between social groups and physical places to have a meaning that corresponds to the realities of modern life. It also means that the health of the city is not measured by the health of any one person, or place, but by how all of it is working together, within a framework of mutual respect.

And I would paraphrase the title of the article, by saying that

"A building culture is not a tree."

Chapter 5

A City is a World Full of Bodies

Jaap Dawson[1]

We long for a world full of bodies we can meet

It's a ten-minute walk from my house to the new train station in Delft, the town I've lived in since 1980. The main street leading to the station has been broken up for more than five years in order to make a tunnel for the trains to ride through. The new station is now underground, but above it there's a massive structure that the people in Delft have baptised 'the Ice Block'. It's the newest of several office blocks for city bureaucrats.

The Ice Block is not an ice cube: it's an ice block. It's like the huge, abstract block of ice we bought when I was a boy after a hurricane in Miami. The power lines were down for at least a week. Only the ice company – apparently with its own source of power – was still capable of making ice. The ice block helped us survive the storm.

We never imagined what it would be like to live inside an ice block. Nor did we ever suspect that ice blocks could grow as large as the eggplant that ate Chicago (GREENBAUM, 1967).

As I approach the colossal ice block, I find myself reflecting on the essay I'd just written on the work of Christopher Alexander. 'Forget the essay,' I heard a voice inside me say. 'Start with the building, the

[1] *Faculty of Architecture, Delft University of Technology, NL (Retired)*

world you experience now. Let your experience direct you in your reflection on Alexander's discoveries.'

The voice is compelling. So is my experience of the Ice Block. And then it starts to rain. I take refuge under the overhang that announces the entrance to the station. I'm glad it shelters me. But does it really shelter me? It keeps me dry, but it doesn't protect me, doesn't welcome me, doesn't relate to my body.

Fig. 1 Entrance to the station in Delft

We can recognize bodies in what we build

Relate to my body? What do I mean by that? If you relate to someone, you have a relationship with another person. You're connected not only as two people, but also as two bodies. And both bodies are living bodies. When you relate, you're alive. When you're related to, you know you're alive.

When I stand under the overhang at the entrance to the Ice Block, I don't feel the presence of a body. I mean a built body, a massive piece of material I can recognize as a body like my own body. Under the overhang I only feel literal dryness. Under the overhang I only meet abstract space. The overhang literally hangs over the space. There is no visual means of support that might define the entrance to the station, that might create the space I walk through, that might greet me as built bodies whom I could relate to as living bodies.

Alexander's Fifteen Properties are all properties of a living body

The entrance to the station in Delft is only one of countless spaces we can't experience as alive, as living. Both terms are descriptions Alexander uses to describe buildings, spaces, and designs that touch us deeply. Alexander uses the terms too when he tells us about the Fifteen Properties he finds present in architecture that really lives.

It would be easy to dismiss a living architecture as a romantic metaphor. That's probably what critics of Alexander's work do. But I'm not satisfied with such a cynical interpretation. I'm convinced we can ground what a living architecture is. Our bodies and our consciousness enable us to do so.

Look again at the marvellous vignette drawings that depict the Fifteen Properties. They all have something in common. The have clear centres and definite boundaries. They demarcate an inside from an outside. They embody a structure similar or analogous to the structure of all living cells. The patterns that comprise the Fifteen Properties are in essence patterns that living cells share with each other, that living bodies share with each other. The connection between a description of something that lives and a body that lives is unmistakable.

And then there's the actual body that lives. It's our body that feels unprotected in the undefined space at the entry to the station in Delft.

If we're preoccupied with sheltering ourselves from the rain or with catching a train on time, we may not always be conscious about how our body feels in such a space. But feel it we do, unless we've become alienated from our own body and feeling.

We feel alienated in an undefined space – a huge square so big we have no massive elements to relate to. We feel alienated when we try to cross a too-broad street: instead of feeling the boundaries of the space, we have to think about them, have to focus expressly on where the traffic is coming from. We feel alienated in a large auditorium or church that lacks columns or wall segments to suggest a space our body naturally feels at home in.

We recognize a living body in a column

Columns are bodies. Without thinking about it, we made bodies of the first columns we built. George Hersey reminds us of our history. The entire history of architecture gives us columns we experience as bodies (HERSEY, 1988). Joseph Rykwert wrote a whole book about how we meet bodies in the columns we experience (RYKWERT, 1996). And Geoffrey Scott, nearly a century before Rykwert, reached a similar conclusion: We feel at home in spaces that columns make between themselves and between rows of themselves. We recognize a body – our own body – in a column of the right scale (SCOTT, 1914).

When we see ourselves, our bodies, in a built body, we obviously are experiencing an analogy. But we're not experiencing an analogy only in a cognitive way. We're feeling the presence of built material that touches us as living material. And if we're surrounded by bodies we experience as alive, then we inhabit a world not of mere things but of living beings. Our world is animated: after all, the bodies have souls!

We can build in a way that keeps us from experiencing the analogy of our body with a built body

Our experience of the world as animated is far older than our experience of the world as a machine. In the Preface and Chapter One of *The Phenomenon of Life* (ALEXANDER, 2002) Alexander reminds us how our view of the world and of life has led us away from a way of building that previously came automatically to us. Once we start to believe that the world is a well-oiled machine rather than a living organism, we suppress our experience of analogy when we design and build. And when we suppress our experience of analogy in a timeless way of building, we're in effect suppressing a belief. I don't mean a belief in the sense of received doctrine: I mean belief in the sense of meaning, of a meaning that infuses us and guides us and helps us make sense of life.

The new belief – and a belief it surely is – comes with its own doctrine: We make the world we build in order to feel physically comfortable in it. The world is a thing, and we are the designers. The world serves our physical needs.

You can find a remarkably clear presentation of the new doctrine in the CIAM declaration at La Sarraz in 1928. The architects who signed the declaration mistrusted our experience of analogy in the images we experience. Their ideology led them to conceive of town planning solely as 'the organization of the functions of collective life' (WOUD, 1991, 210). Their vision continued at the scale of the building: the signers aimed at 'replacing architecture on its true plane, the economic, and sociological plane' (CIAM's, 2011). Where are the images – the analogies – in a vision based on use alone?

You can't help seeing in this vision the tenets of a newly established church. When, you wonder, might we rebel? When, you ask yourself, might we leave this church?

Our body gives us the answer. Our animated body gives us the answer. Once we've experienced spaces and buildings that are alive, that are animated, we now know they're animated because they embody a

structure like the structure of our own animated body. We're not playing with a cognitive metaphor. We're not looking at a world that reminds us of a better world. We're living among built bodies. The bodies protect us from an endless world outside the space we inhabit. The bodies greet us as elements we experience as living. The bodies are comprised of cells, and cells have centres and boundaries.

We can build a living world by following our feeling and intuition

Once we've left the church that told us our world was but a thing and what we built was but a thing, where do we go next? How do we learn again how to build a world that literally lives?

Alexander doesn't tell us. At least he doesn't give us a recipe. He challenges us to experiment. He hopes we'll bear the Fifteen Properties in mind as we build. He reminds us that we discover how to build just by building. We can make full-scale models as we build, discovering along the way whether they greet us as living beings or not. That's the way I've built and rebuilt my own house. I didn't start consciously with the Fifteen Properties as though they were a recipe. I just tried various arrangements and configurations till they felt right. Only then did I see the Fifteen Properties in them.

Why did the Fifteen Properties appear in what I built?

I think they appeared because I let myself listen to my body. That's not something I did consciously. I just tried various designs and arrangements till they felt good in and for my body. And when I looked at them as though I had seen them for the first time, I recognized compositions we could call classical.

Demetri Porphyrios reminds us that 'Classicism Is Not a Style' (PORPHYRIOS, 1982). It's an attitude – an attitude that enables us to build a world we experience as alive. We experience it as alive because the patterns and structures we build reflect the patterns and structures of

life – in short, the Fifteen Properties. We build centres with protecting boundaries. We tell tectonic tales. We differentiate between outside and inside. We connect with the ground. We specify a hat above the body we've built.

We can build a living world by embodying the classical attitude

One clear route to a built world we experience as alive is the route the classical attitude has shown us. We can follow classical examples, be they ancient or contemporary. They are indeed a recipe. And why should we not see if the recipe appeals to us, fulfils us?

The neighbourhood centre that Javier Cenicacelaya built (below) is a timeless example of the classical recipe. It embodies all the Fifteen Properties. We experience it as friendly, as known before we knew it. Its spatial cells cradle our body. In the increments of space we walk through, we meet built bodies. They are alive, just as we are. They define the measures of space that comprise the whole building. Just like our own body, the building could have been built thousands of years ago, yesterday, today, tomorrow, or thousands of years hence.

We can build a living world by attending to boundaries and centres

But how shall we build if we're not entirely reconnected with our built-in tendency to build a world that reflects our own bodily and animated structure?

If we're still members of the architectural church that tells us we should think and control before we build, that we should build spaces that allow us to function as though we ourselves were machines, how might we liberate ourselves and our world?

One way might be the route the Dutch monk Hans van der Laan followed in his search for built spaces that we could experience with our body. Van der Laan played with spaces and their boundaries. He

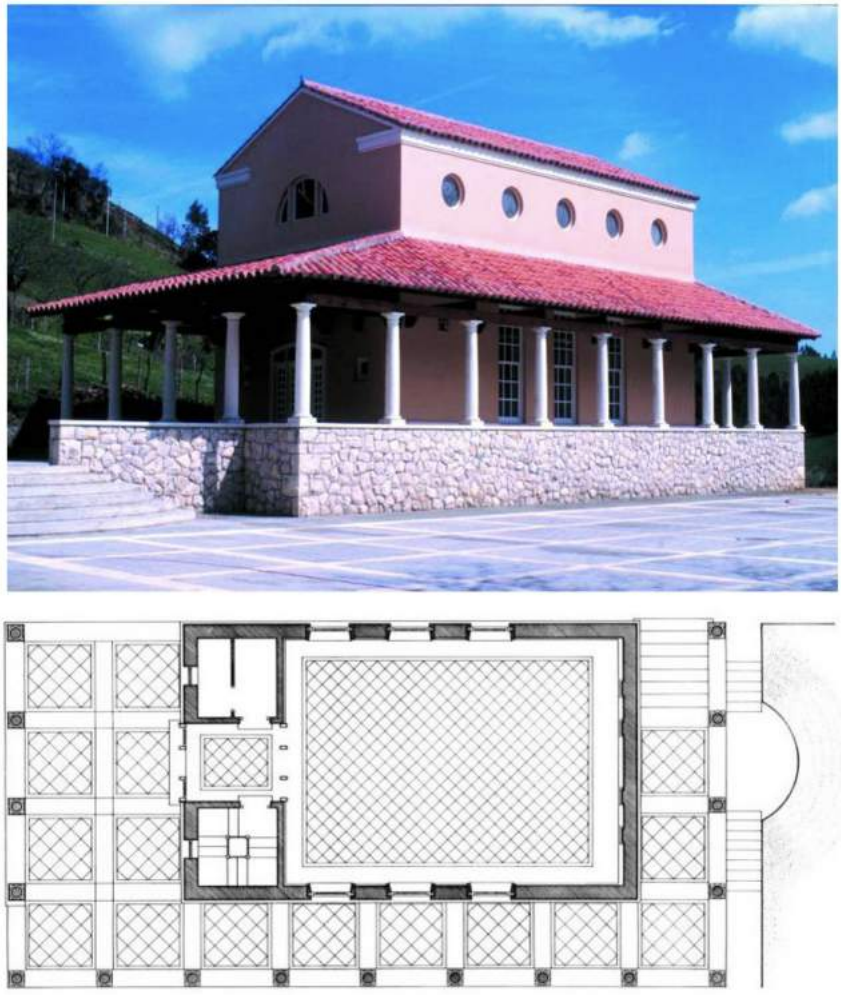

Fig. 2 Centro Rural, Muskiz

wanted to discover objectively how we, our bodies, experience space – not only cognitively but more wholly, with our bodies. Based on his physical experiments he concluded that we experience space thanks to the massive elements that bound it. Van der Laan derived a series of measures we can feel and know as quantities of the original measure of a built column. How many columns could fill the space between the opposing row of columns or a blank wall? The column is, of course, a

body. Bodies standing at a reasonable distance from each other form a perforated wall. And perforated walls on either side of a space generate that space, make that space feelable, make that space live. After all, that space is born between rows of living built bodies.

A row of columns we experience as living bodies stands at a reasonable distance from the wall on the other side of the space the columns bring into being. The reasonable distance is not a distance based on reason; it's a distance we can reasonably ascertain without thinking about it. It's a distance whose measure, according to Van der Laan, is no more than seven times the thickness of the column bodies that determine it.

Once we build a space we can experience as a spatial building block, a space whose measures are segments of the column bodies, we can then build larger spaces. We do so by choosing measures that allow us to experience the original spatial building block. Built bodies stand at just the right distance from each other to allow us to feel the space between them. Because we can experience the bodies as living, we experience the space between them as alive too. We take this experience with us in our encounter with a larger space whose size we can feel and meet because we've already felt and met the original spatial building block.

The church in the Abbey Sint-Benedictusberg (next page) is a prime example. The side aisles are seven times the width of the columns, the built bodies, on centre. The built bodies are alive. They make spaces we experience as alive, as living. These living spaces – the side aisles – allow us to experience the nave as living, as alive because we've already met them with and in our body. The width of the nave stands in relation to the width of the side aisles just as the width of the side aisles stands in relation to the column bodies.

Fig. 3 Abbey church, Sint-Benedictusberg, Lemiers, Nederland

Our body is the source of the order in the Fifteen Properties

The lesson we can learn is that there are at least three routes to building a world we experience as alive, a world that incorporates the Fifteen Properties, a world we've always built till we learned not to.

One route is simply to build, to experiment. On this route we need to build with our own hands. While building we discover what we need to do in order to experience our built world as a world that truly lives. We can follow this route only if we've liberated ourselves from the ideology, the belief, that our built spaces only serve use and comfort, that our built spaces are no more than things.

Another route is to build in the continuing tradition of classical building. Classical building depends on columns as built bodies that determine the feelable spaces between them, that generate spaces

between opposing rows of columns. Classical building creates centres as spaces between boundaries as columns or wall segments. Classical building creates inner worlds protected from the outer world. Classical building arises from our experience of our body, our animated body.

But if we've become alienated from our experience of our body, what then? And if we're alienated from our body but still open in mind for the possibility of a built world we can experience as alive, as living, what then?

Then we can follow the recipe of Van der Laan. We can learn consciously to build spaces in relation to the built bodies that bound them. We can, in short, choose to build spaces and buildings that have a goal: to build a built world that mirrors and reflects and recreates the order of our own biological and inner world.

The Fifteen Properties, it's now clear, are not only a description of living architecture: they're also an embodiment of life on earth, of our life on earth. The Fifteen Properties are rooted in our own body, our own perception, our own consciousness. And if we rediscover how to build cities that live as our bodies live, that spring from the measures of our own bodies, that present us with built bodies, then we have built a truly animated world. We've come home to who we are.

FIGURES

Fig. 1. Station Delft. Author's photo.
Fig. 2. Centro Rural, Muskiz. Cenicacelaya y Saloña, Bilbao. With permission.
Fig. 3. Abbey church, Sint-Benedictusberg, Lemiers, Nederland. Author's photo.

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Chapter 6

A City is a Complex Network

Bin Jiang[1]

Abstract

A city is not a tree but a semilattice. To use a perhaps more familiar term, a city is a complex network. The complex network constitutes a unique topological perspective on cities and enables us to better understand the kind of problem a city is. The topological perspective differentiates it from the perspectives of Euclidean geometry and Gaussian statistics that deal with essentially regular shapes and more or less similar things. Many urban theories, such as the Central Place Theory, Zipf's Law, the Image of the City, and the Theory of Centers can be interpreted from the point of view of complex networks. A livable city consists of far more small things than large ones, and their shapes tend to be irregular and rough. This chapter illustrates the complex network view and argues that we must abandon the kind of thinking (mis-) guided by Euclidean geometry and Gaussian statistics, and instead adopt fractal geometry, power-law statistics, and Alexander's living geometry to develop sustainable cities.

Keywords: *Scaling, living structure, theory of centers, objective beauty, head/tail breaks*

1. Introduction

A city is not a tree but a complex network. Implicit in Alexander's earlier works (e.g., Alexander 1965), this insight on city networks is a

[1] *Faculty of Engineering and Sustainable Development, Division of GIScience, University of Gävle, SE-801 76 Gävle, Sweden; Email: bin.jiang@hig.se*

foundation for the Theory of Centers (Alexander 2002–2005). According to the theory, a whole consist of numerous, recursively defined centers (or *sub-wholes*) that support each other. A city is a whole, as is a building, or a building complex. The centers and their nested, intricate relationship constitute a complex network (see below for further discussion). The complex network offers a unique perspective for better understanding the kind of problem a city is (Jacobs 1961). Based on the premise that a whole is greater than the sum of its parts, complexity science has developed a range of tools, such as complex networks (Newman et al. 2006) and fractal geometry (Mandelbrot 1982), for enhancing our understanding of complex phenomena. Unlike many other pioneers in the field, Alexander's contribution to complexity science began with creation or design of beautiful buildings. The Theory of Centers, or living geometry, is much more broad and profound than fractal geometry. Living geometry aims for creation (Mehaffy and Salingaros 2015), while fractal geometry is mainly for understanding. Creation or design is the highest status of science. This chapter will elaborate on the network city view and how its advance significantly contributes to a better understanding of fractal structure and nonlinear dynamics of cities. I will begin with hierarchy within, and among, a set of cities, then illustrate beauty and images emerging from a complex network of centers, and end up with further discussions on fractal geometry and living structure for sustainable urban design.

2. Hierarchy within, and among, cities

A city is not a complex network seen from individual street segments or junctions. This is because both street segments and junctions have more or less similar degrees of connectivity (approximately four), very much like a regular or random network. However, a city is a complex network seen from individual streets. The streets are created from individual street segments with the same names or good continuity; so-called *named* and *natural streets* (Jiang and Claramunt 2004, Jiang et al. 2008). Unlike street segments that are more or less similar, there are

all kinds of streets in terms of lengths or degrees of connectivity. The topological view helps develop new insights into cities. To illustrate, let us look at the street network of the historic part of the city Avignon in France. The network comprises 341 streets, which are put into six hierarchical levels based on the head/tail breaks, a classification scheme, as well as a visualization tool, for data with a heavy-tailed distribution (Jiang 2013a, Jiang 2015a). Given the set of streets as a whole, we break it into the head for those above the mean and the tail for those below the mean, and recursively continue the breaking process of the head until the notion of far more less-connected streets than well-connected ones is violated; the head/tail breaks process can be stated as a recursive function as follows.

```
Recursive function Head/tail Breaks:
     Break a whole into the head and the tail;
    // the head for those above the mean
    // the tail for those below the mean
     While (head <= 40%):
         Head/tail Breaks (head);
End Function
```

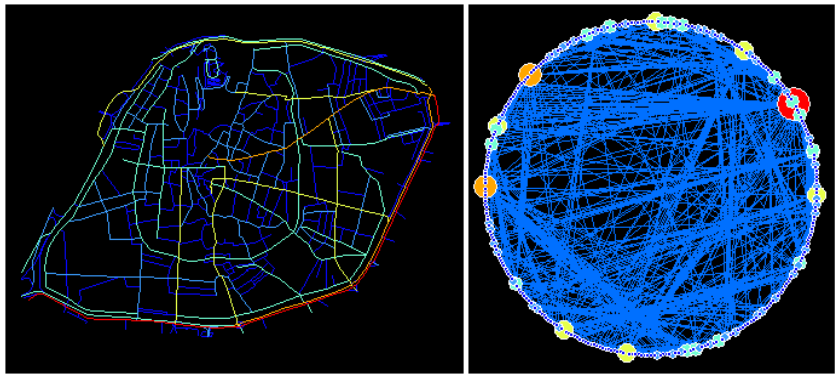

Figure 1: (Color online) Hierarchy of the street network of Avignon, and its connectivity graph both showing far more less-connected streets than well-connected ones. (Note: The hierarchy is visualized by the spectral color with blue for the least-connected streets and red for the most-connected ones. The 341 streets and their 701

relationships become the 341 nodes and 701 links of the connectivity graph.)

The head/tail breaks enables us to see the parts and the inherent hierarchy. The resulting hierarchy is visualized using the spectral color, with blue for the least-connected streets and red for the most-connected ones (Figure 1a). The 341 streets and their 701 relationships (intersections) are converted respectively into the nodes and links of a connectivity graph (Figure 1b). The connected graph is neither regular nor random, but a small-world network – a middle status between the regular and random counterparts (Jiang and Claramunt 2004, Watts an Strogatz 1998). The ring-like visualization shows the connectivity graph with a striking hierarchy of far more small nodes than large ones, with node sizes indicating the degrees of connectivity. Networks with this scaling hierarchy have an efficient structure, commonly known as *scale-free networks* (Barabási and Albert 1999). Both small world and scale free are two distinguished properties of complex networks. A complex network is highly efficient, both locally and globally, inherited respectively from the regular and random counterparts. How is a complex network developed? What are the underlying mechanisms of complex networks? How do we design a complex network of high efficiency? These questions are design oriented, with far-reaching implications for architectural design and city planning. Inspired by Alexander's works (Alexander 2002–2005), a theory of network city (Salingaros 2005) has already been developed for dealing with various urban-design issues.

Not only a city but also a set of cities (or human settlements, to be more precise) is a complex network. All cities in a large country tend to constitute a whole, as formulated by Zipf's Law (Zipf 1949) and in the Central Place Theory (Christaller 1933, 1966). According to Zipf's Law, city sizes are inversely proportional to their rank. Statistically, the first largest city is twice as big as the second largest, three times as big as the third largest, and so on. Zipf's Law is a statistical law on city-size distribution, and it does not say anything about how the cities are geographically distributed. The geographical distribution of cities is

captured by the Central Place Theory. Cities in a country or region tend to be distributed in a nested manner, i.e. each city acts as a central place, providing services to the surrounding areas. Conversely, small cities tend to support large ones, which further support even larger ones in a nested manner. The Central Place Theory is about a network of cities or human settlements that constitute a scaling hierarchy. The underlying network structure formulated by the Central Place Theory resembles the structure of a whole, in which recursively defined centers tend to support each other (Alexander 2002–2005, Jiang 2015). In this regard, cities in a country or region can be considered to be a living structure.

3. Beauty and image out of complex networks

Alexandrian living structure is a *de facto* complex network of numerous centers. The centers are recursively defined, which means that a center contains smaller centers and is contained within larger centers. Besides the nested, intriciate relationships among the numerous centers, they tend to support each other to constitute a whole. In this context, wholeness, as defined by Alexander (2002–2005), can be considered to be a global structure or life-giving order emerging from the whole as a complex network of the centers. This complex-network view of whole captures the mathematical model of wholeness as part of the Theory of Centers, and enables us to compute the degrees of wholeness or beauty (Jiang 2015). Using Google's PageRank algorithm, beautiful centers are defined as those to which many beautiful centers point. This definition of beautiful centers is recursive, and computation of the degree of beauty is achieved through an iterative process until a convergence is reached. Eventually, each center is assigned to a degree of beauty between 0 and 1. The degree of beauty of the whole can be measured by the ht-index, a head/tail breaks-induced index; the higher the ht-index, the more beautiful the whole. Let us illustrate the computation using the Alhambra plan as a working example at a building complex scale.

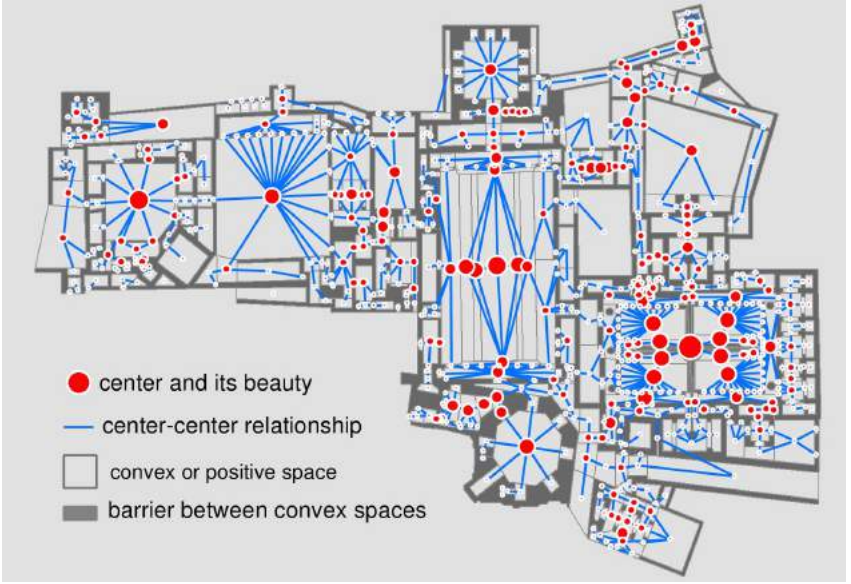

Figure 2: (Color online) The complex network of the centers with the plan of Alhambra (Note: The degrees of beauty are calculated using Google's PageRank algorithm; the bigger the dots, the more beautiful the centers.)

The Alhambra is probably the most beautiful building complex in the world. It possesses many of the 15 geometric properties such as levels of scale, strong centers, thick boundaries, and local symmetries. Seen from its plan, the most distinguished property is local symmetries. The plan does not look globally symmetric, but its numerous local symmetries make it unique and beautiful. Let us focus on the Alhambra plan that is partitioned into 725 convex spaces, each of which acts as a center. Most of the centers are related to surrounding centers, as long as there is no barrier between them. This makes 880 relationships in total. There are a few isolated centers that do not contribute to the whole. The 880 relationships are directed from the peripheral small spaces to the central large spaces. Figure 4 shows the result, in which the dots indicate the degrees of beauty; the bigger the dots, the more beautiful the centers. It should be noted that there are 13 centers hidden or embedded in the network: One as the whole, three sub-wholes, and nine

sub-wholes of the three sub-wholes.

The living structure has deep implications for understanding the city structure from a cognitive perspective. In this connection, the image of the city (Lynch 1960) is another classic in the field of urban design. A large body of literature has been produced over the past 50 years. Much of the literature focuses on human internal representation, or how do mental images of a city vary from person to person? In fact, it is the city's external representation, or the city itself, or the living structure, that makes a city imageable or legible (Jiang 2013b). To be more precise, the largest, the most-connected, or the most meaningful constitute part of a mental image of the city. Among the five city elements (paths, edges, districts, nodes, and landmarks), only landmarks capture the true sense of scaling or living structure. The image of the Alhambra plan consists of three sub-wholes: The left, middle, and right. Each of these comprises three further sub-wholes. Among the many other centers, the most beautiful one, or the one with the most dense local symmetries, tends to shape our image of the building complex.

4. Fractal and living structures

The topological perspective differentiates it fundamentally from the perspectives offered by Euclidean geometry and Gaussian statistics. Euclidean geometry aims for measuring regular shapes, and Gaussian statistics aims for analyzing more or less similar things. These two mathematical tools show some constraints while dealing with complexity of the world. Instead of more or less similar things and regular shapes, there are far more small things than large ones, and irregular shapes. To put them in perspective, Euclidean geometry aims for measurement or scale, while fractal geometry aims for scaling or the scaling pattern of far more small things than large ones. Gaussian statistics aims for average things, while power-law statistics aims for outliers. Events of a small probability in Gaussian statistics are impossible, whereas events of a small probability in power-law

statistics are highly improbable or vital. To a great extent, Euclidean and fractal geometries complement each other, and one cannot stand without another. This is because one must measure all things under the framework of Euclidean geometry to recognize scaling. However, our thinking in architecture and urban design is very much dominated by Euclidean and Gaussian thinking. For example, to characterize a tree, we tend to only measure its height, rather than all its branches. To illustrate, let us examine two patterns shown in Figure 3.

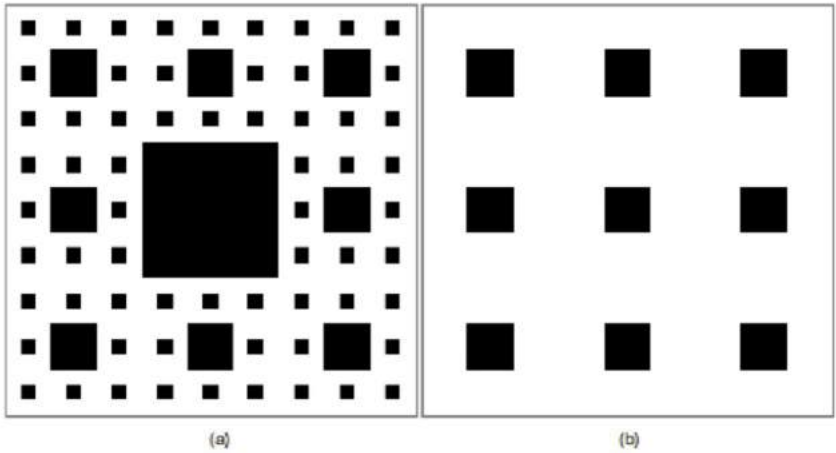

Figure 3: Fractal (a) versus Euclidean (b) patterns. (Note: The left pattern appears metaphorically in traditional buildings, in the sense of all scales involved rather than of precisely the same pattern, whereas the right pattern is pervasively seen in modern buildings metaphysically and in terms of precisely the same pattern.)

The square of one unit is cut into nine congruent squares, and the middle one is taken away. The same procedure is recursively applied to the remaining eight squares again and again, until we end up with the pattern commonly known as Sierpinski carpet (Figure 3a). This particular carpet of three iterations comprises one square of scale 1/3, eight squares of scale 1/9, and 64 squares of scale 1/27. A Sierpinski carpet is hardly seen in reality, but it helps illustrate some unique properties shared by the real-world patterns, referring to not only those in nature but also those emerging in cities and buildings. First, a pattern

recurs again and again at different scales, known as self-similarity. Second, there are multiple scales, rather than just one. It is essentially these two properties that differentiate the left pattern from the right one in Figure 3. It is important to note that the right pattern is with nine squares, which are disconnected each other. However, all the squares of the left pattern are connected each other, according to Gestalt psychology (Köhler 1947). The largest square is supported by the eight middle-sized squares, each of which is further supported by the eight smallest squares. This support relationship is very much similar to the framework of the Central Place Theory.

Unfortunately, modern architecture has been deadly misguided by Euclidean geometry and Gaussian thinking towards so-called geometric fundamentalism (Mehaffy and Salingaros 2006). Geometric fundamentalism worships simple and large-scale Euclidean shapes, such as cylinders and cubes, so removes small scales and ornament. However, scaling laws tell us that all scales ranging from the smallest to the largest (to be more precise, many smallest, a very few largest, and some in between) are essential for scaling hierarchy and for human beings. This scaling hierarchy appears pervasively in traditional buildings such as temples, mosques, and churches, yet has been removed from contemporary architecture and city planning. The life of living structure lies on the smallest scales or fine structure (Alexander 2002–2005) as demonstrated in Figures 1 and 2. It is time to change our mindsets toward fractal geometry, power-law statistics, and Alexandrian living geometry to develop sustainable cities and architecture.

5. Concluding remarks

A city is not a simple network, as simple as a regular or random network. Instead, a city is a complex network, or a middle status between the regular and random counterparts. It is highly efficient locally and globally, inherited respectively from regular and random counterparts. Many urban theories, such as the Central Place Theory, Zipf's Law, the Image of the City, and the Theory of Centers can be

better understood from the perspective of complex networks. Network cities bear the scaling hierarchy of far more small things than large ones, or living structure in general. This is the source of structural beauty and the image of the city. The scaling hierarchy should be interpreted more broadly, i.e., far more unpopular things than popular ones in terms of topology, or far more meaningless things than meaningful ones in terms of semantics. In this connection, a city is indeed a tree in terms of the scaling hierarchy.

The kind of complex network thinking is manifested in a series of Alexander's works that are highly iterative, such as *Notes on the Synthesis of Form* (Alexander 1964), *A City Is not a Tree* (Alexander 1965), *The Timeless Way of Building* (Alexander 1979), and *The Nature of Orde*r (Alexander 2002–2005). The complex-network perspective implies that within a city, every element depends on every other element, and changing one element would affect virtually every other in a design context. In this chapter, I have shown the power of complex-network perspective in understanding city complexity, in particular the topological view of city structure. Further work is expected towards the integration of the Theory of Centers and network science, and of living geometry and fractal geometry, for sustainable urban design.

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Chapter 7

Notes on the Genesis of Wholes: "A City is Not a Tree" in the larger context of Alexander's career[1]

Michael W Mehaffy[2]

Christopher Alexander, the author of "A city is not a tree" in 1965, remained extremely prolific in the five decades since. Almost everyone knows about his best-selling 1977 book *A Pattern Language* – According to long-time *Harvard Design Review* Editor William Saunders, that work "could very well be the most read architectural treatise of all time" (Architectural Record, May 2002, p. 93). Also well known are *The Oregon Experiment* (1975), *The Timeless Way of Building* (1979), *The Production of Houses* (1985) and *A New Theory of Urban Design* (1987). Alexander has also been remarkably prolific as a designer and builder of some 300 structures during that time.

Beginning in 2003, Alexander began publishing perhaps his most ambitions work of all: a four-volume magnum opus, *The Nature of Order: An Essay on the Art of Building and the Nature of the Universe*. The grand title, and equally grand and dense text, has fuelled a perception in some quarters that Alexander's career somewhere

[1] *Portions of this essay first appeared in Urban Design International, under the title "Notes on the Genesis of Wholes: Christopher Alexander and His Continuing Influence." I am indebted to Ward Cunningham (pioneer of pattern languages of programming, and originator of "wiki") for information about Alexander's subsequent influence on computer science, and to Marcial Echenique, Head of the Architecture School at the University of Cambridge, for information about Alexander's early theoretical influence within architecture.*

[2] *Sustasis Foundation, Portland, OR. Email: michael.mehaffy@gmail.com*

derailed from his earlier, rigorous scientific path, evidenced by "A city is not a tree," into a gauzy world of mysticism, solipsism or worse.

But the truth is more interesting, and more potentially useful for the rest of us. Alexander's career is in fact a straight line from the Cambridge (England) physics student, dealing with precisely the same topic throughout: the relation of parts to wholes, and the search for useful new design tools for their genesis and transformation.

Along the way he has surprised even himself with the increasing philosophical complexity of his conclusions; but he has never deviated from the scientific method that brought him there.

Furthermore, let me assert, his career reveals as much about the modern history of planning and architecture, and the philosophical issues scarcely yet confronted, let alone resolved, as it does about one individual's remarkably diverse, idiosyncratic, but (as I shall argue) coherent corpus.

Alexander, the first PhD student in architecture at Harvard, became instantly well known in the design world with the publication of his landmark PhD thesis and first book, *Notes on the Synthesis of Form*. The book was widely acclaimed and made Alexander a star of design theory. In fact its influence extended far beyond the world of architecture and planning: it was said to be required reading for researchers in computer science throughout the 1960s, and reportedly influenced major software innovations of the 1970's including object-oriented programming. It helped to launch the influential "design methods" movement (which Alexander later repudiated). It was equally a seminal text for the generation of architectural theorists that included Lionel March and Horst Rittel[3].

[3] *For example, an early review in* Industrial Design Magazine *termed it "one of the most important contemporary books about the art of design, what it is, and how to go about it."*

Like Herbert Simon's classic paper of that era, "The Architecture of Complexity", *Notes* took up anew the age-old philosophical question of the relationship between parts and wholes – the vital but oddly neglected philosophical topic of *mereology* – but in a specific modern form. Both Simon and Alexander wanted to know the precise mathematical structure of that relationship, and its development and transformation over time. In Simon's case the focus was on human cognition and computation, whereas Alexander was interested more specifically in the designer's challenge. As he formulated it then: how does a designer synthesize a coherent and successful form out of the elements of a design program?

Like Simon, Alexander made the basic structural observation that parts tend to relate to wholes in hierarchies, roughly speaking. Simon called them "nearly decomposable" hierarchies. This nearly-but-not-quite-hierarchical quality turned out to be key: there are subtle but significant areas of overlap and redundancy, and in that fact this is something profoundly important. These overlaps may seem accidental or trivial, but they are not: they are essential attributes of what we would today recognize as web-network structures, and they occur in very particular ways. Alexander quickly recognized, perhaps even more than Simon, that these areas were somehow of fundamental importance.

A City is Not A Tree

That insight was the salient point of "A City is Not A Tree," Alexander's widely-cited 1965 paper on the failures of that era's new towns – and by extension, modern urban planning and even design as a whole. As readers will likely know by now, the tree to which he referred to was a mathematical tree, a neat hierarchical system of nested sets and subsets:

> Whenever we have a tree structure, it means that within this structure no piece of any unit is ever connected to other units,

> except through the medium of that unit as a whole. The enormity of this restriction is difficult to grasp. It is a little as though the members of a family were not free to make friends outside the family, except when the family as a whole made a friendship.

He contrasted that structure with a semilattice, a more complex kind of structure with overlap, ambiguity and mutual interaction. This characteristic was a key aspect of the architecture of complexity.

The city is full of these overlapping and ambiguous systems, Alexander noted, and they are responsible for a great deal of its complexity and richness:

> It must be emphasized, lest the orderly mind shrink in horror from anything that is not clearly articulated and categorized in tree form, that the idea of overlap, ambiguity, multiplicity of aspect and the semilattice are not less orderly than the rigid tree, but more so. They represent a thicker, tougher, more subtle and more complex view of structure.

And yet, as he showed, much of modern planning exhibited this tree-like structure. He argued that the rational mind inevitably defaults to these neater, more easily managed categories of thought.

> It is for this reason - because the mind's first function is to reduce the ambiguity and overlap in a confusing situation and because, to this end, it is endowed with a basic intolerance for ambiguity - that structures like the city, which do require overlapping sets within them, are nevertheless persistently conceived as trees.

But the result of this can be devastating:

> …the city is not, cannot and must not be a tree. The city is a receptacle for life. If the receptacle severs the overlap of the strands of life within it, because it is a tree, it will be like a bowl full of razor blades on edge, ready to cut up whatever is entrusted to it. In such a receptacle life will be cut to pieces.

"A City is Not a Tree" quickly took on the status of a landmark critique, joining the ranks of Jacobs' *The Death and Life of Great American Cities* in shaping that era's seminal criticisms of modernist planning. With other critical texts of that era, it helped to put a brake on the rush of new towns and urban renewal "projects," and it set the stage for a more circumspect, asset-based approach to planning.

Yet forty years later, we can ask whether the implications of this seminal work were ever fully realised. Today a new generation of planners and architects seems to have forgotten - or never learned - Alexander's elegant mathematical analysis. New towns following the old model are springing up around the world, notably in the developing world, and new infill projects are proposed for rapidly-growing cities. There is a greater emphasis on mixed-use and interaction, but not much difference in the fundamental planning methodologies or results. As Jacobs noted in 1961, the urban professions have still not made the progress of other fields, particularly the biological sciences.

The Development of Pattern Languages

Alexander next asked, if the mind inevitably tries to force complex systems into neat hierarchies, then how can designers counteract this trend? Are there methods available to overcome this limitation?

Alexander noted several hopeful sources. One was in the structure of natural languages. An entire complex system, with all its overlap, can be represented by a word or phrase, and can be linked to other systems and other words through grammatical rules. While following basic hierarchical rules of structure, natural language nonetheless does permit tremendous ambiguity, overlap and interactivity. Poetry, for example, is an obvious example of language that is rich in overlap and density of interrelations.

Another inspiration came from computer science. Alexander had continued his work in the synthesis of form using computer programs, and he made an intriguing observation. Amid the unwieldy thicket of data he was generating, he saw recurrent patterns of the same elements, or the same kind of solutions. If these patterns could be abstracted, they could perhaps be re-combined in usable ways, preserving the essential network structures of the patterns. Such a "language" itself could, like a natural language, contain overlap and network connectivity.

At its heart, a pattern is simply a recurrent configuration of forces that can be resolved in repeatable ways. To take an obvious example – so obvious that no designer actually has to think about it in practice – a door is a system that resolves the physical forces that occur when it is swinging between open and closed, using a configuration of hinges and knob (Figure 1, right). But the positions of the hinges and knob are not arbitrary: they need to have a certain configuration for the door to work properly. If the knob is on the same side of the door as the hinge, it will not work very well! The arrangement of hinges and knob is the kind of key configuration that is captured by a pattern.

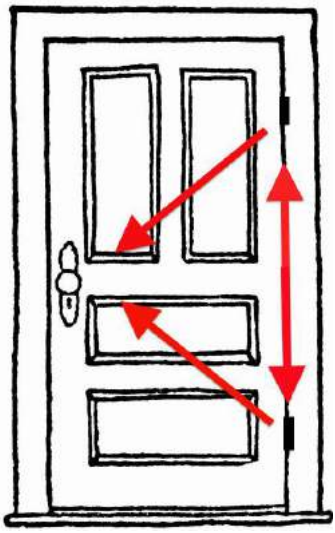

Figure 1

As one moves beyond the scale of a local configuration and its "strong" forces, one encounters other relationships that are notably weaker – what Alexander termed "weak forces." For example, I might have two doors in the same room, but their positions don't really have any critical relationship to one another. They can be on opposite sides of the room, or on adjoining sides. The doors are not randomly placed in relation to

one another, but by comparison to the requirements of the hinges and knob, the doors are only coupled by a “weak” force.

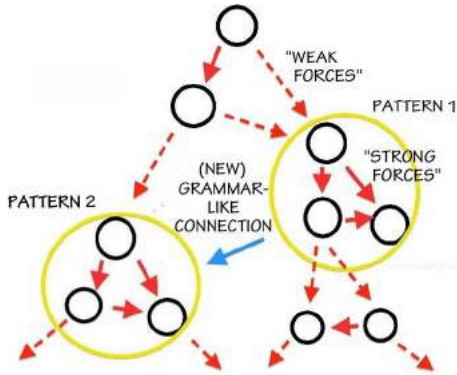

Figure 2

In fact, most structures in the world are complex mixtures of these “strong forces” and “weak forces,” as Alexander observed. The structures with strong forces form clusters, but they are not rigid. They are, instead, “patterns” – recurrent relationships between parts, that can themselves form new relationships at larger (and also smaller) scales. (Figure 2, right.) The doors in my room might connect it to several other rooms, and ultimately to my house, which connects again to the street and to the house next door, and so on. Similarly, the hinges on my door can be composed of diverse arrangements of screws, and so on.

As designers, once we recognize this clustering, we are free to use it to our advantage. We can combine the clusters in many different and creative ways, while still retaining the essence of the strong force configurations, so that our designs are likely to work. For example, we can make many different shapes and sizes of door, so long as they all have hinges on one side, and knobs on the other. (Again, this example is so obvious that we don't actually have to think about it; other examples, however, are more subtle, and this “pattern logic” becomes more useful.)

It is not yet obvious why this “pattern language” approach resolves the inherent problem outlined in “A City is Not a Tree.” That is, it is not obvious why patterns can form “semi-lattices” (or web-networks) and not just “trees” (or rigid hierarchies). After all, don't our houses have rooms, which have doors, which have hinges, which have pins, and so

on? Isn't that a rigid hierarchy? In that case it is, but we are not at all limited to that kind of relationship.

The neat tree-like nature of this system is broken when a new pattern is formed that spans across the relationships of other patterns. At an obvious level, a door can be (and usually is) shared by *two* rooms. Multiple rooms can be inter-connecting, and pathways between them can literally overlap. A hallway can be very precise in one context (e.g. enclosed with walls and doors at the ends) but quite ambiguous in another: just a pair of doors aligned in one part of a room, which becomes a regular passage. The pattern language approach is equally adept at managing both kinds of design configuration.

In addition, other kinds of relationships can be cross-cutting. "Parts made of brass" might encompass my door hinge, but not my doorknob – or it might include both. Sets of patterns comprising other patterns could overlap – but also might *not* overlap.

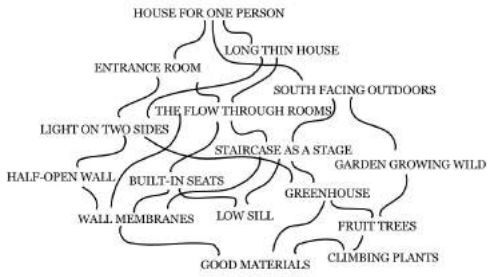

Figure 3

Understanding this web-network capacity for overlap was an enormous revelation for Alexander, and it opened his eyes to yet another revelation. The same capacity for ambiguity and overlap exists in human language, and notably in poetry. The rich inter-connection of relationships is precisely what gives language its power, and what gives poetry its capacity for meaning. What about the poetic qualities of the built environment?

Alexander began to recognise that human beings had already been using something like a "pattern language" in their traditional building cultures. The apparently humble structures of vernacular building were

in fact extremely robust and capable of producing exceedingly complex results. Something like this pattern structure seemed to be deeply rooted in the nature of the interactions between humans and their environment. It might even be rooted in the very nature of things.

Alexander developed this concept of a "pattern language" through a series of tests, and found it worked remarkably well. He began to envision a resource that any ordinary person could use to produce reasonably good vernacular buildings, in place of the unsatisfying standardised buildings that comprised the vast majority of the built environment.

Alexander and his colleagues compiled an initial set of 253 patterns, and, in 1977, published them in the book *A Pattern Language*. The book became an immediate and perennial bestseller, and a major influence on yet another generation of architects and planners.

Design Patterns in Computer Software

As it happened, the benefits that originated with computer software came full circle, and spawned major new developments in that field. In 1987 Kent Beck and Ward Cunningham, two Tektronix software engineers in Oregon, were inspired by the idea that pattern languages could perhaps be developed into a robust programming methodology. Beck had come across Alexander's work in his University of Oregon dorm, which included students from the Architecture School.

The design pattern methodology proved to be a great success, and a global phenomenon in the computing world. The influence is if anything greater than that in the world of architecture, spawning a line of innovations including The Sims, Wikipedia and many others.

In one sense the success should not be surprising: after all, the structure of a design problem in one field is similar to that in another, and a methodology that solves it in one might also work in another.

More intriguing is the possibly greater empirical success of design patterns in computing than in architecture, where the actual prevalence of pattern language methodology is considerably more limited. This may be because while Alexander and his colleagues developed patterns in a small group, using a "proprietary" model, the software engineers had a wider, more "open source" approach. The design pattern movement (as it is called) includes conferences, papers and many other activities, both proprietary and public.

The Nature of Order

The popularity of *A Pattern Language* was surely gratifying – in particular its hoped-for success with non-architects seeking to design and build for themselves. But Alexander and his colleagues were disturbed to find that many of the designers inspired by the book produced crude work that lacked the simple dignity of older vernacular buildings. Clearly they had not succeeded in replacing the traditional pattern languages of vernacular building with an equivalent new technology. What was missing from the methodology?

Alexander came to believe that he had not sufficiently dealt with the detailed problem of geometry. Returning to the problem of the relation of parts to wholes, he asked, what is it about the particular geometries of the built environment that we find beautiful and satisfying? What characteristics do they have, and what detailed processes actually create them? And why is this so?

Answering this question, and documenting the ideas for his readers, was the task that would occupy him for the next 25 years, culminating in a magnum opus subtitled "An Essay on the Art of Building and the Nature of the Universe."

Alexander was well aware of the work of theorists like Reyner Banham, who had simply concluded that humanity was in a different era -- the modern age of the machine -- and the complex social and

economic conditions in which the great traditional buildings were created no longer existed. Hence the effort to create such qualities again was in vain.

But Alexander the structuralist was having none of it. This was a misunderstanding of the determinants of technology, overestimating a temporary set of limitations as a final deterministic fate. The alternatives available to us were hardly limited only to fictional historicist simulacra.

As a scientist, Alexander saw the processes of morphology as phenomena of nature that transcended any particular era of human history, and that were always available for us to incorporate in human creations. Indeed, he saw the modern era of human technology as a crude one, in need of reform. "I am a modernist," he told this author – a declaration that might surprise his less-informed critics - although he is quick to add that he is a modernist who believes the time has come for radical reform of design technology.

Taking his cue from nature, Alexander studied the processes of morphogenesis in biology and other natural phenomena, and the characteristic geometries that resulted. Working phenomenologically rather than reductively, he grouped them into a series of categories, eventually distilling them down to 15 "properties". They range from familiar ones like "boundaries" and "alternating repetition" to more esoteric-sounding ones like "not-separateness". Even so, as always, the structural logic of even the esoteric-sounding ones is rigorous.

In addition to these geometric properties, Alexander also looked at the processes that shape them. He made an intriguing observation: each of the 15 properties has a corresponding kind of transformation that gives rise to it – and this goes for human acts of creation as well. These transformations do not create structure from scratch, but instead preserve some aspect of the previously existing structure. Hence Alexander referred to these as "structure-preserving transformations."

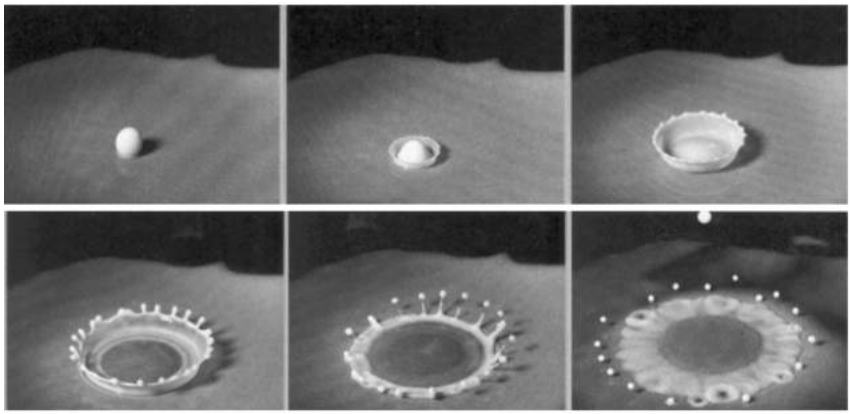

Figure 4. A simple milk drop goes through a "structure-preserving transformation" that articulates new structures with identifiable geometric properties – in this case, strong centers, alternating repetition, boundaries, local symmetries and others. Alexander has found that 15 categories can be used to describe all such emergent properties. (Courtesy Edgerton Digital Collections.)

A New Emphasis on Holism

A key feature of this view is the recognition of interdependent, system-wide effects that occur at every stage, and that must be understood and accounted for in their entirety – an approach known as holism. Such holism is not a new phenomenon in science: it has been an active topic from the beginning of quantum physics, and pops up increasingly in many fields today. (Indeed, Alexander has proposed a new name for "Structure Preserving Transformations," which he now calls "Wholeness-Extending Transformations").

In essence Alexander has developed a radically new theoretical framework for understanding the act of design, and the system in which it occurs. At the core of his new work is the recognition that good design is not a matter of elements working properly in an additive atomic system, but rather of regions of space amplifying one another in a larger totality. That is, one cannot really take the environment apart into recombinable elements, as is routinely done nowadays in the analysis stage of design programming. Rather, one must understand the

environment as a field of wholes, each supporting and amplifying one another in an interlocking totality. One can be very precise and descriptive about these wholes, and one can use very specific tools to manipulate and transform them; but one cannot avoid looking at the totality at each step of the way.

This "systemic" understanding of structure – in contrast to the "combinatoric" one that has previously dominated – is a common feature of organisation theory, biology and other fields, and the familiar "systems approach". But the notable contribution of Alexander, the Cambridge (England) educated physicist, was to give this understanding a specific geometric analysis, describing the relation of process to product.

Alexander calls each spatial region a "center," emphasizing that it is not an isolated entity, but an embedded field within an infinitely larger system of fields, with gradually diminishing contextual influences. One cannot look at a part of the whole without looking at its relation to the whole, and the complex influences of its location within the field.

Though this view has close parallels with the biological sciences and other fields, as a theory of planning and design it is radical, and its implications have only begun to be recognised. Taken to its logical conclusion, it implies completely different forms of diagnosis and prescription, different tools and methodologies, and different systems of production.

A Science of Qualities

It gradually dawned on Alexander that it is impossible to talk about the structure of a built environment and its effect upon the human user, without facing squarely the human users themselves, and the qualitative nature of their experience as an *a priori* condition that must be accommodated. One could pretend that qualitative experience didn't matter, and only quantitative analyses mattered. But it was increasingly clear that this omission was precisely the source of much of the current

grief, and the reason that progress had begun to grind to a halt. It had continued in fields like neuroscience, artificial intelligence and other subjects of complexity, precisely because these fields had recognised the necessity of facing the phenomenon of subjectivity, and the subjective experience of value.

As Alexander noted, value is the unwelcome guest at the party, simply because it is so hard to define in quantitative terms. It is the ultimate holistic, emergent phenomenon. And yet, Alexander noted, value *is* a sharable phenomenon, and a discussable one. There are cognitive methodologies that can indeed reliably find large areas of shared value. Moreover, these shared areas turn out to have a definable relation to structure itself. When it comes to living organisms, and apparently, when it comes to the built environment, value is rooted in the structure of things.

For many commentators, this is treacherous, alarming stuff – the makings of totalitarian design, or an enforced blandness of "average tastes". But for Alexander, there is no alternative but to face it squarely. While some things are variable, not everything about value is entirely relative or "subjective". Our job as scientists is to tease this apart carefully, using rigorous scientific methods.

In this respect, Alexander sees no problem whatever applying the rigor of science to subjective and qualitative phenomena. Indeed, he sees them as necessary allies in confronting the current challenge of the built environment.

A biological perspective may help to put a more comprehensible perspective on the situation. Clearly there are matters of individual taste and preference in the built environment, but equally clearly, matters of shared valuation. Car exhaust is likely to be universally regarded as an undesirable feature of built environments, whereas, say, fresh air is generally regarded as desirable.

There are structures within the built environment that affect human health and well-being, and for Alexander, it is the business of built environment professionals, not unlike doctors, to diagnose and prescribe more healthful and more desirable conditions. There is certainly art to it; but there is equally science, to be applied to the professional care of the well-being of others.

The relegation of value to a secondary or even peripheral role is, according to Alexander, a result of the quantitative emphasis that occurred in science around the time of Descartes and Newton. That was an enormously powerful and useful abstraction, but it came with increasingly negative unintended consequences. It created an artificial divide between value and structure, and as a result, it blinded the design professions, and the culture as a whole. Alexander's great insight was to suggest that structure has an intelligible tie to value, and that there are sharable, reliable methods to tease this out. And further, if we are to adequately respond to the current set of challenges, the time has come when we must do so.

For Alexander, none of this is inconsistent with a progressive notion of modernity. Indeed, this is modernity's inevitable next phase.

The Continuing Influence

Today, Alexander remains an unquestionably central figure of planning and design. His ideas, which are dismissed as quixotic, grandiose and impractical by many architects, are delivering undeniable results in other fields – often with high demand for empirical results, like computer science. The field of architecture and design seems long overdue for a rediscovery, and perhaps that is partly Alexander's own fault; but at the same time, as Jane Jacobs noted almost a half-century ago, the fields do seem to be stubbornly laggard.

At a time when an unbridled faith in design as a means of social progress has given way to a diminished perception of design as a method

merely for "organisational efficacy," Alexander's clear-eyed insistence that major progress is still possible sets him apart. At a time when the emphasis on sustainable design is growing exponentially, his biological understanding of the form-creating process is starting to look remarkably relevant and useful.

Alexander's continued warnings about the structural defects of tree-like urban planning and architecture would also seem to be sadly still relevant, in an age when the cautionary lessons of Jane Jacobs and others have been brushed aside by a naïve new generation of image-hungry designers, gleefully ready to repeat the many horrific mistakes of that era – if anything on an even larger scale, in developing countries like China and India. In the years to come, the growing crisis of sustainability is even more likely to bring these chickens home to roost.

Certainly his contributions to the history of design, and his ongoing influence on computer science and other fields, cannot be denied, even by those critics who believe he veered off along the way into an arcane world of mysticism. As I have argued, they would do well to look more carefully at the unifying symmetries, and philosophical and scientific parallels, within this remarkable career.

It is certainly true that Alexander has left a legacy long on grand ideas and tantalising starts, and short on fully practical, implementable methods. Along with brilliant insights have come huge problem areas that, at best, require massive further development – as he himself has noted. The economic dimension of the development process alone, for example, poses profound problems that are a long way from being resolved. Lacking progress in these key areas, Alexander's actual impact on the built environment has been understandably modest.

Alexander's personal style has always been iconoclastic, and dismissive of conventional wisdom. That spirit was formed in him early, as a young candidate for a Cambridge scholarship, when an accidental magnetic influence skewed the results of a laboratory test,

and Alexander alone refused to modify the results to meet the predicted results. That bit of stubborn iconoclasm won him the scholarship, and as he tells it, he never forgot that lesson. But it has probably complicated his ability to collaborate with other researchers, or to develop much stomach for the political messiness of human affairs, never his strong suit. Yet it is precisely this stubborn and dogged spirit that has propelled him onward to new insights, and radically fresh approaches. As is often the case with iconoclasts, it may be up to others to pick up many of these threads, and develop them into complete methodologies and useful new standards.

A number of investigators have formed collaborative efforts to develop further many of these promising starts. Perhaps most intriguing, the example of software engineers in developing design patterns, suggests that a more "open source" approach, particularly with patterns, might be enormously helpful. In place of a single small, tight team working under Alexander's lead, an army of such teams of collaborators (and, on occasion, competitors) might be able to match the impressive gains of the software designers. A number of groups have now embarked on such efforts.

By their nature, many of the remaining challenges do not lie in neat tree-like compartments, but span across disciplines. One prominent group of investigators has agreed to form a loose interdisciplinary research association, dubbed the Environmental Structure Research Group, to investigate these topics. Some of their members have contributed to this volume, and taken forward other work in an Alexandrine vein.

Alexander's many students certainly continue to influence the profession, and many now teach at institutions in the United States, England, China, Israel and many other countries. Some of these students, frustrated at the lack of coordinated progress on many of the remaining topics, have recently established a group called the Building Process Alliance. Representatives of the group have attended

conferences such as the Congress for the New Urbanism, the Environmental Design Research Association, the Council for European Urbanism, and a number of others, and other intriguing collaborative links are in formation.

Alexander himself has remained active, with a particular ongoing focus on developing usable tools. A recent focus has been on developing a new kind of code, as a kind of generative design tool. Such a "generative code" can be thought of, in analogy to computing terms, as a local "operating system" that guides design and construction through an integrated design-build process.

Alexander's focus has remained very much on the creation of form, and the way that parts go together to form wholes – or, perhaps more accurately in many cases, the way wholes differentiate to create new wholes, and new parts along with them. In that sense, his work throughout his career has focused on morphogenesis – a topic that takes on new urgency in a time when "sustainability" has become an urgent goal, and broadens into topics of social engagement and organisation, economic process and other dimensions of the culture of building. But instead of aiming for what he once termed the "synthesis of form," Alexander's aim now might better be characterised as the "genesis of wholes". Judging from his previous successes, the direction of his more recent work would seem to warrant careful attention at the very least.

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Chapter 8

'A City is Not a Tree' and A New Theory of Urban Design:
From Urban Critique to Environmental Structure to Urban Process

Hajo Neis[1]

"You are no doubt wondering by now what a city looks like which is a semilattice, but not a tree. I must confess that I cannot yet show you plans or sketches." ('A City is not a Tree,' Alexander 1965)

"*A New Theory of Urban Design* provides an entirely new theoretical framework for the discussion of urban problems, one that goes far to remedy the defects which cities have today." (Alexander, Neis, Anninou, King, 1987)

Abstract

This article describes and constructs the intricate connections between one seminal critique of modernist urban structure and modernist urban design in the 20th century and a book that was published 22 years later that tries to respond to some of the criticism of the former in a constructive fashion. While the article 'A City is Not a Tree' (Alexander 1965) is primarily an analysis of the failure of 20th century urban planning and design, the book A New Theory of Urban Design (Alexander, Neis, Anninou, King) is an attempt to remedy some of those failures by proposing a new way of designing and building our cities, suggesting that they can achieve physical wholeness in the structure of the city in a process of a growing whole.

1 Department of Architecture, Portland Urban Architecture Research Laboratory PUARL, University of Oregon; hajoneis@uoregon.edu, USA: 001 503 412 3731 – Fax: 001 503 412 3745

2 Alexander, C., Neis, H., Anninou, A., and King I. (1987) A New Theory of Urban Design, Oxford University Press, N.Y.

Introduction

As the title suggests, this article will not dwell on 'A City is Not a Tree' (ACNT) alone but will try to cover the work that responds to the analysis and critique presented in ACNT, in other words, the intellectual and practical development that has taken place from 1965 up to today. Special emphasis is placed on the book *A New Theory of Urban Design* (ANTUD), which might be considered the prime response for attempting to create and shape natural cities with life and numerous urban relations, overlaps, and ambiguity, resulting in a city of positive complexity.

The two quotes at the beginning of this article present a sequence which first raises an issue and question about the nature and character of city design and urban structure. Specifically, Alexander warns about artificial and tree-like cities. The second quote seems to suggest that there is a framework that has been designed and developed to solve some of the problems in contemporary urban design.

In this article we will cover several main aspects of development from the original article 'A City s not a Tree' to the main response of *A New Theory of Urban Design*, briefly interjecting an important aspect of the city as a system of patterns that comes with the development of the book *A Pattern Language* APL (Alexander et. al. 1977). Through this means we can observe the process which provides the subtitle of this article.

In addition to the constructive response of *A New Theory of Urban Design* to 'A City is not a Tree,' another main component of the presented argument is the change of mode from critique and analysis of city structure to process, urban dynamics, and the idea of the city as a growing whole, which promises to be capable of creating a structure with meaningful overlap, connection, and ambiguity in a process of step by step formation.

A City is Not A Tree (Critique of Urban Structure)

The seminal article "A City is Not a Tree" by Christopher Alexander is an enlightening analysis of the shortcomings of the structures common to 20th century cities. The article can also be considered a fundamental critique of modern urban design and modern urban development of the first two thirds of the 20th century in that it distinguishes 'artificial cities' which are more tree-like, from 'natural cities,' which are more semilattice-like.

> *"I want to call those cities which have arisen more or less spontaneously over many, many years natural cities. And I shall call those cities and parts of cities which have been deliberately created by designers and planners artificial cities. Sienna, Liverpool, Kyoto, Manhattan are examples of natural cities. Levittown, Chandigarh and the British New Towns are examples of artificial cities."* (ACNT)

In its critique of modernist cities, the well-known article emphasizes three main points:

1. Distinction of natural and artificial cities based on observation and critical analysis
2. Use of the two mathematical models of semilattice and tree as a way of supporting the first argument and analysing several particular cities in this way
3. Use of psychological analysis that demonstrates why planners and urban designers are creating artificial tree-like cities

The first and most important aspect of a city that ACNT emphasizes is the amount of connections and relationships that a city has (or does not have). It is these relationships that are so critical for a lively and healthy city: the relationships between the people and the buildings, streets, districts, parks, neighborhoods, and the city as a whole. If we take an example from urban infrastructure and transportation, it can be argued that a city with several public and private means of connection and modes of transportation along with the ability to switch between

them (i.e. from rail to bus, or bike to foot etc.) is more likely a healthier and more resilient city than a city that is mostly based on a single mode of transport, usually private automotive transportation, as seen in many 20th century American cities.

Alexander argues that from a human point of view, modern attempts to create cities artificially are completely unsuccessful when compared with known ancient cities that have acquired the patina of life. Alexander distinguishes between ancient and modern city structures by using two mathematical set models, one of a 'tree' and one of a 'semilattice.' Both the tree and the semilattice are ways of thinking about how a large collection of many small things goes to make up a large and complex system. Both are categories for structures in set theory.

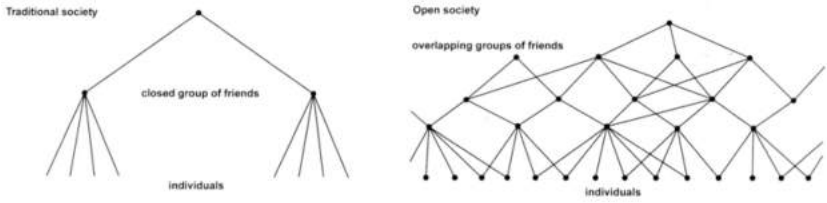

Figure 1. From the article 'A City is not a Tree' in 1965: Comparing Tree and Semi-lattice.

Alexander compares tree structures with closed traditional societies and semilattice structures with open modern societies, concluding that a semilatice structure is a better city for our modern society (Illustration 1). Looking closely at mathematical definitions of a tree and a semilattice, complicated relationships emerge, revealing that in certain contexts a tree happens to also be a semilattice. But as Alexander points out, we are mostly interested here in semi-latttices that are not trees as represented by overlapping units (semilattices) vs non-overlapping units (trees). Generally, a semilattice is a much more complex and subtle structure than a tree. Alexander explains that "a tree based on 20 elements can contain at most 19 further subsets of the 20, while a semilattice based on the same 20 elements can contain more than one

million different subsets." Alexander uses this mathematical analysis as a basis to describe the shortcomings of modern urban design. He says: "It is this lack of structural complexity, characteristic of trees, which is crippling our conceptions of the city" (ACNT). Furthermore, he demonstrates his claims by analysing nine modernist cities of the 20th century, including famous places such as Brasilia, Chandigarh, and Tokyo-Bay. He concludes that all of them have been designed and built as tree structures (Tokyo Bay remains a design proposal by Kenzo Tange).

So far, the contrast of these two urban relations has been demonstrated using the two mathematical concepts of tree and semilattice. Alexander also illustrates the difference in complexity through a psychological explanation. He argues that "the mind has an overwhelming predisposition to see trees whenever it looks into complex relations, it cannot escape the tree conception." To understand in real terms the difference in relational complexity between a tree and a semilattice, consider the following explanation using fruit and sports equipment: suppose someone has two pieces of fruit (an orange and a water mellon) and two balls (a tennis ball and a football). He or she can group these objects according to function (food and sporting equipment) or by shape (two spheres and two elongated spheres). In both cases we see a system as a tree. Only when we start to see the two ways of groupings together in one mental picture do we reach the complexity of a semilattice. And Alexander argues that for this reason alone many urban structures have been laid out as trees, lacking complexity and richness of connections and, ultimately life because of our own limitations to appreciate necessary complexity.

> *"For the human mind, the tree is the easiest vehicle for complex thoughts. But the city is not, cannot and must not be a tree. The city is a receptacle for life. If the receptacle severs the overlaps of the strands of life within it, because it is a tree, it will be like a bowl full of razor blades on edge, ready to cut whatever is entrusted to it. In such a receptacle life will be cut to pieces. If we make cities which are trees, they will cut our life within to pieces." (ACNT)*

The article 'A City is Not a Tree' (ACNT) had a tremendous impact on architects, planners and urban designers from its time in the late sixties up through today as it has helped to guide and shape views on urban design theory and practice all over the world. The impact of this article is that a new, more critical generation of architects and urban designers began to emerge, which have a more complex understanding of how to analyze, design, and build rich, progressive cities with life.

From Urban Critique (A City is Not a Tree, ACNT) to Environmental Structure (A Pattern Language, APL) to Urban Process (A New Theory of Urban Design, ANTUD)

The question of how to create a socially supportive semilattice-like city has been approached by Alexander and his colleagues through various efforts. Here, I will limit the investigation to internal development of work by Alexander and his colleagues at the Center of Environmental Structure in Berkeley.[3] It is relevant to note that while another book by Alexander and colleagues, *A Pattern Language* (APL*),* is not part of the main investigation here, there are a few points that will help to illustrate the progression from urban critique to the development of an urban design theory based on patterns, or *A Pattern Language* (APL) that was published in 1977. Three points are of relevance here: The city as a system; connections in the structure of the city and environment; and the quality of these structures and connections.

This article will focus mostly on ***A New Theory of Urban Design*** (ANTUD) which deals with organic city design, planning issues, and urban and building design. ANTUD was published 22 years after ACNT and 10 years after APL. We will also briefly look at A City is Not a Tree (ACNT) to A New Theory of Urban Design (ANTUD) and

[3] *A) Alexander, C. Hirshen, S., Ishikawa, S., Coffin, C., and Angel, S. Houses Generated by Patterns. CES 1969. (Peru UN Project.) B) Alexander, C. and Center for Environmental Structure. 'The Grass Roots Housing Process.' Draft, 1973. C) Alexander, C., Davis, H., Martinez, J., and Corner. D. The Production of Houses, 1985.*

the relationship of the two quotes at the beginning of the article, one from 1965, and the other from 1987. What ideas and concepts were continued? What ideas and concepts were developed, modified, or changed? What are completely new ideas or developments? And finally, what are the new questions, coming out of the new work?

Let us start with the question 'what has changed in urban design and what is completely new?' By far the largest change/new development in urban design thinking by Alexander and CES is the shift from structure, structural analysis and modernist critique to process, constructive urban design, and an active urban design theory and practical approach for the 21st century. From this single fact alone we can incorporate other relevant questions and issues, such as:

a. Use and development of the concepts of artificial and natural city
b. Use and development of the concepts of tree and semi-lattice
c. Emphasis on connections and relations that are needed to create a healthy environments and social situations with life (quality of the connections)
d. Use and development of psychological concepts in relation to complexity
e. Change and transformations from critical to structural issues and to process and dynamics
f. Emphasis on actual design, development and building of urban areas and neighborhoods
g. Emphasis on generative and regenerative processes
h. The absence of explicit patterns and pattern language

A New Theory of Urban Design (Urban Process)

With the formulation and publication of *A New Theory of Urban Design* in 1987, we can observe several new developments in urban criticism and expression. First, there is a continuation from structural analysis to the active development and design of urban space that tries

to avoid the limitations of tree-like simplicity in urban design and building design. Second, there is a shift and extension from structure to process and dynamics, which helps to define an appropriate way of making connections. Third, there is a strong inclusion of the age-old understanding of the city as an organic city with an organic process.

> *The venerable cities of the past, such as Venice or Amsterdam, convey a feeling of wholeness, an organic unity that surfaces in every detail, large and small, in restaurants, shops, public gardens, even in balconies and ornaments. But this sense of wholeness is lacking in modern urban design, indeed with architects absorbed in problems of individual structures, and city planners preoccupied with local ordinances.(ANTUD)*

Here we can see how the notion of a natural city vs. an artificial city is extended to wholeness in the structure of the city noting the organic unity that is missing in modern cities. And while the notion of organic unity starts with Plato and continues with Alberti and others, it is the modern understanding that was influenced by Alfred North Whitehead in *Process and Reality*. Whitehead emphasizes connections as reality defining (Whitehead 1978). It can be argued that this idea was continued in mathematical form as semilattice in ACNT by Chris Alexander and advanced in ANTUD as system, structure, and most importantly, as 'growing structure' and 'growing whole.'

The important question then is what this new theory is made of and how it can be considered a modern and contemporary organic urban theory (without losing the qualities of previous theories of organic development). The simple answer is in the method applied. In order to discover the principles, laws, and rules that are necessary for creating a growing whole in the city, the authors developed a set of ideas and principles and proposed a set of seven systemic rules that embody the theory on a practical level.

But before we get to the practical level, it is important to give structure to the seven detailed rules of urban growth with the ideas of a growing

whole (chapter 1) and the overriding rule (chapter 2). These two meta-rules clearly emphasize process-oriented principles and systems of rules in which the urban structure emerges from individual and connected acts of design and construction rather than large-scale planning.

The Idea of a Growing Whole

In the book *A New Theory of Urban Design*, the process of achieving wholeness in the structure of the city starts with the idea of a 'growing whole.' The idea of a growing whole is based on observations and detailed analysis of traditional cities and also captures a more traditional understanding of the organic city with regard to the kind of detailed qualities that we admire in these cities, such as Venice, Amsterdam and Motovun (in Istria). In addition, the new aspect of this idea is the emphasis on process, in which the whole is an ever-changing and adapting quality in the process of organic growth captured in four fundamental features of organic growth:

> *First, the whole grows **piecemea**l, bit by bit.*
>
> *Second, the whole is **unpredictable**. When it starts coming in to being, it is not yet clear, how it will continue, or where it will end, because only the interaction of the growth, with the whole's own laws, can suggest its continuation and its end.*
>
> *Third, the whole is **coherent**. It is truly whole, not fragmented, and its parts are also whole, related like the parts of a dream, to one another, in surprising and complex ways.*
>
> *Fourth, the whole **is full of feeling**, always. This happens because the wholeness itself touches touches us, reaches the deepest levels in us, has the power to move us, to bring us to tears, to make us happy. (ANTUD)*

The Overriding Rule

The overriding rule gives singular purpose to the set of seven detailed rules:

1. *Wholeness or coherence, is an objective condition of spatial configurationsm which occurs to a greater or lesser degree in any given part of space, and can be measured.*
2. *The structure which produces wholeness, is always specific to its circumstances, and therefore never has exactly the same form twice.*
3. *The condition of wholeness is always produced by the same, well defined process. This process works incrementally, by gradually producing a structure defined as "the field of centers," in space.*
4. *The field of centers is produced by the incremental creation of centers, one by one, under a very special condition. (ANTUD)*

The following rules were formulated through the process of creating a connected structure during urban growth: *As one center X is produced, so, simultaneously other centers must also be produced, at three well defined levels:*

i. Larger than X. At least one other center must be produced at a scale larger than X, and in such a way that X is part of this larger center, and helps to support it.

j. The same size as X. Other centers must be produced at the same size as X, and adjacent to X, so that there is no "negative space" left near X.

k. Smaller than X. Still other centers must be produced at a scale smaller than X, and in such a way that they help to support the existence of X. (ANTUD)

This all sounds very good, but it is also hard to understand because the concepts of center or wholeness in cities can only be defined recursively, which means that the understanding of these concepts is

itself a learning process. In order to understand how to apply a single overarching rule, a set of sub-rules for a particular kind of urban area has been researched and developed. So, in principle, one could apply the single rule through particular sub-rules for urban development, urban design, and urban architecture.

Let us emphasize one more time that the one encompassing rule requires that every act of construction, every increment of growth in the city, works toward the creation of wholeness. It is the reality of each piece of construction that has to show understanding and application of this one rule.

The seven intermediate rules (each intermediate rule is itself a system made up of several sub-rules) help to make the one rule realistic and feasible to implement in a day to day urban design and building process.

1. Piecemeal growth

   This rule, or system of rules establishes the piecemeal character of growth as a necessary precondition of wholeness. It does so by defining the small size of the building increments. The rule is necessary simple because wholeness is too complicated to be built up in large lumps. The grain of development must be small enough to allow room and time for wholeness to develop. In order to guarantee the piecemeal nature of the growth, this rule is made precise by three sub-rules.

   a. The first sub-rule says that no building may be too large.

   b. The second sub-rule guarantees a reasonable mixture of building sizes.

   c. The third sub-rule requires a reasonable distribution of functions.

2. The growth of larger wholes

Every Building must help to to form at least one larger whole in the city, which is both larger and more significant than itself. Everyone managing a project must clearly identify which of the larger emerging wholes this project is trying to help, and how it will help to generate them.

This rule is partially based on a study about the historic growth of the town of Motovun in Istria. (Funke, W., Heinrich, T., Neis, H., Urban Design Report, Technical University Darmstadt 1974)

3. Visions

This rule defines the content and character of the individual increments. The rule requires that the increments arise from a vision of what is needed to heal the existing structure, and not from an intellectually formed concept.

Every project must first be experienced, and then expressed, as a vision which can be seen in the inner eye (literally). It must have this quality so strongly that it also can also be communicated to others, and felt by others, as a vision. (ANTUD)

4. The basic rule of positive urban open space

Once a vision has defined the life and activity which is to occur in some new increment of growth, this vision must be embodied in a physical design. To make this design whole, it is absolutely necessary that the space created by the buildings have a positive character. The rule says simply: *Every building must create coherent and well-shaped public space next to it.* To delineate this idea, we have formulated a set of rules which identify five types of exterior spaces and the necessary relationships between these elements. The five elements are pedestrian space, buildings, gardens, streets, and parking.

5. Layout of large buildings

   It might be a little surprising that the layout or design of large buildings (4-6 stories) are part of this set of principles and rules because in today's world urban design is quite often considered design of cities without the design of buildings. However, in this theory they are widely relevant because of their huge impact on the city as a whole: *The entrances, the main circulation, the main division of the buildings into parts, its interior open spaces.... are all coherent and consistent with the position of the building in the street and in the neighborhood (ANTUD).* This principle has 25 rules in sequence, which outline how to design a building that augments overall city structure.

6. Construction

   Rules for building construction are important to outline here because the formation of buildings is essential to the wholeness of the city. The rule deals with two levels of structure: first, the structural system of buildings in structural bays and the flexibility of structural bay subdivision; and second, the exterior appearance of buildings and their relation to each other in their construction material and details.

7. Formation of centers

   The principle, or system of rules for the formation of centers (and field of centers) addresses the geometry of all shapes within the process of creating larger wholes at all scale levels. It is the closest to the principle of the overriding rule addressed in chapter 2. The rule says: Every whole must be a "center" in itself, and must also produce a field of centers around it (ANTUD).

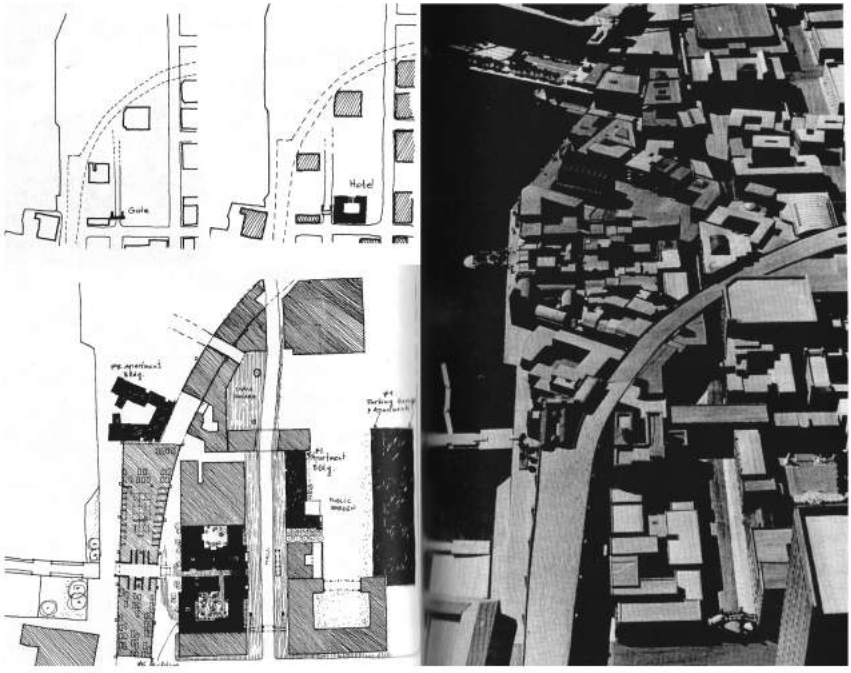

Figure 2: Initial Evolution of the San Francisco Waterfront Project in a sequence of generative steps and a view of the completed evolution in model.

The Experiment: The San Francisco Waterfront Project

The new theory was first tested in a project at the San Francisco waterfront in an area where today the SF Transbay Project is being planned and constructed. The project was carried out in 1978-79 and resulted in a surprising, new, and unexpected process where the traditional process of modern urban design and planning was almost completely reversed so that the individual acts of design and construction create the structure of the city compared to large scale planning and urban infrastructure plans. While this approach permits a strong bottom-up approach, it still requires to understand the larger structures at the appropriate scales in the visionary process of growth and development.

Above we show a few illustrations from ANTUD to show a sequence

of this kind of generative urban development in a simplified version. The important takeaway is the notion that the design process unfolds so that a series of relatively small, piece-meal interventions, aggregate into a structured whole. From a small kernel develops an entire district. For a fuller understanding of these sequences and application of rules we recommend to have a closer look at the book *A New Theory of Urban Design.*

Design for a new University of Oregon Campus in Portland

One project that was carried out more recently in 2011 in a similar fashion as the San Francisco Waterfront Project was the design proposal for a new University of Oregon Urban Campus in Portland. The proposed location was on an existing post office distribution and sorting site in northwest downtown Portland at the end of the North Park Blocks. This project was carried out as a Master Thesis Studio, "Generative Architecture and Urban Design for a New University of Oregon Urban Campus in Portland," at the University of Oregon Portland 2010-11 by professor Hajo Neis and his students.

We executed a comparable unfolding process with similar rules to develop this urban project. However, in this project we were able to work with newer digital technologies, which made the documentation process faster and easier to follow than in the San Francisco project, which was purely based on hand drawing techniques and hand model building. That said, the notion of an unfolding whole is retained, and once again, small, incremental development yields a surprisingly rich urban district.

On the next page we show a selection of figure-ground illustrations that explain part of the sequence.

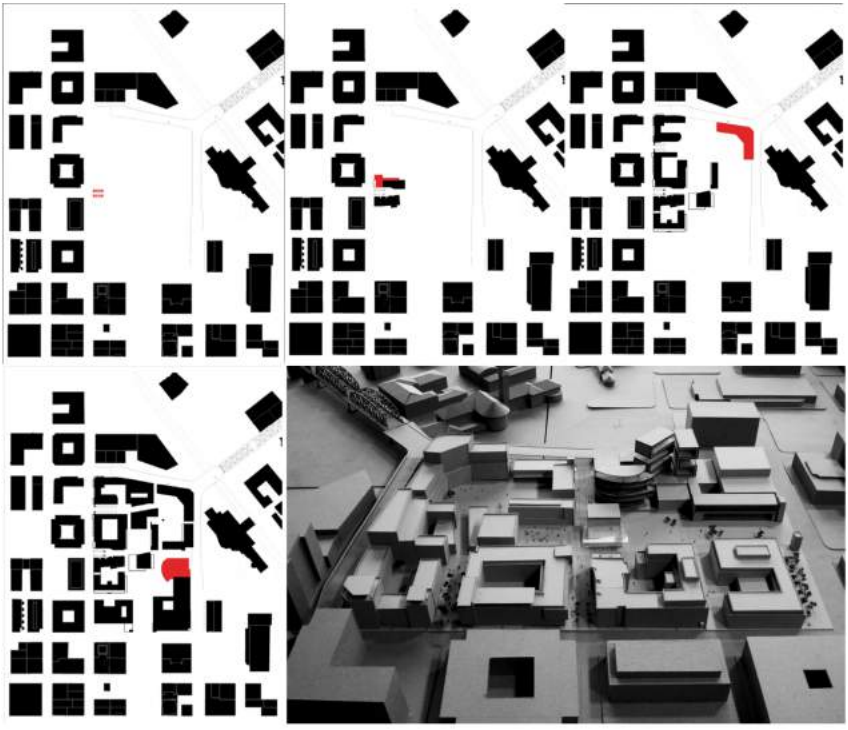

Figure 3: Evolution of the University of Oregon New Urban Campus Project Proposal, in a sequence of generative steps, and final completed model.

Conclusion: From Urban Critique to Environmental Structure to Urban Process

This article explored possible connections between the article 'A City is Not a Tree' and the book *A New Theory of Urban Design*. The main connection can be summarized in the formulation 'from urban critique to urban design process' in a diachronic sequence of progress and intellectual development. While artificial cities and urban structures were criticized for their one-dimensional qualities in 'A City is Not a Tree,' detailed principles and systems of rules were developed and tested *in A New Theory of Urban Design* to overcome these points of critique and start to create natural cities or organic cities in detail at different levels of scale. The outcome of this progress has been shown

to be practical in the examples of the two projects: first, the original project of the San Francisco Waterfront in 1987 and a more recent project in Portland in 2011. Other projects that have been undertaken by CES on a practical level include the 'New Town Guasare' Project in Venezuela, a neighborhood in Colombia, and others. [4]

While the intellectual journey from urban critique to environmental structure to urban design process has affected the discourse and practice in the field of urban design and urbanism, the initial discussion and progress caused by *A New Theory of Urban Design* as theory and practice requires a more all embracing contemporary view for solving current urban problems in the world.

Here we are starting to look at (re)generative process and design in the city, or the (Re)Generative City, a perspective that emphasizes the recurrent efforts to maintain, rebuild, restructure, strengthen and rejuvenate the city for its continuing survival, resilience, and prosperity in the circle of ecological life. The concept of regenerative process and design can be seen as a new or renewed emphasis in the overall discourse of sustainability, that departs from other major directions in sustainability in a progressive way by emphasizing and entering into a holistic approach to life on earth and the city.

The article 'A City is Not a Tree' may be understood in this context as an important starting point of an intellectual development that is by far not over and complete yet and needs to be continued in the area of regenerative urban process and life, urban design and urban architecture with more practical project applications and theoretical experiments in different kinds of large scale urban projects and development.

[4] Plan for New Town Guasare –Venezuela. (Comprehensive Urban Design and Building Project with numerous integrated urban and building growth simulations – Overall project developed with Kevin Lynch). Report Alexander and CES 1983/84. See also: Alexander, C. The Nature of Order. Book Three: A Vision of a Living World. Center for Environmental Structure, Berkeley, 2005.

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Illustrations

Illustration 1 from the article ‘A City is not a Tree’ in 1965: Comparing Tree and Semilattice

Illustration 2: Initial Evolution of the San Francisco Waterfront Project in a sequence of generative steps and a view of the completed evolution in model.

Illustrations 3: Evolution of the University of Oregon New Urban Campus Project Proposal in a sequence of generative steps and final completed model.

Chapter 9

Alexander and Emerging 'Images of the City': On Form, Metaphor and Theory

Dellé Odeleye[1]

1. Introduction: Images of the City

In my introductory class to urban design for architecture and planning students, I often begin with a mini-workshop on the role of the senses in appreciating places, including activities that involve student teams in using all their senses to explore spaces on campus and the adjoining neighbourhood. Subsequent sessions then introduce them to a range of formalised approaches developed by key contributors to urban design 'theory' (I explain why 'frameworks' is more appropriate) – followed by a visit to conduct an urban analysis for their project brief. Like other educators, I have to choose how to present these concepts and thinkers – primarily as individuals? or as movements / themes? I integrate both, setting out the historical to modernist movements following Knox (2011) but using my own informal categorisations of contextual methodological strands that have developed within the post-modern period, to link comparable ideas and approaches together.

I characterise these crudely as:

- The 'Contextual Morphologists' (Sitte 1898, 'contextual city planning'; Conzenian / British urban morphology; Italian and French morphological schools, McGlynn and Samuels 2000 'funnel and sieve', etc.)

[1] *Anglia Ruskin University, Chelmsford, UK*

- The ‘Functional-Aesthetic Reactionaries’ (Jacobs, 1961 'The death and life of great American cities’; Lynch, 1960 ‘Image of the city’ and 1981 ‘Good city form’; Cullen 1962 ‘Townscape’; **Alexander** 1960 ‘Notes on the synthesis of form’ and 1965 ‘A city is not a tree’)

- The ‘Urban Humanists’ (Gehl 1971, ‘Life between buildings’; **Alexander** 1979; Alexander, Ishikawa et al 1977, 1980, 1987' ‘timeless way/patterns/ Oregon/new theory’; Bentley et al 1985, ‘Responsive environments’; Tibbalds, 1992 ‘People-friendly towns’)

- The ‘Spatial Configurists’ (Hillier and Leaman, 1976 ’space syntax’; Hillier and Hanson, 1984 ‘Social logic of space’; Hillier 1996, ‘Space is the machine’)

- The ‘Typological Urbanists’ (R. Krier 1979, ‘Urban space’, L. Krier 1989, Poundbury; Bentley 1999, ‘Urban transformations’; CNU/Calthorpe 1993/Katz 1994/Duany et al, 2002, ‘New Urbanism’; **Alexander** 2002-5 ‘The nature of order’)

- The ‘Complex Urban-Physicists’ (Batty and Longley 1996; Allen 1997, Batty 2007, Bettencourt, 2013)

Other characterisations exist (See Attoe and Logan, 1989; Gauthier and Galliland's 2006 urban morphology-based scheme; Cuthbert 2008 critiques) – but neither this informal listing nor the named contributors are meant to be definitive or exhaustive, they are merely presented to the students as an introduction. Nor is it an entirely linear categorisation, though there are clear sequential influences for example, from Lynch’s earlier image-ability elements and good city dimensions into Bentley et al’s responsive environments methodology – and similarly, from urban morphology’s levels of resolution into CNU’s Smartcode. These and other influences (e.g. city is not a tree’ insights for later ‘permeability’/connected street principles) and shared concerns by key contributors about addressing modernist deficiencies are

highlighted to students within an overarching narrative demonstrating connections between many of the ideas, in spite of the disparate methods.

Interestingly, Alexander's work spans three of these categories, beginning with his 'A city is not a tree' essay, amongst other contemporaneous reactions to Modernist outcomes (drawing upon contextual sensibilities). These essentially challenged the then prevailing interpretation of 'form follows function', in arguing that neither the resulting form, nor functions were working as they should. Though this thread continued in Alexander's patternist trilogy, the emphases shifted in my view, to a more humanist focus – on learning from past solutions to recurring problems – and developing participatory processes to involve users, not only in professional projects, but also empowering them to initiate their own projects using this toolkit of 'patterns'. The notion of a latticed network persisted in the relationships he and his colleagues posited between the identified patterns. Readers may be surprised to see Alexander's 'nature of order' volumes included as 'typological urbanism' alongside new urbanism. My rationale is that they each recognise 'types' – of habitat/location, form, geometrical structure, and/or process, as a basis for urban coding (form-based or generative).

Nonetheless, there is a significant level of overlap between these informal categories –and my listing is just one of various thematic categories that contemporary urban design conceptualisations could be organised into. This notion of overlapping, non-discrete sets was itself a key aspect of Alexander's argument, which we'll revisit next.

2. Alexander's Image of the City and Early Responses

Alexander's now classic essay (1965) has arguably been as misunderstood as it has been cited. In terms of context, it is worth remembering Jane Jacobs' prescient claim (1961) that cities were problems in 'organised complexity'. Alexander's use of his

mathematical background prior to entering the architectural field, was evident in his 1960 notes on the synthesis of form PhD thesis. His essay shifted focus to the analysis of what he considered a tacit assumption underlying city planning and design processes –i.e. that it is (or should be) hierarchically structured and segregated both in terms of its movement system and its component districts (equivalent to mathematically abstract 'tree-like' structures).

Alexander argued that the consequence of these implicit 'top-down' assumptions in the artificial (modern) city, were disconnections between the 'branches'/ routes and neighbourhoods having only restricted, sequential links through the trunk. And that the actual, 'bottom-up' overlapping connections existing between routes and districts in natural, (traditional) cities resulted in semi-latticed/ networked relationship structures – generating the complexity missing from new towns.

In several respects, the essay provided an alternative set of supporting arguments for Jacob's (1961) earlier identification of rigid zoning as a key problem and her recommendations for mixed use districts and multi-use sidewalks. Alexander's use of sets and critique of discrete/ subsumed sets in contrast to 'overlapping' sets was also prescient, a feature of the essay that to my awareness, has not been highlighted, is how this foreshadowed the outlines of 'fuzzy sets' from the mid-1960s by Lotfi Zadeh based on addressing the problems created by 'crisp' sharply bounded, 'either-or' categories. (Zadeh, 1984) and subsequent development by the 1990s, of 'fuzzy logic / algorithms' and theory of fuzzy systems now used in a wide range of applications, from control systems to digital signalling and smart machines (Kosko, 1993; McNeil & Freiberger, 1994).

However, Alexander's contention that humans are inherently prone to decompose complex realities into neatly ordered, simplistic sub-units, while plausible, seems a generalisation that could be further probed. My argument is that while simplification does occur, various cultures

around the world managed to develop means to avoid this trap *collectively* in their towns, so we've had 'help' in coming to our current predicament. Obvious candidates include the rise of reductionist approaches in science – but also in my view, a misapplication of evolutionary ideas (to hierarchical social organisation) through pervasive metaphorical thinking. More on this later.

A number of Alexander's premises or conclusions were rejected by some critics. Karp and Karp (1967) argued that tree-like thinking was something of a 'red-herring' as no one claimed cities were trees. They then proffered the view that while one part of the city (its movement system / road layout, albeit with one-way traffic) *could* be perceived as having a tree structure – this, like the analogy of the human circulation system, was also a false analogy, based on views of sectional 'slices' through dead organisms. They contrasted such sections to the whole circulation system in a living organism which they considered more of a 'net' – arguing that the 'tree' view was simply a folded net.

The rest of their argument both extends this metaphor to the organs / cell tissue in organisms, while recognising its limits in terms of organic proportional scaling with growth –deemed problematic in the case of cities, where people, not cells, are the functional units. The role of the car in temporarily extending the scale of a human and the extent of their movement was then used to argue for the relative presence / absence of 'tension' in different social classes in terms of the conditions in where they could afford to live, and effects of subsequent efforts to regenerate declining urban areas.

While this line of argument appears to start with an interesting point relating trees to nets, it then initially seems to diverge into other issues. However, on further reading and reflection, they appear in my view to be (indirectly) exploring the issue of how physical /abstract structures relate to, and influence social organisation and dynamics of urban decline and regeneration.

In ‘a city is not a semi-lattice either’, Harary and Rockey (1976) acknowledged the value of Alexander’s original graph theoretic analytical approach, while taking issue with his conclusions of all natural cities having a semi-latticed structure. This was based on their view that the essay firstly, confused concrete with abstract complexity – secondly, that it did not identify the role of culture/ social organisation as providing a stable structure to human societal dynamics that enliven cities beyond physical attributes –and finally, that it did not sufficiently define mathematically, his use of the ‘tree’ and ‘semi-lattice’ terms.

While the first and third points are debatable, their second point dovetails with the suggestion I will make here – that particular evolutionary assumptions about social organisation are implicit in ‘tree-like’ thinking on cities. The evidence for this is more recent, and could not have been known by Alexander at the time the essay was written. However, it does lend some support to his (more generalised) view of a tendency to oversimplify complex realities.

3. Tree-like Assumptions? – Hierarchical Social Evolutionary Ideas

So why has abstract ‘tree-like’ thinking been so entrenched? – is it inborn, or imbibed through the educational or other prevailing cultural systems?

The problem of *consciously* designing cities (i.e. large scale spatial organisation) as opposed to organic growth, may perhaps be considered to share features with the problem in the information sciences –of how to organise information (knowledge organisation). Robinson & McGuire (2010) argue that the approach prevalent in Western thought, based on ‘mutually exclusive conceptual categories’ originating from Aristotle –has generated ‘tree-like’ hierarchical models. This strict placement, of entities sharing characteristics into the same category, is the basis of traditional set theory. They summarise the argument initially proposed by Deleuze & Guatarri (1976) that this hierarchic intellectual model constrained thinking patterns in certain ways. And

that it influenced the nineteenth century expansion in scientific Linnaean taxonomic and bibliographic classification systems, which relied on this Aristotelian model of 'arborescent' (tree-like) knowledge organisation. According to Robinson & McGuire (2010, p.4-5):

> *This model is characterised by vertical and fixed linkages, and binary choices, and by the linking of elements only of the same general nature…A concept must typically fit into one and only one place in a classification scheme, and the hierarchical divisions must be made by a single criterion, and must be mutually exclusive (Langridge 1992, Olsen 1999). All items with any particular characteristic are distinguished from all others of the same kind. "Tree logic" is therefore "a form of cognition in which information, ideas, people and institutions are ordered hierarchically according to predecessors and roots... Thus tree order … offers a taxonomy of forms within a category" (Cavenagh 2007, page 44)'*

Evolutionary assumptions drawing upon this logic have had a profound influence on ethnographic, anthropological and historical analyses and interpretations. The linear idea of social history since the nineteenth century, underlaid the 1960s notion of "general and specific evolution". This aimed to solve the problem of linking the universal and particular by combining global and local aspects of history, society, and culture. The evolutionary trajectory of 'band – tribe – chiefdom – state', has also been very influential since 1962 - casting societies with less social hierarchy and political centralisation as being less developed (Bondarenko, 2007, 2011).

A "multilinear evolution" concept, posited that in different environments, cultures can evolve differentially – albeit with the state (defined by Weber as based on a bureaucracy) still at the apex of social evolution. 'Stateless' societies were still viewed as evidence of lower attainment along the linear trajectory towards statehood. The more recent multi-linear view is that societies are not on a single trajectory

but follow a diversity of evolutionary tracks - with neither the band, tribe, chiefdom, nor state, being inferior or superior to another: rather, they are just initially and essentially different (Bondarenko, 2007, 2011). And recent research has been used by Taylor (2012) in defending Jacobs (1969) thesis – and proposing (controversially) that contrary to the tendency to conflate the state with cities (i.e. as city-states) it is more likely that cities preceded the emergence of states.

4. On Form - The 'Urban Revolution' and Social Organisation

Max Weber's five criteria of urbanism which influenced many subsequent urban geographers, was based on Western classical sociology and included: complete autonomy (i.e. a city-state), autocephaly, marketplaces, and fortifications. He was aware of the narrowness of his indicators and the fact that it necessarily excluded from urban status, a wide range of settlements traditionally classed as towns, or cities that lacked the main features of European cities. Sociologist, William Munro (1926; cited in Wheatley, 1971) adopted Weber's definition and established criteria which were influential for over 25 years:

> *"Offhand one might say that it (the city) is a large body of people living in a relatively small area. That however, would be a very inadequate definition, for it would convey no intimation of the fact that the city has a peculiar legal status, a distinct governmental organisation, a highly complicated economic structure, and a host of special problems which do not arise when an equal number of people live less compactly together. A comprehensive definition of the modern city must indicate that it is a legal, political, economic and social unit all rolled into one."*

There were a proliferation of post-war definitions relating to early cities, but the most widely cited, put forward by the archaeologist V. Gordon Childe in his influential (1950) paper proposed 10 criteria as supposedly underlying the *'Urban Revolution'*:

1. Large numbers of people concentrated in a limited area;
2. Elite control of peasant-created food surplus and its 'redistribution'
3. Hierarchical social organisation;
4. Emergence of exact and predictive sciences;
5. Residence-based, rather than kinship-based, group members
6. Craft specialisation;
7. Social-surplus concentrated in monumental, public architecture
8. The use of writing;
9. Naturalistic art;
10. Long-distance foreign trade

These are more descriptive than explanatory, and also characterise a particular range of cultural contexts. Childe was thus, unable to establish functional relations between these criteria – some of which are either of doubtful generative significance in urbanisation, or are not specific to cities – especially naturalistic art, foreign trade, social hierarchy, monumental architecture and writing (Wheatley, 1971).

So what is an 'urban' settlement or 'city'? And how can we identify a representative range of ancient and traditional forms of urbanity to learn from? About the only factor that is agreed upon is that, a larger areal extent and population size (i.e. population growth and increasing scale) tends to distinguish a 'rural' settlement, from an 'urban' town or city – the thresholds being subject to debate and regional contexts.

The mainstream sociological and archaeological definitions however, included other attributes such as; subsistence intensification, social stratification (hierarchy), centralisation of power, literacy, and citadels enclosing imposing public monuments, treasuries or food surpluses.

For our purposes, here, it was the underlying assumptions about the role of social hierarchy in defining the urban, that are most pertinent to Alexander's critique of tree-like abstract structures in *'The City is not a tree'*. On the one hand, built form is often considered to reflect in some

way, their respective societies, and on the other hand, to influence society itself - a view summarised in Winston Churchill's often-quoted statement that *'we shape our buildings and afterwards, our buildings shape us'*[2]

5. Non-Hierarchical Complex Organisation?

Despite there being no single, agreed definition of the 'urban', archaeologists have tended to consider changes in the size, distribution and integration of populations forming hierarchical patterns, as indicating the evolution of a settlement from pre-urban to urban status. This urbanity has commonly been linked with a 'state-level' society (Patch, 1991).

For instance, due to many African settlements not fitting early 20th century models of the city, which defined cities in terms of specific traits, the impressive scale of precolonial African towns was attributed to external influences in the second millennium A.D. Despite the tenacious grip that this model has held on popular views of the African past, archaeological evidence accumulated in recent decades is beginning to dispel the myth of a city-less precolonial Africa. (Munroe, 2011).

Archaeological excavations and investigations into urban prehistory over the past twenty-five years in the Middle Niger at Jenné-jeno (Mali) led by a team of archaeologists, Susan and Roderick McIntosh (1999) - show the extent to which some early non-western examples did not conform to the expectations of urban archaeologists elsewhere around the world. It has implications for the preconditions of pre-industrial urbanism anywhere – the African data has encouraged researchers in northern China and in Mesopotamia to reconsider their own discoveries in a different perspective.

[2] *Speech to the House of Commons (October 28, 1943), on plans for the rebuilding of the Chamber (destroyed during the blitz), in Winston S. Churchill (2003), Never Give In! : The best of Winston Churchill's Speeches (2003), Hyperion, New York, p. 358*

Susan McIntosh (1999) describes how, initial settlements (c. 250 BCE) within the Inland Niger Delta (IND) in the Western Sudan displayed rapid population growth during centuries-long occupation of multiple, high density settlement clusters, of a central mound between 20-80 hectares in area, surrounded by medium and small mounds within 200m – the total area in the vicinity of Jenné-jeno for instance, exceeding 100 hectares within a millennium - likely population of over 20,000 by c. 800 C.E. (McIntosh, 2000). This distribution of settlements in tight clusters is very interesting, the main point being the maintenance of spatial boundaries (reflecting a measure of independence from and resistance to the centre) together with close proximity (indicating that serious conflict or hostilities between the mound settlements were not a determining spatial factor). In her words:

> *"Jenné-Jeno challenges us to make room in our explanatory schemata for a population of over 11,000 packed onto more than 130 hectares of tell surface within a 12 km^2 area that apparently* ***did not do*** *any of the following:… display obvious wealth differentials; develop a settlement pattern reflecting increasing centralised organisation; or develop a settlement pattern consistent with high levels of inter-site conflict." (1999:77; My emphasis.)*

Issues relating to the organisation of these sites, which are as large and heterogeneous as many in Mesopotamia, central Mexico or the Andes, but with no evidence of kings or power elite, throw up questions of definition, distinctiveness and authority. What significance should be given to the particularly dispersed / clustered form of these early towns, or from the lack of monumental architecture[3] at an obviously wealthy, densely populated site such as Jenné-Jeno? Such urban complexes or 'componential-cities' with large specialist populations involved in

[3] *Taylor (2012) controversially uses Jacobs and the findings of urban archaeologists including the McIntosh's to replace the standard content-based/ 'monumentality' definition of cities with a process-based 'city-ness' definition. City-ness is a relational, network approach to cities (a communicative 'central flow theory') opposed to the object-focus of Christaller's (1966) 'central place theory'.*

sophisticated trade networks, covered impressive areas – more than 50 sq. km (with up to 22,000 people in 1100 CE) in the case of the entire Jenné-Jeno complex at its peak.

The combined attributes of such evidence of non-aggregation (clustering) and absence of power elites and of coercive control, required functional analyses (e.g. reconstructing eco-dynamics of the human landscape, application of the rank-size rule[4]) as well as investigating rules of inter-ethnic relations and the persistent oral traditions that pervade towns/villages in today's Middle Niger, in order to assess levels of urbanism and extrapolate a possible socio-economic bases for the past. 'Cognitive archaeology' since the 1990's, combines hard physical data methods with cross-cultural insights into ideology, symbols and social formations of reality, for testing past ways of thought as inferred from material artefacts (McIntosh, 2000)

Based on Carol Crumley's introducing the conception of a "heterarchy"[5] into settlement archaeology (1979; 144*"... as the relation of elements to one another when they are unranked or ... possess the potential for being ranked in a number of different ways"*) urban archaeologists (Crumley et al, 1995) thus posited '*heterarchies'* (horizontally structured societies) to explain how these complex polities and urban settlements emerged and thrived, and the

[4] Based on recognising that cities do not exist in isolation, but perform specialised roles within a broader hinterland. Geographers had noted an inverse relation between the ranks and sizes of settlements in urban systems (when plotted, a descending logarithmic straight line results). The rank-size distribution implying few cities with large populations and many with small populations is thought to represent either an underlying 'minimal cost and optimal efficiency' mechanism, or, an inherent stochastic process in systems growth. For more recent work, see Batty 2011, 'Defining City Size', Editorial in Environment and Planning B: Planning and Design, Vol.38, pp753-756 and And Bettencourt (2013) Origins of scaling in cities. SCIENCE, pp1438-41

[5] A term coined by McCulloch, Warren S. (1945), A heterarchy of values determined by the topology of neural nets. Bulletin of Mathematical Biophysics 7: pp 89-93. "Heterarchy [is the] form of organization resembling a network or fishnet" while "[h]ierarchy [is the] form of organization resembling a pyramid" (web cybernetics & systems dictionary, 2004: quoted in Bondarenko, 2007)

mechanisms used to maintain a dispersed distribution of power to resist centralising tendencies. Heterarchy implies a more egalitarian or overlapping socio-political structure, in which each element retains some measure of independence in decision-making within the community.

Such examples of alternative pathways to complexity, have shown that the prevailing neo-evolutionist view of complex socio-spatial organisation (as being necessarily based on elements such as hierarchical social structures, centralised or 'compact' cities with citadels for an economic or political elite which controls labour, etc.) are inadequate to describe the full range of dense, complex urban polities, in places as diverse as west Africa, northern China (Shang), southeast Asia (Harappa) and to a lesser degree in late Uruk Mesopotamia. The need for urban historical analyses to be based on archaeological evidence, instead of reliance on social-evolutionary theorisation about human development has been highlighted by Pauketat (2007). According to Clarke[6] (1979).

> *"The multiplicity of urban forms and functions represents a multidimensional structure which, while it may be collapsed into one dimension, arranged linearly and dichotomised endlessly, can only be done so with great arbitrariness and loss of information, to produce a classification useful only for limited purposes"…. "Complex systems cannot be specified by laundry lists of attributes, whether physical or organisational, any more than a watch can be understood from a list of its parts."*

Research adopting a functional model of the city has forced us to see cities as more than a simple collection of traits. According to this model, urban centers are differentiated from, but closely integrated

[6] *Quoted in McIntosh, S.K and McIntosh, R.J (1995) 'Cities Without Citadels: Understanding Urban Origins Along the Middle Niger', in T. Shaw, P. Sinclair, B Andah and A. Okpoko (Eds.) 'The Archaeology of Africa: Food, Metals and Towns', Routledge, One world archaeology series 20, London/New York.*

with, their rural communities. Cities are thus settlements that provide specialized services to a broader hinterland. The key issue, therefore, is not what a city *is*, but what a city *does* for rural communities within its sphere of influence. (Munroe, 2011)

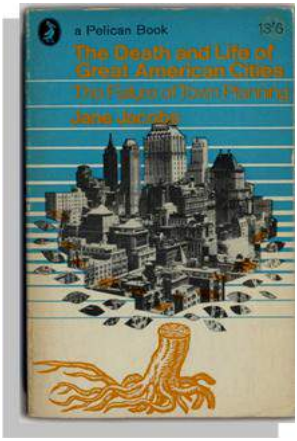
As indicated earlier, there appears to be an evolution-theory influence underlying mainstream perceptions of hierarchic structure as being the most developed form of organisational and/or social organisation. The ubiquity of centralised, hierarchical diagrams in organisational management has tended to reflect such un/conscious tree-like assumptions, until fairly recently – and arguably still predominates compared to more recently advocated, flatter or networked structures (Wang, 2010) The heterarchical concept, as opposed to hierarchy and centralisation, has been of increasing usefulness in the archaeology of complex society – and has influenced more recent post-modernist models of business organisation –see for instance, Chakravarthy and Henderson (2007) whose influential paper argued for heterarchical strategies. This concept has also since been integrated with concepts of 'networked' structures.

6. On Conceptual Metaphors

The pervasive nature of our reliance on metaphor was highlighted in a 'ground-breaking' book by Lakoff and Johnson, (1980). In it they outlined a number of evidenced claims:

Firstly, that metaphors are not simply rhetorical or poetic flourishes. They structure not only particular literary genres, but our everyday language usage – and moreover, they are not just linguistic devices, but fundamentally influence our thoughts, actions and experiences.

A metaphor essentially frames our understanding and experience of one type of object / situation, in terms of another one. They posit that our *conceptual system*, which we tend to be unconscious of, is primarily metaphorical. For instance, in Western culture, arguments are framed in terms of battle / war, such that elements of argument and the act, are expressed using the vocabulary of war; e.g. 'Her claims are *indefensible',* 'I *demolished* her argument', 'If I use that *strategy,* he'll *wipe me out',* 'He *shot down* all of your arguments'. A culture that frames argument as a dance would have a different concept of it. (Lakoff and Johnson, 1980). Types of metaphor range from structural, to orientational (linking a set of conceptual values [good/bad] in terms of spatial orientation [up/down]), and ontological (entity/ substance), etc.



Early cover of Jane Jacobs' book (depicting a modern city as a tree cut off from its roots)

Secondly, they claim that conceptual metaphors are *culturally systematic* in the way they coherently shape patterns of our thoughts and actions –even though for example, the 'Theories as buildings' metaphor does not ordinarily use all parts of a building to frame the concept of theory. So we say; 'Is that the *foundation* for your theory?' 'The theory needs more *support'*. 'So far she has put together only the *framework* of the theory'. But <u>not</u> (in ordinary language usage); 'Her theory has lots of little *rooms* and long, winding *corridors'*. 'Complex theories usually have problems with the *plumbing'*. (Lakoff and Johnson, 1980)

So metaphors are partial, *figurative*, mappings embedding the deep values of a culture. They do this by highlighting (valourising) some features and hiding (downplaying) others. Thirdly, by being initially grounded directly or indirectly, in our individual/ societal experiences, metaphors help us understand challenging domains of experience in

terms of others that are clearer to us. This involves the need for conceptually categorising natural experiential domains (the body; its interactions with the environment and with other people). Lakoff and Johnson's contention that mapping these domains leads to overlapping/fuzzy categories rather than crisp/discrete ones – in which understanding / meaning occurs as a whole (gestalt) experience, also seems to echo Alexander's essay stance concerning traditional movement and spatial structures in the city. My suggestion is that hierarchic and evolutionary based assumptions probably underlie his identified tree-like metaphorical conceptualisation of cities.

7. On Theory – Emerging Images of the City?

Returning to the list presented at the beginning of this essay – of thematic categories I use to introduce contemporary contextual urban design ideas to my students, one might ask how such a categorisation (or other variants) might be extended, given our current increasing fixation with 'future cities'? – What images of the city are emerging? – And will the shortcomings of previous utopian / futurist visions be avoided?

Alexander's insights from the city essay have been subsequently reaffirmed by the originators of a range of contemporary postmodernist urban design approaches – ranging from his own 'Pattern Language' popular with environmentalists, self-builders and enormously influential in software programming – to methods promoted within the mainstream industry such as 'Space Syntax' axial mapping software (Hillier and Hanson, 1984) the 'Responsive Environments' methodology (Bentley et al, 1985), 'New Urbanist' form-based coding (CNU, 2013) transcribed as 'Design Codes' in the UK using other perspectives and methods over the years. While these highlight the limitations of modernist-derived movement patterns such as rigid road hierarchies, disconnected estates and cul-de-sacs, the language used in their analyses, did not explicitly connect with Alexander's critique of abstract, 'tree-like' movement and spatial structures. And little or no

attempt seems to have been made (prior to this volume of essays) to explicitly link it to contemporary urban planning, design, and transport –nor to situate it within the inter-disciplinary currents of more recent urban studies and emerging ideas about cities - despite anecdotal comments about its influence.

There appear to be several reasons for this; firstly, Alexander's use of mathematical constructs and language in design fields where most practitioners were perhaps unable to rigorously critique his use of these bases; While this may be partly due to the particular use of set and graph theory, it is curious that space syntax, the methodology closest to Alexander's in its focus on abstract structure –and which had itself, begun with some graph analyses, albeit then moved into a more axial approach, seems not to have viewed the essay as a precursor to its own concerns at the time.

Secondly, Alexander's own subsequent abandonment of explicit mathematical approaches in his later, more qualitative critiques of architectural practice, meant his own work moved in other directions and he did not make explicit connections himself, with this earlier article nor with his PhD ('Notes on the Synthesis of Form') - another seminal text which helped spawn the 'design methods' movement - even if conceptually, comparable themes were being pursued.

This disconnection between the essay's key message, and development of disparate postmodern urban design approaches, (which did not seem to link with, or build upon the existing) meant that its implications did not quickly percolate into the mainstream of design practice in the UK – nor necessarily translate into urban and transport planning guidance or assumptions.

The first Essex Design Guide in 1973 produced early contextualised advice and CABE (late 1990s-2010) in the UK commissioned useful practice guidance aimed at distilling key urban design approaches into overarching principles for architects, planners, urban designers,

developers and clients in the UK development industry.[7] Despite the campaigning of UK organisations such as the urban design alliance, the Urban Design Group, etc, it was not until 2007 and probably due to CABE's influence, that new urban design based national guidance for residential roads (Manual for Streets vol.1) was published –followed by comparable new guidance for non-residential roads in 2010 (Manual for Streets vol.2).

This belated recognition of the overlapping issues linking road/transport design and urban design, is a step in the right direction (albeit more than 50 years after Jacobs, 42 years after Alexander and over 20 years after Bentley et al's & other urban design recommendations). If as suggested by Paynter (1989; 369 quoted in McIntosh, 1999) we need to view complexity as *"the degree of internal differentiation (horizontal as well as vertical) and the intricacy of relations within a system",* then our challenge going forward, is to better understand and represent the characteristic nature of differentiation and relations within *types* of cities.

I will end with a number of questions arising from my main argument. Given the projections that the greatest rates of urbanisation will be in the 'global South' –what are the implications for a need to analyse a wider range of past cultural examples of generative urban forms?

And if conceptual metaphors are indeed a central inescapable aspect of our thinking, how could we exploit these in explicit and progressive ways? What alternative conceptual metaphors could also be influencing urban design to ensure greater urban variety and resilience? Should 'smart' technology be the over-riding driver in planning our future cities? How could the 'soft computing' principles of 'fuzzy language algorithms' (Zadeh, 1984) on which smart systems are based (Kosko, 1993; McNeil & Freiberger, 1994) also be harnessed within urban

[7] *Commission for Architecture and the Built Environment, set up by the 1997 Labour Government, but no longer publicly funded, and now merged with the Design Council as Design*

design to facilitate the over-lapping movement and spatial relationships advocated by Alexander in his essay? Only time will tell. Clearly we have much more to do over the next 50 years.

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Chapter 10

The City and the Grid: Building Beauty at Large Scale

Sergio Porta[1], Yodan Rofè[2], MariaPia Vidoli[3]

1. Introduction.

The enduring popularity of "A City is not a Tree" (Alexander, 1965) for scholars in different areas of knowledge does not seem to show signs of receding. Quite on the contrary, a quick search on Google Scholar reveals that its annual rate of citations in the past five years is about 3.5 times that of the overall period since its first publication in 1965. In this paper Alexander proposes a focus on the complex nature of cities that, along the same line of Jacobs' chapter 22 of *"The Death and Life of Great American Cities"*, entitled *"The kind of problem a city is"* (Jacobs, 1961), challenges to the heart the conventional approach to urban planning and design. This challenge is all the more relevant today, when the call for a profound renovation of the foundations of the discipline comes not just by planning scholars, but also governmental and educational bodies (Bothwell, 2004; Farrell, 2014; U.N., 2015; UN-HABITAT, 2009). The urgency of this problem is obvious in an age

[1] *Urban Design Studies Unit, Department of Architecture, University of Strathclyde, Glasgow UK.*

[2] *Desert Urban Planning and Architecture, Switzerland Institute for Dryland Environmental and Energy Research, Ben-Gurion University of the Negev IL.*

[3] *Urban Design Studies Unit, Department of Architecture, University of Strathclyde, Glasgow UK.*

characterized by both unprecedented urbanization, predominantly involving the poorest parts of human population in the weakest planning systems (UN-DESA, 2014), and the unprecedented impact of human activities on the fundamental forces of nature (Steffen, Broadgate, Deutsch, Gaffney, & Ludwig, 2015). In the light of our failure in the post-WWII urbanization of the Global North, the question is simple: can we planners help at all with the urbanization of the Global South, which occurs far faster and at a larger scale? How can we become part of the solution, rather than the problem? In a rapidly urbanizing world, patronizing a niche cannot suffice; we need *a new mainstream*, one that works.

One way of seeking a route out from the current disciplinary cul-de-sac is by re-framing the organic analogy of cities as living organisms. Notwithstanding the countless references to nature that have permeated the culture of cities since Plato some twenty-four centuries ago (Marshall, 2008; Steadman, 2008), we planners have mostly approached the analogy with an inspirational attitude, seeking inspiration from nature's visible forms rather than from the structures and processes through which such forms come to existence; in fact, a plain *biomorphic* attitude. On closer inspection, this biomorphic attitude is just the simplest expression of a larger *developmental* approach to cities, as opposed to a truly *evolutionary* one (Mike Batty & Marshall, 2009). In evolutionary biology two different processes of form generation are clearly distinguished: *ontogeny* (where form is generated by "morphogenesis"), which characterizes *individuals* along their life-long (intra-generational) trajectory from the cradle to the grave; and *phylogeny* (where form is generated by "evolution"), which characterizes a *population of individuals* along an open-ended, long-term (inter-generational) trajectory. The two types of change are profoundly different, with different forces at work; primary evolutionary forces like mutation, natural selection and genetic drift operate only at the population (phylogenetic) level, while entirely different forces, for example nutritional or cultural, are at work on the development of individuals. Confusing the two would lead straight into

a Lamarckian[4] dead-end, which is in fact where we planners have been for decades, and still largely remain. Planners have always found it rewarding to interpret cities as individual organisms because in such developmental analogy they could act in the role of God (or Nature): if a perfect adulthood exists for our cities, planners are the ones who know how it looks like and how to achieve it by comprehensively engineering all factors involved along the way. A paradoxical outcome indeed, for a way of thinking inspired by nature: in fact a rather mechanistic approach to a phenomenon—that of the city—of enormous, almost unconceivable complexity.

Historically planners have practiced the biomorphic/developmental analogy with nature predominantly as a source of pure inspiration (therefore, more appropriately, as a metaphor), rather than as a matter of rigorous investigation. That was functional to the establishment of urban planning as a discipline in the first half of the past century. The recovery from it though, is certainly needed if planners are to do their part for a sustainable future. However, that will never come painlessly. In all evidence, working in a truly evolutionary perspective requires re-thinking the object of our investigation, shifting from the good city form to the process that generates it and the role that certain spatial features play in such process: effectively, it requires a new science of cities (Michael Batty, 2008). That, in turn, entails a different way of conceiving our position as part of an ecological process of urban evolution, which goes together with a different configuration of the practices around which our discipline is conventionally shaped (C. Holling & Orians, 1971; C. S. Holling & Goldberg, 1971). That may include, for example, realizing masterplans that are resilient and adaptive, or building regulations that do not inhibit informal

[4] *Jean Baptiste Lamarck (1744-1829) was among the first to propose, at the dawn of the XIXth Century, that the diversity of life is not the outcome of an act of creation, but rather the result of adaptive change over time combined with environmental pressure. His theory, however, failed in explaining how evolution works, because he thought that all happened at the level of the single organism. For him, it was the individual body that would respond to the environment by developing and adapting during its lifetime, and the acquired characters would be passed on to the descendants. His observation was right, but his explanation was to be rapidly disproved and ultimately dismissed.*

participation (Duany, 2013; Feliciotti, Romice, & Porta, 2015; Sergio Porta & Romice, 2014).

The discussion of the organic analogy clarifies that the current call for a disciplinary re-foundation can only be laid out on the ground that Alexander anticipated in "A City is not a Tree", that of the city as a complex whole that is configured to respect and support the structure of urban life, and therefore to serve it, by sharing with it the generative principles of biologic evolution. Alexander has devoted his life to progressively clarifying such principles in the inanimate world of construction; he ultimately re-framed the conflict between the mechanistic/conventional and the human/living systems of space production in terms of the irreconcilable "battle" between, respectively, "System B" and "System A" (Alexander, Neis, & Moore-Alexander, 2012). In this light, the problem of a new discipline is one of establishing System A as the new normal, or, in short, that of *System A at the large scale*. Alexander acknowledges that this is, unfortunately, an unresolved matter. In a recent paper presented at the Pursuit of Pattern Languages for Societal Change conference of Krems in 2015, we have treated this problem, concluding that, rather than a compromise between System A and System B, we should seek a deeper understanding of the way System A works in the long term or, really, re-frame System A in an evolutionary perspective (Sergio Porta, Rofè, & Vidoli, in print).

More specifically, we found that what really defines System A is its capacity to generate beauty in the land, and that the fundamental factor characterizing System A's is the *amount of life* that is generated into the process of making. We then observed, by looking at practical cases of beauty generation at small and large scale, that life occurs in fundamentally different ways depending on the *timeframe* of the process itself: in the short-term cycle of *project change* (sub-generational), life comes through coordinated activities of *observation*, *interaction*, and *co-action*, all based on the involvement—in various different ways—of the community of the builders (end-users, suppliers,

planning officers, developers, technicians, designers…); on the other hand, in the longer-term cycle of *urban change* (super-generational), life gradually spreads through the process by the countless uncoordinated—or better self-organized—interventions of individual citizens, groups or organizations, each pursuing their own mission, project or interest. We termed this latter bottom-up form of change *"informal participation"*. Alexander as first acknowledged in "A City is not a Tree" the existence of *"informal"* decision making as a second semi-lattice-shaped structure operating within the tree-shaped structure of formal administrative and executive control: this informal line of control *"varies from week to week, even from hour to hour, as one problem replaces another. Nobody's sphere of influence is entirely under the control of any one superior; each person is under different influences as the problems change"* (Alexander, 1965, p. 4). Moving this reflection one step further, in fact beyond public policy and into the broader domain of social interaction, we identified informal participation as a primary evolutionary force in urban change and the fundamental driver of System A at large scale. Planners—we concluded—hold a crucial role in this framework: the burden is on them to define and set in place, in the design phase, the *spatial structure* that supports and enhances the occurrence of informal participation over the whole post-design phase, in fact over the entire duration of the place's successive evolution in time.

The way Alexander uses the term "morphogenesis" (Alexander, 2004) to identify the process of beauty generation that is typical of System A, elsewhere called "living process" or "life preserving transformation" (Alexander, 2003), is technically precise: in fact it refers to the process of natural growth of individual living organisms (a tree, a shellfish, a human being) that is so defined in evolutionary biology; in Alexander's own words: *"the emergence of a new structure in nature, is brought about, always, by a sequence of transformations which act on the whole, and in which each step emerges as a discernible and continuous result from the immediately preceding whole"* (ibidem, p. 19). Alexander refers to morphogenesis in direct opposition to the

"mechanistic" or "artificial" process that characterizes System B; in this respect, his reflection remains very far from the simplistic formalisms of the biomorphic approach and at the same time firmly internal to the developmental interpretation of the analogy with nature. Nowhere in his writings the distinction—fundamental in evolutionary biology—between development and evolution, plays any role in addressing the problem of how living structures (and therefore beauty) are generated in the short as opposed to the long-term timeframe of the process. We argue that this distinction is crucial to capture the nature of the process that generates beauty in the long-term processes of change by informal participation, or the way System A works at the large scale of the city.

In this paper, we build on those foundations and move on to shed some light on the *spatial structure* that planners should attend to in the design phase, and how they can do so in practice. We address this problem as the "problem of the grid", after Leslie Martin's article entitled "The Grid as a Generator" (1972). This work was firstly published seven years after "A City is not a Tree" as part of a book that Martin co-edited with Lionel March (Martin & March, 1972). The article has been re-printed in several occasions including recently a special issue of Architectural Research Quarterly dedicated to Leslie Martin's memory just after his death in July 2000, where it is celebrated as Martin's *"greatest piece of writing"* (ARQ_Editors, 2000, p. 291), and the "Urban Design Reader" edited by Tiesdell and Carmona (2007). At least part of the resurgence of interest in Martin's article is probably due to the current popularity of the mechanistic vs. organic controversy in planning, of which it certainly was an early precursor. The reason why we find it relevant in this context is that this article is largely dedicated to a long confutation of Alexander's "A City is not a Tree", nevertheless ending up into unwillingly proving it by demonstrating a point that Alexander would have in fact entirely supported: that the most traditional model of planning cities at large scale, that of parcelling the land into a geometrical grid of orthogonal streets, does not prevent, but may even favour, the generation over time of complex

and vital urban environments. That is of utmost relevance for our purpose here, in that we might be able to show that a rather conventional planning system, one that is relatively light and straightforward, is in fact perfectly capable to express System A's core constituency. In other words, it looks like there might be something there that can drive us towards a "System A at large scale" that is not confined within an academic reserve, that in fact has long been mainstream in pre-modernist urban planning and design, and could pave the way to reinstating System A as the future mainstream of a truly sustainable discipline.

2. The Problem of the Grid

That Alexander is against the grid is apparently common knowledge. Indeed, the continuous references throughout his work to the naturally *"generated"* as opposed to the mechanistically *"fabricated"* (Alexander, 2003, pp. 182-185), makes this conclusion an easy take for the reader, one that immediately slips into the assumption that Alexander's agenda is essentially anti-planning altogether. Yet, we hope to demonstrate that a slightly closer look at his written work is sufficient to demonstrate that such conclusions are both fundamentally wrong. This misunderstanding has been there since the early days of Alexander's research, significantly contributing to establish the generally accepted assumption that Alexander's approach to a more human system of space production, later termed "System A", might be quite a good idea, but is inherently impractical at the large scale.

Perhaps one of the earliest and most influential examples of that misunderstanding is exactly Martin's "The Grid as a Generator". The importance of Martin's position in generating and establishing this misinterpretation of Alexander's thought is proportional to his relevance in the world of architecture, at least in the UK, in the whole post-war period up to his death. The stature of his figure is well portrayed by the introductory editorial of ARQ's special issue: *"Leslie Martin, who died in July, once bestrode the world of architectural*

practice, research and education like a Colossus. His buildings were written about by the young Aldo Rossi in Casabella, he held professorships at Cambridge and elsewhere and he established the Centre for Land Use and Built-form Studies (later renamed in his honour). He was one of the judges of the Sydney Opera House competition, he was architect of arguably the most successful and best loved post-War public building in Britain and he shaped the form that architectural education in Britain has taken for over forty years" (ARQ_Editors, 2000, p. 291). Less than one year later, on the same journal, Kenneth Frampton wrote of his *"exceptional leadership lasting […] for nearly fifty years from the mid-'30s onwards. He was, I often think, with all his strengths and weaknesses, the Gropius of our time"* (Frampton, 2001, p. 12).

The feeling, mentioned above, that System B is leading both our cities and the planning profession towards disastrous failure, is not anything new by any means. It is in fact where Martin starts from in "The Grid as a Generator" (Martin, 1972). Martin acknowledges that *"The activity called city planning, or urban design, or just planning, is being sharply questioned. […]. The attack is more fundamental: what is being questioned is the adequacy of the assumptions on which planning doctrine is based."* (ibidem, p. 6). Those assumptions, according to Martin, can be summarized in *"two powerful lines of thought:* […] *the doctrine of the visually ordered city [and the] doctrine of the statistically ordered city"* (ibidem, pp. 6-7). The former draws back to Camillo Sitte and has to do with the idea that cities are a total work of civic art which, as such; in this approach *"The planner then is the inspired artist expressing in the total city plan the ambitions of a society"* (ibidem, p. 6). The latter embodies a view of the city as a mechanism that, in principle, statistical sciences and industrial organization could understand, predict and reduce to perfect functioning; planners are here the masters of urban science, those providing the rigorous knowledge and firm guidance that is required for the endeavour. Conventional planning is a form of combination of both these two approaches. Against this vision of planning—Martin's

argument continues—sharp criticism was being raised from a point of view that intended cities as *natural organisms*. According to that line of thought, the increasing failure of city planning was due to its *artificiality*, or its difficulties to acknowledge and understand the inner natural principles of cities. Martin mentions as champions of this city-as-organism counter-approach Jane Jacobs' "Death and life…" (1961), and in fact Christopher Alexander's "A City is not a Tree" (1965). And there is where things start becoming tricky.

Martin spends a few pages of his paper to explain why Alexander was wrong in blaming grid planned cities as artificial, which in fact he never did, and equally Jane Jacobs was wrong in pretending that *"elaborate patterns of living can never develop within a preconceived and artificial framework"* (Martin, 1972, p. 9), which in fact she never stated. In Martin's view, the natural city advocated by Jacobs and Alexander is "organic" first and foremost in its visible shape, i.e. it *looks* curvilinear on a map, or in any case ordered in a non-Euclidean geometric way; in particular, it is curvilinear in the form of its street layout, as opposed to that of the artificial city, which is gridded; the grid pattern of the street layout would *per-se* manifest the artificiality of the city. Needless to say, Martin's criticism operates entirely within a *biomorphic* interpretation of the organic analogy that is his own much more than his alleged opponents'. The organic city of Alexander (as well as, though less rigorously expressed, in Jane Jacobs), is one where the physical units in which life occurs have a structure that is not made of separated and rigidly hierarchical parts (the "tree" structure), but rather of parts which are overlapping and interconnected (the "semilattice" structure). Both Jacobs and Alexander, however, do refer primarily to the structure of urban *life*, not that of urban *spaces*. The physical structure of cities that works well according to organic principles is one that does not prevent, but actually enhances, the cyclical overlapping of life units. Quarters, estates, playgrounds, shops, street types, pocket gardens, benches, newspaper racks, anything physical that in one form or another, at any scale, hosts definable units of life, cannot be separated in dedicated physical elements and set apart

from each other: quite on the contrary, those physical units must be closely integrated in space so that life units can overlap and find their most appropriate spatial environment as they emerge and change in time. That has nothing to do in principle with one particular street layout model, be it gridded or curvilinear. In fact, three out of four of the historical cases that Alexander quotes as exemplary "natural cities" are manifestly gridded (Fig.1), while four out of the nine "artificial" cases presented in "A city is Not a Tree" — namely Columbia, Greenbelt, Greater London Plan and Mesa City — exhibit a curvilinear and seemingly organic street layout.

Figure 1. Three out of four of the examples cited by Alexander in his "A City is not a Tree" as "natural cities" show a neat Euclidean grid-iron layout, with Siena being the only curvilinear case.

As for Jane Jacobs, the area of New York she has continuously referred to as an example of beautiful organic environment, the one where she has been living for long time, Greenwich Village, is a quarter of Manhattan, a notorious example of rigidly grid-shaped street layout.

Alexander goes straight to this point when commenting the curvilinear Mesa City project designed by Paolo Soleri: *"The organic shapes of Mesa City lead us, at a careless glance, to believe that it is a richer structure than our more obviously rigid examples. But when we look at it in detail we find precisely the same principle of organization."*

(Alexander, 1965, caption of fig.4). That is, in fact, what the "tree" and the "semilattice" structures are, in Alexander's mind: principles of organization, not physical forms. They are, as he put it right at the outset of his paper, *abstract structures*. Moreover, it is precisely the simplistic translation of one abstract structure into an aesthetic feature, especially as applied to representations *in plan*, that characterizes modern planning and makes it artificial and unsuitable to urban life.

Undoubtedly, Martin posed in his criticism a rather "careless glance" at Alexander's "A City is not a Tree". However, every cloud has a silver lining. In his attempt to disprove what he thought were Jacobs and Alexander's flaws, he devoted the rest of his paper to a brilliant demonstration of the benefits of the grid as a principle of planned and nevertheless evolutionary urban development. His point is that planned spatial structures can offer a valuable substrate to the "spontaneous" occurrence of urban life; or, as he sharply put it, that: *"an artificial frame of some kind does not exclude the possibility of an organic development."* (Martin, 1972, p. 8). Indeed, Martin goes further in his argument, sustaining that *"an 'organic' growth, without the structuring element of some kind of framework, is chaos. And […] it is only through the understanding of that structuring framework that we can open up the range of choices and opportunities for future development."* (ibidem, p. 9). Because it would be difficult to find better words than Martin's to describe this essential concept, we quote him extensively: "*Many towns of course grew up organically by accretion. Others, and they are numerous and just as flourishing, were established with a preconceived framework as a basis. Both are built up ultimately from a range of fairly simple formal situations: the grid of streets, the plots which this pattern creates and the building arrangements that are placed on these. The whole pattern of social behaviour has been elaborated within a limited number of arrangements of this kind and this is true of the organic as well as the constructed town. […]. The grid of streets and plots from which a city is composed, is like a net placed or thrown upon the ground. This might be called the framework of urbanisation. That framework remains the*

controlling factor of the way we build whether it is artificial, regular and preconceived, or organic and distorted by historical accident or accretion. And the way we build may either limit or open up new possibilities in the way in which we choose to live. The understanding of the way the scale and pattern of this framework, net or grid affects the possible building arrangements on the land within it, is fundamental to any reconsideration of the structure of existing towns. It is equally important in relation to any consideration of the developing metropolitan regions outside existing towns. The pattern of the grid of roads in a town or region is a kind of playboard that sets out the rules of the game. The rules outline the kind of game; but the players should have the opportunity to use to the full their individual skills whilst playing it." (ibidem, pp. 9-10).

In the rest of his paper, Martin goes deep into the description of three exemplary grids, those of Savannah, Chicago and Manhattan, and the way change occurred over all of them in different ways at all scales creating amazing diversity and ultimately successful cities over generations. His account of this change sits entirely in urban morphology, with reference to one of the founding fathers of this field, M.R.G. Conzen (which is highly unusual for urban planners). Urban morphology is in fact the branch of urban studies that deals specifically with the form of the city and the way it changes in time. That the same Manhattan which was portrayed by Alexander as an exemplary case of natural city was also one of the cases which Martin picked up to demonstrate that the "artificial" city can work just as well, should have suggested Martin that there might have been something wrong in his interpretation of Alexander. And it is a fact that Alexander's successive work has many times and very clearly touched the subtle interplay that a living process needs between a rigid—or indeed even "brutal"—geometry and the "natural" formation of centres around it, see for example (Alexander, 1987, pp. 162-170; 2003, pp. 401-412). That is not secondary: in fact, it is our opinion that Martin's demonstration of the potential of the grid to support organic life-enhancing patterns of change in the long term is fully aligned with Alexander's demonstration

of the semilattice structure of natural cities. They are the same thing, and are in fact demonstrated by the same case, that of Manhattan.

Naturally, this is not to say that any grid would *per se* be conducive to a well functioning, adaptive and resilient urban system. Certainly, a wealth of literature has explored what are the structural properties of urban street layout that make it similar to complex systems in nature, such as cross-scale self-similarity, or the ability to show high local clustering as well as high global connectivity (Zhang & Li, 2012). And we have shown that after WWII modernist planning principles have generated out-of-scale grids coupled with hierarchically separated background "neighbourhood", which inhibit the principles of a resilient structure (S. Porta, Romice, Maxwell, Russell, & Baird, 2014). The point that both Alexander and Martin have shown is that the coexistence of rapidly evolving small-scale urban elements and a long-term large-scale structure is the foundation of a resilient city, and that a good, well-proportioned and interconnected street grid can be such structure. Martin's criticism actually proves Alexander's point in "A city is not a Tree" more than anything else; moreover, it gives a solid ground to our search of how System A can work in the long term, hence at the large scale, at the same time shaping the future mainstream in urban planning.

6. Conclusions.

The discussion of the paradoxical case of Leslie Martin's criticism of Alexander's "A City is not a Tree" in his 1971 paper entitled "The Grid as a Generator" has brought us to establish a point that is important in our exploration of a way to make System A working at large scale and at the same time be mainstream in urban planning. The point is: a "natural" city, a city that is supportive of human life, a city that is resilient and adaptive to ever-changing surrounding conditions, in short a System A city, is not a city that replicates the exterior appearance of a natural organism, but one that replicates its inner structure. This structure is first and foremost *organizational*, in that it has to do with

the way its parts are related to each other at all scales. It is this organization, at this level, that Alexander refers to when talking of a semi-lattice structure as characteristic of "natural" or "generated" cities, as opposed to "artificial" or "fabricated". Importantly, this has nothing to do with one particular shape of the city, be it in plan or elevation, or in the street layout or buildings.

In particular, a System A street layout may be curvilinear or Euclidean, that does not matter. What matters is that the street layout, and indeed the whole organization of blocks, plots, buildings, public spaces and in short of urban space, does not establish barriers that separate from one another the spots in the land where life takes place, or the urban components at different scales. That is important because life in cities changes continuously, in a way that naturally overlaps in space in unpredictable ways, and therefore it must be allowed to "flow" unconstrained over the spatial substrate of the urban system and across its various scales. This idea, far from being just a notional descriptive observation, is commonplace in the sciences of complex networks (Boccaletti, Latora, Moreno, Chavez, & Hwang, 2006), and defines the core of what a living system is well beyond the boundaries of urban design and planning. In system theory for example, inner interconnectedness has long been recognized as the universal property of complex systems—both natural and human, and both societal and urban—that essentially enables the system's dynamic interactions across scales and ultimately its evolution in time (Gunderson & Holling, 2002). The essential opposition between the fluid spatial boundaries of urban social communities and the fixed geography of "neighbourhoods" in modern planning theory is the heart of Alexander's argument in "A City is not a Tree"; interestingly, he illustrates this point on the basis of an early work of a sociologist, Ruth Glass (Glass, 2013, c.1948), who about two decades later would significantly contribute to the discussion of the social implications of urban regeneration by pioneering the debate on "gentrification" (Glass, 1964). However, the profound implications of neighbourhoods as essentially social constructs whose boundaries naturally overlap in

space and continuously changes both in space and time – an understanding that Alexander articulated as early as fifty years ago – have gone entirely ignored within the planning community to date.

Alexander himself has spent considerable effort in his later production in the exploration of what are the founding rules of the semi-lattice structure he proposed in "A City is not a Tree", and crucially that of the process that generates it. That opens up an entirely new front for this discussion: if beauty does not come by-design, but rather by a natural process of "morphogenesis", how can we reconcile this principle with the notion of an initial planned layout, for example one that establishes a geometric grid in the land? This is a controversial point that can be resolved only in a truly evolutionary perspective. At a closer look, far from being contradictory, the combined presence of a deeper permanent structure and an endlessly diverse visible superstructure, or of *"diversity and unity"* (Savage, 1963, p. 3), is the tangible universal signature of biological evolution. This structure in cities may well emerge spontaneously at inception, but when the size of the settlement increases beyond that of a village it is very likely that at least in part its growth is planned. Planning in cities is always part of the overall evolutionary process, not distinct and certainly not opposed to it. In cities of foundation, the whole city can start off according to a plan, and certain mixture of originally planned and originally "spontaneous" areas is what we see on the ground almost without exception in all large cities of our time. Nevertheless, what really counts is not how cities started off, or what their design phase was. What really counts is what occurs to cities after their initial design, the evolutionary process that changes both the grids and the "organic" urban fabrics bit by bit, endlessly, in time. The primary force that animates this process is the informal participation of individuals, groups and organization to the shaping of change. As long as the initial structure is such—no matter if planned or not—that it supports and fosters informal participation as well as protecting the land, the conditions for a long-term unfolding process of beauty generation to start and flourish are set. That is a System A at large-scale perspective, one that is fit to become

mainstream in the next generation of sustainable and resilient urban planning.

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III REMINISCENCES

On the impact of "A City is Not a Tree," and its relation to colleagues' later work

Chapter 11

A series of short contemporary reminiscences by colleagues and theorists

Robert Campbell

Architecture Critic (Boston Globe)

Christopher Alexander, whom I know only slightly, has had an enormous critical influence on my life and work, and I think that's true of a whole generation of people. For me it began on the second floor of the library of the Graduate School of Design at Harvard, when I was looking for something else, and I ran across an essay by this person Christopher Alexander, called "A City is Not a Tree."

That was a landmark moment in my development as a thinker and as an architect. It really blew away what were the foundational principles of the education at Harvard in those days, and it established in me an interest in actually looking at the world – not looking at set of preconceived abstract mechanical ideas that were supposed to replace the existing world.

I will try to describe it, although the diagrams could describe it better. The easiest way to think about "A City is Not a Tree" is with transportation. Here's your house, on a little street – think of it as a tree, your hose is a leaf at the end, and then a little branch comes down, and meets a bigger branch, then a bigger branch, then a bigger branch – and finally you're on the Interstate. And there's been no way to move laterally through that system. You can only come and collect at the trunk of the tree or the Interstate. That was a planning principle that you will see exemplified in the British New Towns, after World War

Two, and many other examples of Modernist planning. This was a rationalized scheme. They say, we have a community sized enough for an elementary school, and then we'll have five of those that will be big enough for a high school, and five of those that will be big enough for a downtown, and so on.

Chris, being a mathematician, used the term *semilattice* – essentially a complex kind of network, with diagonal and lateral connections through the system, following the way that people really live.

My next contact was a book called *The Oregon Experiment*, which again blew me away. I remember talking to Oxford University Press about it, and they had no idea what they had. I said "you'll still be selling this book at the turn of the century – we are already some years after that now, and the book came out in the 1970s.

The Oregon Experiment posits the idea of growth by gradual accretion. That's certainly one of the many ideas that I took out of it. You don't master-plan the world and build it; the world grows by accretions. And then each new accretion that you add to the existing fabric, has something to relate to.

I understand they still use it as a planning guide at the University of Oregon – I was out there about ten years ago and I was told they were still using it.

And then came what I think was Chris' masterpiece, and the one book you should read, if you read only one book: *A Pattern Languag*e. I regret to inform you that it's longer than *War and Peace,* at 1,171 pages! But luckily it's not a narrative, so you don't have to read from the beginning to the end – you can dip in anywhere.

Chris is someone that I would characterize as one of a trio, and the other two are Vincent Scully, and Jane Jacobs. They all share the same quality, which is a distrust of the intellectual abstract Platonic idea of

the world. They are people who go out, and look, and draw their conclusions, and write them down, and go home. They don't spend any time at all worrying about where they belong in the "firmament" of intellectual ideas and theories and movements in architecture, because they're not interested.

I think this amounts to a movement, and all three of them have now won [the Vincent Scully Prize]. They all have a different way of looking at the world – a way that I think is much more appropriate.

The last experience with Chris before I actually met him was a lecture he gave at Harvard on Persian and Turkish carpets. It was not a topic that I thought I had any interest in at all. And again I came away with an idea that had never occurred to me before, that has been rooted in my mind ever since. A large pattern, like that pattern of the carpet, is made up of smaller patterns, each of which is complete in itself. This is a simple idea, but when you see these examples of, "yes, it's done this way and no, it's not done that way" – you realize right away the logic of that. And then you can translate that into city planning.

The city is a whole, but each part of it is a whole.

(From the Vincent Scully Prize roundtable discussion at the National Building Museum, Washington, D.C. 2009.)

Bruce F. Donnelly

Access Places

On May 29, 1974, when I was ten years old, three men who were members of the Black Muslim group of Cleveland, Ohio, kidnapped Andrew ("School Boy") Jackson, a drug dealer and pimp of young girls. They drove around to his bars and to his home in East Cleveland, gathering money and valuables. Leaving his home near midnight, the group was approached by a police car. Jackson broke free of the group

and ran to the car for safety, and meanwhile, the kidnappers became trapped. They tried to flee south on Mt. Union, but they were bottled in to a little enclave of four streets. They holed up in a house owned by a family named O'Brien. A SWAT team was called.

I heard the noise in my back bedroom, which faced the back yards of the houses on Mt. Union. I looked toward what turned out to be gunfire, decided to get my parents, and turned on my light. A police sharpshooter fired a bullet that neatly pierced the window glass and shattered my bedroom light.

Before it was over, five people were shot, including a friend of mine: trapped in a bullet-ridden house on a street that wasn't *quite* a dead end, but certainly was cut off from the area.

Some months later, my father gave me a copy of "A City is Not a Tree" to read. I'd been studying sets in school, and was curious about architecture and what we'd later call "urbanism." I read about a street corner with a newspaper box, just like the one near my house. I read about overlapping sets, just like I was learning about in school. And I saw pictures and diagrams of dead-end branches. It all clicked: the horrible "projects," the isolation, the kidnappers trapped, crime . . . and the supposedly beautiful ideas of pristine new cities.

I realized people had friends, and those friends knew friends, but not everyone knew everyone else. Whom you knew was constrained by where you were. I put police presence and control together, and safety, but also hatred between blacks (Jackson and the Black Muslims) and between blacks and whites (O'Briens).

I had never thought of a city as a tree before, but I never realized it was a place, either. A few months after the crime, I thought for the first time about how streets worked as a technology. It was also the first time I ever really understood how the Jewish ghettos worked.* But more than that, it was the first time that I understood how urban systems

controlled who could know whom. In retrospect, it was the first time that I really learned to think as an urbanist.

*I am Jewish, despite my surname.

Bill Hillier

Chairman of the Bartlett School of Graduate Studies
University College London

"A City is Not a Tree" pointed clearly to a change in the way we need to think about cities -- not as assemblies of one-off components that are hierarchically sorted, but as systems with global properties that manifest at local places. That, for me, is also the key insight and power of Space Syntax as a methodology.

I like to think that space syntax analysis – of cities for example – makes the structures of highly complex objects intuitively clear, and so can inform design. But the structures come from the objects themselves, rather than from a branch of mathematics. This possibility seemed to be implied – though not stated – by "A city is not a tree."

In a sense, *The Social Logic of Space* was an attempt to go on from "A city is not a tree" in the light of Chris's illuminating critique of human thinking in the paper – getting rid of the dominance of hierarchical thinking was the key idea.

Charles Jencks

Landscape Architect and Theorist

Karl Kropf

Urbanist and Theorist

At a time of increasing concern over the adequacy of design methods, "A City is not a Tree" broke open and reoriented the debate. It also

represented a fundamental change in Christopher Alexander's thinking. While retaining the mathematical foundation underlying his *Notes on the Synthesis of Form*, “A City is not a Tree” takes it in a very different direction. Where the one seeks a crystalline logic to arrive at the notion of 'fitness' between form and programme, the other points to a fundamental ambiguity and overlap in the relation of form to its uses. The one is an extreme extension of Modernist rationalism, the other a reaction against it.

Fred Kent

President, Project for Public Spaces

Christopher Alexander has been a sleeping giant for far too long. His elucidation 50 years ago of the growing formal/controlling excesses of the design community including architects, landscape architects, landscape urbanists, traffic engineers, planners and even urban designers that was and is continuing today, was extraordinary. He saw a trend emerging that has taken hold in every city everywhere. If we had listened to him and the other prophets of that time we would be living in a very different world. We view his era as the foundation of thinking on public spaces and "Placemaking". There were others that were his peers that collectively added to this issues he spoke to so many years ago. They included Jane Jacobs, William "Holly" Whyte, Donald Appleyard, Margaret Mead, Alan Jacobs, Jan Gehl, Clare Cooper Marcus, and Galen Crantz, all of whom stand out as significant leaders. With such a stellar cast of great writers and thinkers, what happened and why it was also put into hibernation, needs to be better understood.

We are convinced that these eminent thinkers got undermined by a force of individual, silo-defined agendas developed by the different disciplines mentioned above. They defined their agendas to support their purpose to create jobs and grow their impact on what they thought was critical to their future – agendas that they could impose on the unsuspecting public. Each discipline became its own audience.

The outcome has been a reaffirmation of Alexander's conflict between organic growth and control, where control has permeated government as well as the universities as "the" way to build communities of the future.

The only problem is, that is not the way many people are beginning to see what the future needs. They are becoming part of a major international force to bring back the "informal, community led" outcomes that historically defined cities around the world. One key force is the rise of innovation districts that have become a mantra for cities trying to jump start economic development in their city. But along with that is a growing movement back to more dynamic environments in which people can influence and share ownership not only with their work, but where they live. Thus, *Innovation* requires *Placemaking* to fulfill these newly defined needs. By combining innovation and place into a synergistically powerful combination, communities are adapting this same formula to other kinds of HUBS such as cultural, transportation, market, and even neighborhoods.

Why did we have to wait 50 years to bring about that shift?

My view is that the academic world retreated into more and more abstract research, where intellectual endeavors disconnected real life and its implications from academic pursuits. It allowed researchers to pursue pure topics, unaffected by complicated everyday life.

Through this re-emergence of Place Thinking, Placemaking, Place Governance, and Place led development that works with and through communities, we are seeing the massive reawakening of research, community organizing, and activation on many levels occurring all around the world. Many people are also seeing the connection between global climate change and place, offering as an important pathway out of a future of incredible despair and ruin.

Elizabeth Plater-Zyberk

Co-founder, Congress for the New Urbanism

Christopher Alexander has always been a part of our professional and academic life. I was actually surprised to note that *A Pattern Language* came out in 1977, because somehow I thought it was there before I even started being an architect in the earlier 1970s. And the reason I think it seemed that way is that it has always felt that Christopher Alexander's presence has been in the background, supporting us, as he said himself in his own words. His writings and lectures really have been a bulkhead for practice for many of us, and a kind of safe haven – by his very thorough examination of how people use buildings, and how one might design, incorporating that kind of analysis.

And this was of course at a time, which continues, when architects were expected to tell the user how to live in buildings of designs that have never heretofore existed. This is still being very much promoted in our profession. So he gave us the cover, in a sense. And when I say us, I mean of course Andrés [Duany] and myself, in our practice, and the New Urbanists as a whole. He gave us the courage to buck the dominant professional and academic trends, and the inclination to focus beyond the individual building, on placemaking that might in fact please its users. That was a kind of radical idea!

Chris' scholarship in fact has been his criticism. By his proposals, he has been implicating and critiquing contemporary practice.

(From the Vincent Scully Prize roundtable discussion at the National Building Museum, Washington, D.C. 2009.)

Witold Rybczynski

Author and theorist

I want to mention *A New Theory of Urban Design,* which is not as well known as *A Pattern Language* although it should be. It's a preposterous title, of course, as Alexander himself admits, but it's a wonderful book. It's wonderful because, like all his books, you hear the voice of the man when you read it. It's a sane voice – he's explaining how things work, and at the same time he's teaching you things. Through the book you feel you have a connection with the author. Alexander's books deal with theory, but they're written in a way that is very much alive.

(From the Vincent Scully Prize roundtable discussion at the National Building Museum, Washington, D.C. 2009.)

John Worthington

Collaborative Urbanist
Director, the Academy of Urbanism
Patron, Urban Design Group

Chris Alexander from his publications and teaching of the 1960's and 70's is arguably as well known and discussed as any architect of the second half of the twentieth century. *Notes of the Synthesis of Form* (1964) and later *A Pattern Language* became a part of every architectural student's essential reading. Chris, though passionate about making and building, paradoxically, was outside the world of professional architects.

Alexander's insights, like Kahn's designs, have been an influence throughout my professional life. As a student at the Architectural Association (1960-64) I was already interested in collaborative working and the process of briefing in design. The publication of *Community and Privacy* with Serge Chermayeff (1963); his dissertation findings, *Notes on the Synthesis of Form* (1964); and the seminal essay "A City

is not a Tree" (1965) hastened my desire to study further in the States. A Harkness Fellowship (1965-7) was the opportunity to explore the interaction between briefing and design, Initially with Kahn in his Masters studio at Penn (University of Pennsylvania) and then to the West Coast and Berkeley with Chris. Every afternoon with a small group we struggled, taking the clarity of individual patterns, to create a coherent form for a Californian Barn. Berkeley was in ferment: flower power, civil liberties, and within the faculty, the disparate voices of those such as Horst Rittel ("Wicked problems," his paper published with Churchman, 1967), Ezra Ehrenkranz ("California Schools System") and Mel Webber ("Urban Place and the Non-Place Urban Realm," 1963).

Returning to England, my focus was less on a desire to design buildings, and more on what to build and the planning and use of space. With Frank Duffy, who had followed me on a Harkness Fellowship to Berkeley and stayed on to complete his PhD at Princeton, we established an outpost of JFN, a New York firm of Space Planners (1969) and we founded DEGW in 1973. Alexander's work and the American experience stayed with us as we proceeded to build a global practice integrating spatial and organisational demands from the scale of the chair to the city, with design for change as its focus (*Design for Change: The Architecture of DEGW,* Birkhauser 1998).

As the director of the Institute of Advanced Architectural Studies (IoAAS) at the University of York and Professor of Architecture (1993-97) I was again reminded of Chris. The computing department looked on Alexander's work with reverence, and we found a common interest in briefing. During this period Chris spent time in the UK and was involved with the Prince of Wales's Institute of Architecture and Summer School, and over a five year period, designed and built the West Dean visitor centre. Meanwhile his links with the mainstream professional and academic communities were tenuous.

In 2011 the Urban Design Group awarded Chris their lifetime

achievement award, reflecting his work on *A Pattern Language* (1979) and *A New Theory of Urban Design* (1987). This was a brave move as Chris had moved forward from the work of that period. He was increasingly interested in the process of making (e.g. the Eishin College Campus, near Tokyo) and the nature of the forces that shape a collaborative process of design integrated with constructing – a period poetically described in *The Battle for the Life and Beauty of the Earth: A Struggle between Two World Systems* (OUP 2012).

In 2012 I had the opportunity to spend time with Chris, and I recognised how much he still had to offer, but I also realized how much he was now an outsider. As past President of the Urban Design Group (1989-91) and a current Patron I was asked to invite Chris to give the UDG annual Kevin Lynch lecture, in recognition of his lifetime achievement. He was hesitant initially but agreed to do an evening in conversation with myself. The three of us, including his wife Maggie, had a delightful day together, a good lunch and time to walk the grounds at West Dean. Making and the process of collaboration absorbed the day. Patterns were mostly relegated to an earlier era. Sitting having tea on the centre's terrace and listening to the enthusiasm of the families around us who entered our discussion, was a delight. He was humble in his responses and generous in his praise of those who worked with him.

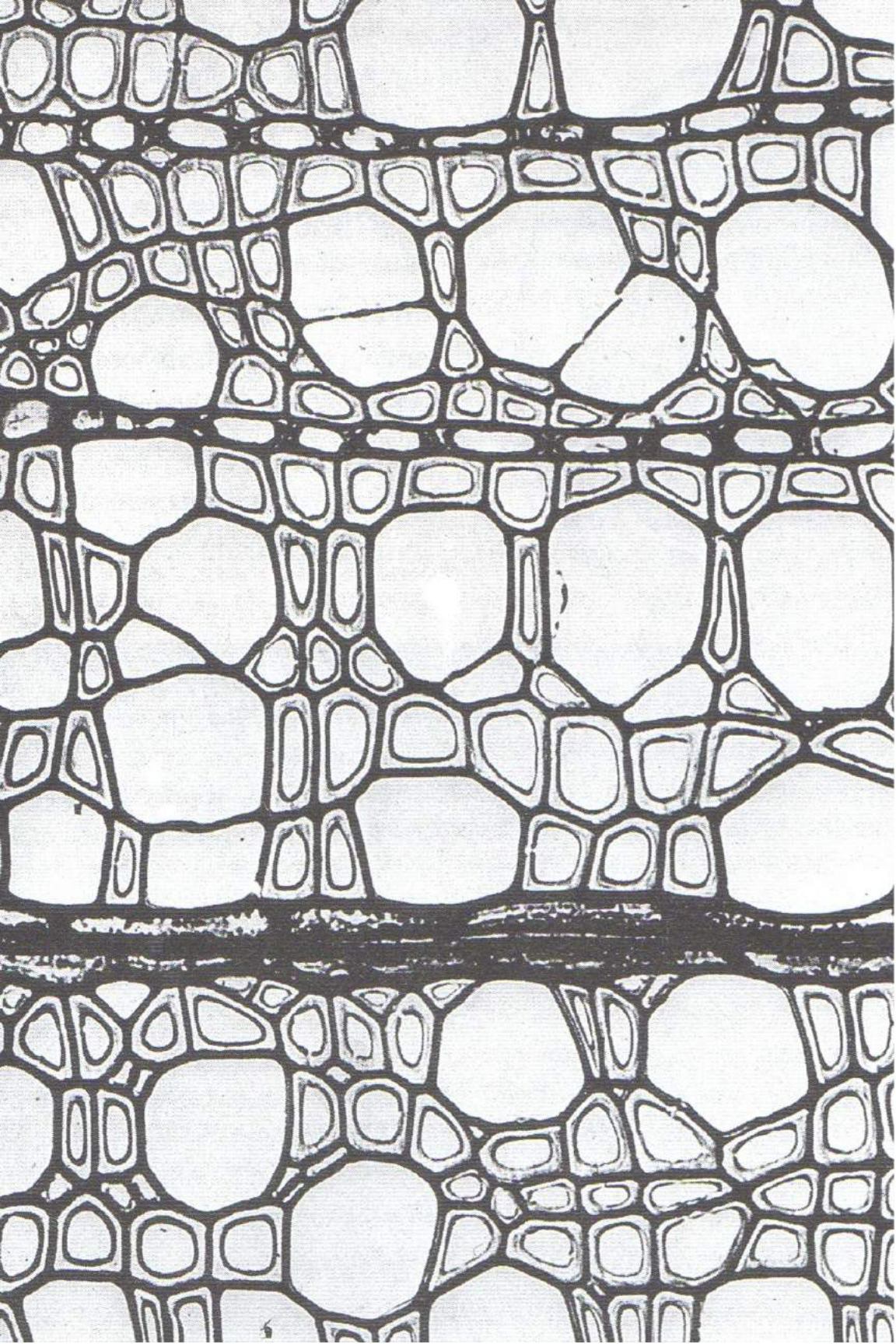
On the evening of the presentation, we had a packed hall eager to hear a continuation of discussion of *A Pattern Language*. The story of Eishin, with the rejection of all that the current construction system stood for, made the professionals in the audience feel uncomfortable and threatened. The younger generation was happy to be in the presence of a celebrity.

In this world of paradox (as Charles Handy observed in 1994) Chris's philosophy of the organic, open, overlapping and ambiguous world, is of its time. The ubiquitous technology and apps can now achieve the vision we struggled to describe, 45 years ago at Berkeley. We were

searching for a pattern language to make a self-regulating, better city.

Chris and Maggie at West Dean Visitor Center in 2012. Photo by the author.

IV DIALOGUE



Chapter 12

New Science... New Architecture?

A conversation about geometry, life, and the challenges of the future

Christopher Alexander and Michael Mehaffy
Center for Environmental Structure (2003)

NOTE: The following interview first appeared in the web journal Katarxis 3 (www.katarxis3.com) which also has a wealth of other essays, interviews and photographs. The interview was conducted in 2002, and it provides more context for Alexander's work after "A City is Not a Tree".

Michael Mehaffy: We're seeing some astonishing things coming out of the sciences just now. Geometry seems to be the hot topic - the complex structure of proteins, the unfolding processes of embryology, the distribution of large-scale structures in the cosmos, and so on. And there has been more confirmation of the fantastic notion that life itself is a certain kind of geometric structure. From there it does not seem too big a leap to the assertion that consciousness, and the conscious experience of quality and value, are rooted in geometric structure as well. Certainly recent work in the neurosciences seems to suggest this.

Of course, you have been arguing something like this for years, and developing it as the basis for a more advanced architecture. You have criticized the kind of abstract expressionism that has bogged down modernism at the level of sculpture, and you have argued for a much broader and more adaptive architecture, one more rooted in the geometries of human life. The new sciences seem to us to provide a lot of fresh evidence for your assertions, and to point the way to some very

promising new tools for evaluating and perfecting the qualities of a built environment, along the lines you have suggested.

You recently said you find these new geometrical insights of science very promising and exciting. What is it that you think is most exciting about these new developments from your point of view?

Christopher Alexander: It's the idea that, instead of talking about architecture in traditional terms, which invite all the criticism about romanticism and about being buried in the past - all of this actually just being replaced by an emerging body of fact which establishes the substantial nature of these claims.

You know, up until about 1600 it was essentially religious authority that held sway, and one did what that tradition said to do. And people were comfortable with that, and there wasn't much need to be questioning it.

Around the time of Descartes and Newton, something else happens - the authority that comes from things is the observations of our own senses. We're going to pay attention to what we can see and what we can identify and what we can know. And the criterion for knowing it is, that whatever we hold to be true can be put in some kind of experimental form, that another person can then be convinced of. And that unless something meets the standard of being sharable in that kind of sense, it isn't going to pass muster.

Now that's an incredibly powerful thing that's been running now for about 400 years. It's really swept the world. And it has made the world what we know it to be today. But the thing is, value has not been included in this approach.

So you've got all this stuff which has this wonderful way of being shared, by observation, experiment, you own eyes, your own fingers, and so forth. But all the matters of value that we're fundamentally concerned with as architects - they slip through the net, they're just not

dealt with. They're all seen as arbitrary.

Now, if we successfully put forth the idea that value can be discovered through an experimental procedure which gets results, which helps people to reach agreement, and therefore is sharable, this suddenly puts value in and among that huge movement that began around 1600. Where suddenly, we're looking at an understanding of things that can come from fairly simple experiments that we do by examining ourselves, and our reactions to things, but in a very special way.

So I do think that the new scientific developments which have occurred, the whole slew of things in computer science, simulations, generativity, complexity theory, of course - all fascinating, all very important, because it provides foundations for those sorts of things as well. But the real crux of it is arriving at a sharable method.

And so I think this issue about the scientific cauldron which is capable of giving birth to this material is a phenomenally powerful thing.

MM: And historic?

CA: And it is historic, yes.

MM: You speak in a very direct and personal way, and as you said recently, that is the essence of science - the ideas and the discoveries of what works. You can put all the window-dressing and the other parts on it, but that's not the science.

CA: My interest is in buildings. And I'm a scientist insofar as I try to understand what's going on in buildings, in a reproducible, accurate fashion, and try to tell the truth about it. I'd say that the principal thing that has helped me to thread my way through this rather incredible briar patch is trying to tell the truth about what is really going on - when you're in a building, when you go into a building, when you come out of a building, when you use a building, when you look at a building,

when you look out the window of the building, and so forth.

And I'd say that the biggest problem with 20th century architecture was that architects became involved in a huge lie. Essentially what happened at the beginning of the 20th century was really a legacy of the 19th. New forms of production began to be visible. And in some fashion artists and architects were invited to become front men for this very serious economic and industrial transformation.

I don't think they knew what was happening. That is, I don't think in most cases there was anything cynical about this. But they were actually in effect bought out. So that the heroes of, let's say, the first half of the 20th century - Le Corbusier, Mies Van Der Rohe, Gropius even - a very nice man, by the way - were brought on board in effect to say, OK, here's all this stuff happening, what can you do with it? Let's prove that it's really a wonderful world we're going towards. And instead of reflecting on questions about, well, what was it that was going to be wonderful about this world - from the very beginning, the architects became visual spokesmen, in a way to try to prove that everything was really OK. Not only that it was really OK, but somehow magic.

You know, there was this phrase, elan vital, which was bandied about a lot in the middle years of the century, and in the early years of the century as well - of, there's something incredible happening here, we're part of it, we're reaching forward. But all of this was really image factory stuff. And what they didn't know about the late 20th century was only known to a few visionaries like Orwell and others who could actually see really what was going on.

I don't think this is a very flattering view, and I suppose architects would reject it, angrily. But I do think it's true.

MM: It's essentially a program of apology for industrialism?

CA: Glorification, of something that is inherently not glorifiable. And it's really very very similar to the ads we see on TV every day now, except this was being done with architectural imagery, and with buildings. And the architects are busy, right to this day, still trying to perpetuate that process that they successfully did in the 20th Century.

MM: In the book you speak about the Cartesian world view, the mechanistic world view, and how it is, at least for you - and you've made parallels to others - giving way to another world view, a world view of process and of complexity. Are your critics trying to understand you in terms of one world view, and you're speaking from another?

CA: I actually don't think it's as deep as that. I think they know they're not doing very good work - especially the mainstream architects. And they don't really know what to do about it.

Going back to your other question - you know, I'm still really working at the question you asked me about science. The first rule of any scientific effort is observation. You know, you have to see what's going on and tell the truth about it, and not get hoodwinked by preconceptions. And so in that sense of course what I did was very deeply rooted in science, and in my scientific training. And it was the intellectual struggle that I have had to go through over these 25 or 27 years of writing this book *[The Nature of Order]*, because the things that it seems to me necessary to conclude as one studies what is really true are staggering. I mean they are completely inconsistent with the scientific world picture that we have believed in certainly the 20th century. And so especially for me, given the fact that I came from a scientific background at Cambridge, I had the most incredible difficulty actually writing this stuff down.

So gradually then, things arose out of that which I suppose people may claim kinship of all sorts.

There are so many major unsolved problems, which have reached similar conclusions for parallel reasons. Wholeness in quantum mechanics, for example, or unfolding of geometry in embryology. So you have lots and lots of things which have reached surprisingly similar conclusions, for very different reasons, just because people facing scientific problems in these different fields somehow seem to be coming up against a brick wall. Same one. And that I think is due to the fact that the world picture we've had doesn't support reality very well.

MM: And do you think that those people in those other fields are also changing their world view, in a parallel way to what you have discovered?

CA: I think so, yes, I think that's quite true. And I think that actually very similar problems have arisen in physics. [David] Bohm1 faced tremendous difficulties - I mean, even though he probably was the person who made the single biggest contribution to understanding of what's really going on in some of the perennial puzzles of quantum mechanics - they wouldn't even let him lecture at Berkeley the last time they tried to get him here. And Brian Goodwin for instance, in biology - absolutely on the forefront of this kind of thinking.

I think there are dangers in all this - I don't like "woo-woo" land at all.

MM: And you have been accused of being "new age" and so on.

CA: Yes, for example, right. And so in some ways I quite deeply regret having had to write the book that I've written. You know, because it has a taint, almost.

MM: Simply because it's against the current world picture?

CA: It's partly that, for sure - but the ground is so treacherous. If you just take the subject of wholeness, for example - good lord, it is

difficult. It's really difficult to get a strong firm grip on the concept, on the structure that it has, even how to talk about it clearly. There are peculiar things like self-reference in the logic of how you have to talk about it, that are very uncomfortable, for somebody who is used to normal scientific thought.

If we're just talking as architects, and we're talking about a particular room, let's say, and we're trying to figure out how to build the windows in that room, so as to make the room as good as possible... Now, the thing that's going to get us furthest in making that attempt is painstaking observation of our feelings as we are in the room, whether let's say the room is unfinished or something, whatever state it's in, and we're trying to guess what kind of window is going to have this effect. And whether we do it through mockups in the full size or whether we make models or we even try little sketches or whatever it is we're doing. But what we're trying to read is what depth of feeling comes into being because of the window being such and such a size, shape, position, and so forth. Now, this is hard work, very hard work.

MM: The core task is to figure out how to make beautiful places. And the other parallels in science are a supplement to the core task, more a reinforcement, or an echo if you will, of what that is?

CA: Right, yes exactly. It's partially even - you might almost call it a political effort. Because I think that this very bad form of architecture that has existed is vulnerable to this particular attack. And the reason is quite simple. You see, the thing is, the modernists really - because they've got their head in the sand to cover up the traces of what was begun so many decades ago, and was essentially founded in really untruths, they have to keep saying, "I don't want to know the facts, I've just got to keep going with this thing that we're all supposed to be doing." So they're all very vulnerable to the question about, well look, there actually are scientific ways of asking about these things and studying them. But if an architect of the modernistic persuasion is so vulnerable in his actions or his thoughts or his work that he can't dare to

consider this possibility, then that will very quickly become very visible as a huge weakness.

MM: One of the goals of this issue of Katarxis is to explore the relationship with the Classicists. As we were talking before about alliances, is there a way that we could have an alliance, in spite of whatever differences there might be?

CA: Well, by an odd coincidence, I wrote something about this for the [TradArch, U. Miami] listserv. I agree with you that it is a necessary alliance. I really agree with that completely. I don't have any doubt about it. And I think the same goes for the New Urbanism.

MM: Yes. Andres Duany, who you know very well, said that Leon Krier's influence was a revelation for him, a formative moment. And I know that Andres is also sympathetic to the idea of "organic" order. And he once told me that something you said to him was the basis for "everything we're doing now."

So that was one of the questions I wanted to ask you too - what's your advice for the New Urbanists? It relates to the one about Classicism, because that's such a strong strain within the New Urbanism.

CA: Right. I think that many of the people who are involved in the CNU actually have not understood the problems that the developer represents, and what has got to be done in order to change that situation. It's very very serious.

I find that one actually much easier to talk about than the Classical issue.

I feel emotional sympathy for the Classicists. You know, in reading the pages of TradArch, there's something so nice about the way they talk to each other and the way they like to talk about buildings. There's something very warm-hearted about it, which I find extremely moving.

But I get off the bus when I have to start thinking about - well, I don't want to put Doric columns in the jungle, you know.

You know, in the history of modern architecture, there was a refrain that kept coming back, which was such and such is not honest - copying things from other times and places is not honest. And you may be surprised to hear that I completely agree with that. Although I think what architects did with this idea was crazy, because or course it became a mad rush toward newness for its own sake.

But it is undoubtedly true that in each era, forms must arise that come from the technology and economics and social circumstances of that era. So that if one sets out a program where you're essentially sort of copying old forms in any version, you're liable to be in a hell of a lot of trouble. And I think that trouble is evident. I think that to some extent it explains the slight smirk of discomfort that people have when they're looking at not only Classicist buildings, but what you might call developer kitsch. I mean, there's a lot of developers who certainly clearly understand that people do not want glass and aluminum houses. But they don't know what to do about it, so you get your - whatever - your Cape Cod, you know, lookalike, and all these different things.

So what I'm really saying is, developers have in effect got this problem, just like Classicists have got this problem. I mean, developers have other problems too, but I'm just saying this is not peculiar to people with a classical bent.

And I think that it is necessary to spend time - I would say major amounts of time - thinking only about form and geometry. Thinking about the language of form that is appropriate now. That we can use. And this doesn't merely mean, OK, we're going to have some generating system which is magically going to put things in our hands. I think that's a fallacy actually. Because although certainly nobody believes in generating systems more strongly than I do, but some aspects of the generating system actually have to specify geometrical

organization.

And if we're not constantly thinking about, OK, here's such and such kind of a building, and here we are in 2004, what is a really comfortable and right kind of form for such a building. And how do we do it? And then of course, what's the generative process which will produce endless buildings of that kind, in that sort of sensible manner.

The Classicists, interestingly, have absolutely no problem doing those kind of exercises. That is, they spend a huge amount of time teaching people simply how to draw buildings that are good, in organization, shape, proportion and so on and so forth. And actually I don't believe it can be done any other way - except that I don't believe one wants to be using only classical forms for that purpose.

But when I say, I don't think one can do it any other way - you know, I think there's a lot of very intelligent people, who would love it if somehow one didn't actually have to make that artistic commitment, or take on that artistic act. And if somehow, from some sort of scrambled mélange of systems or dynamic variables, or whatever, that the form is going to give itself. And sort of come without the artistic commitment to it. And I don't have any problem with that thesis if it was true. That is, if you could do it. But I don't think one can do it. I don't think it works.

MM: No matter what system, don't you need the human being there to say what is their feeling at any given point in time, and whether that is true for them?

CA: Oh, certainly, absolutely you need that. No question about that.

I mean a very significant and interesting issue has to do with roofs. You know, 1965, 1970 it was completely taboo to use a pitched roof. There was quite a struggle - I played some role in that struggle myself, and I remember all the humorous episodes involved in trying to get

students to say, yes, actually I can make a pitched roof, and think well of myself. But in fact I think that the pendulum has swung too far in that direction. I mean, it's one thing in a snow and ice climate, where you've got real problems with large amounts of snow sitting on roofs, causing snow load and all other kinds of problems. But in many of the world's climates, that's really not a fundamental problem. And also the waterproofing methods that we have now are so incredible compared with those from earlier times, that you don't necessarily have to have a roof that will literally let the water run off and shed itself.

So I don't think there's anything wrong with building pitched roofs. But actually what I've gradually come to find is that the buildings with flat roofs is a bit more comfortable in terms of seeming to reflect the ordinariness of everyday life. And pitched roofs are OK, they're sometimes unbelievably beautiful - but also sometimes, a little bit on the cute side. And it's not that easy to avoid that. And I find it curious that in an odd sense, a flat roof may be more suitable - leave things alone a little better, and so forth.

It's very difficult to define this, but there's something there that makes sense out of technology, that makes sense out of very vague, large-scale feeling of a certain kind of site, or certain kinds of neighborhoods, and leaves things alone better, and is actually, in an odd sense, more structure-preserving to the earth. Now this is not a universal rule by any means, but I'm -

MM: It's an exception to the usual classical approach?

CA: Well, definitely that. And it means that you're actually on your mettle, if you can even get an answer to this problem. You know, because you're thinking about stuff - my gosh, there certainly is no pre-cooked answer in history to be found to this. And it's a hell of a tough question.

Or another example, it's in Book 3 of The Nature of Order. We were

suddenly faced with the issue of building marble floors for the Megaron in Athens, which is a huge concert hall. And the floors we were asked to do were about two acres in size. Very large concourses. And to do the kinds of intricate patterns of the kind that [the owner] specifically wanted in two acres, it looked as though there were likely to be 400,000 pieces. Now, just to cut 400,000 pieces of marble is an incredible problem in itself - let alone assembling it. On top of all that, we had to put that floor in - we were given two months to do it. So we set out a way of using a water jet cutter, prefabricating pieces, creating circumstances where you could both do mockups while you were developing the floor, then you could do them again in the actual place.

MM: Computer-controlled?

CA: Yes, exactly. All of this sort of thing. Well, it really changes the result. That is, if you compare that with the kind of floors that were built in Italy in the 12th century, they're really different. And it's not, I don't think, all that helpful to say it's vaguely classical in feeling - actually it's not. But I mean somebody who is persuaded by Classicism might say, "well anyway, you know, the reason these floors are nice is because they vaguely resemble that sort of thing." But actually I think the reason that they're nice is that they have that living structure which I've written so much about, in a demonstrable fashion.

And that that's really what the people who have immersed themselves in classicism - that's really why they're doing it, because they have a passion for buildings, they don't know how to get that result, without emulating those ancient types. It really is not a harmful thing to do, but it isn't the best way to do it.

MM: Right. I thought your paper [“Classicism and the Many Cultures”] did a good job of discussing the fact that tradition is really a much wider thing than Classicism, and you have different traditions all over the planet, and you have, you know, us in our day, able to make our own tradition. And tradition isn't at all something that's frozen in

time.

CA: Right. This business about finding a language of form which comes out of a technology, out of a technique, and out of the feelings that exist in our environment, is really the core of the matter. And although the modernists have – it's weird, because actually they would probably subscribe to a great deal of what I've just said. But what they actually do with it is so peculiar and often offensive.

MM: And they were embracing a form of industrialization that was - how would you characterize it? Inhuman?

CA: Well, it was really limited. It really was the first few decades of industrialization. And the things that were being mass-produced, and what could be done by mass production, were very limited. But more important, you know, all of that mass production stuff came from Taylor. And there are serious social problems. In other words, it came from something that's actually quite gruesome, humanly speaking. I'm just talking about the production techniques.

MM: I wanted to ask you what you think is happening to technology today, particularly computers, and the potential to create a more human kind of technology at this point.

CA: Well, it's positive. You know there's all these kind of one-off assembly lines now. Special purpose, car manufacturer, furniture manufacturer, and so forth.

MM: Cabbage patch dolls, where each doll is different, to take a trivial example.

CA: Yes, that's right. But still, nevertheless it's interesting. But the trouble is that even the people that I think are the most far-sighted and the most intelligent in dealing with that stuff are completely, I'd say almost 100 percent trapped in the notion of combinations. Of

recombination and recombination of components.

MM: The reductive technology in the early industrial period which still very much grips us? Pulling things apart and putting them together in little bitty pieces instead of trying to create wholes?

CA: Right. And of course what happens in the biological world is that the wholes come about by differentiation - not by assembly. And that's an entirely different class of things.

MM: That's a crucial point, isn't it?

CA: Yes, very very - absolutely crucial. And probably - it's probably the single most serious issue, because without that you just cannot get there. And yet so much of the definition of an architect, the definition of a contractor and of a subcontractor, and all these things - they're all virtually assumed to be playing some role in the assembly process. And the idea that all these folks might be playing roles in a differentiation process, and that it really and truly was that, is just I think almost out of reach at the moment. And I think it's one of my biggest aims in the Nature of Order is to show what this means, that it is feasible, to set it up as a model of our profession, what we must do.

MM: Something else I wanted to ask you about is that in our current view, everything is personal taste. And anyone who suggests otherwise is a dictator. And you certainly have had that allegation.

CA: Oh, yes!

MM: Right. And so, to go down the path of saying, well wait a minute, everything isn't personal taste, is very frightening. Are we heading towards, you know, something where our freedom is going to be taken away? I mean it's terra incognita.

CA: Yes, it's a complex subject. Actually, it's ironic - in a way, it's

quite peculiar, because probably of all living architects, I'm probably the one who's most catholic. So, it's quite a stretch to do that, and yet it's very effective.

MM: And there's a related concept I wanted to ask you about, and that is that tradition implies authority. Tradition in the broad sense, not just tradition in the Classicist sense of following a historic pattern.

CA: Right. One of the things which I am trying to do in Book 3 is, in effect, say look, there's this family of forms, this idea of living structure. It does seem to me quite plain that we must draw our material from that family. And if you go outside that family, you're going to continue to devastate the earth.

OK, so now let's just think about some numbers for a minute. Because that statement can have a lot of different interpretations.

One interpretation, an extreme one, is that for any given problem, there's only one solution. I mean, I've been accused of saying that, which I've certainly never said. The second, slightly more sophisticated version of that is, that as you're wending your way through the path of a design process or a building process, there's only one best step to take at any given moment. Also not something I've said. But of course if those things were actually said, it would indeed be frightening, because it would have a sort of deterministic quality which would be actually quite strange and I think uncomfortable, for anybody that was doing anything.

The real situation is quite different from that. I've got an appendix in Book 3, where I discuss the number of possible configurations, how many of those are living structures. And all of this is quite difficult to make estimates of. But the numbers are fascinating because they're so utterly, absurdly gigantic. If you take a sort of middle-size building, a few stories high, and you say, OK, how many possible arrangements are there within the volume of that building and its immediately

surrounding open space. Now the number that you come up with is one of those numbers that looks deceptive, it's something like 10 to the 10th to the 17th. I mean, it is a number so utterly insanely huge, that's the number of all possible configurations within that sort of volume.

So then you say, alright, well now how many of those are probably living structures? Can one make an estimate? And that number is an infinitely small fraction of the first number that I just told you. But even though you have to divide that number by 10 to the godzillion, to get down to the living structures, when you try to estimate this out - the number of living structures is still utterly gigantic beyond measure. Far, far larger than the number of seconds since the universe began, or the number of particles in the universe.

So that what you have to realize as an architect, thinking about generative theories, and thinking about unfolding... suppose that you're in a process and at a given moment, there might be, let's say a thousand things that you could do, and let's say that there's a hundred sensible things to do. And you're going to take steps over and over and over again over a period of a year, let's say. So you're going to make these kinds of choices, and you're going to have the opportunity for a hundred choices, twenty thousand times.

So that any idea that this is deterministic, or that this really putting you in a bind because it's authoritarian or it's under control, or it's whatever - is just actually the sheerest nonsense.

You know, I've known quite a few traditional craftsmen, in real traditions, in different societies and different cultures. I've never met a person who was in one of those traditions, who felt themselves to be in a bind, who felt themselves to be locked into something, who felt themselves to be under authority. Of course what they actually feel is free. Because they know what to do, and therefore they can do whatever they want.

So that this whole discussion about totalitarianism - what it really boils down to is the contrast between freedom to be arbitrary, as opposed to freedom to be appropriate. And if - of course if you want to have freedom to be arbitrary, that's one thing. And much of what we've got going on in the world of architecture today is based on that supposition. If you want to be appropriate, you can still do a million different things, but being appropriate is going to guide you, and that is what is going to tell you what to do.

MM: We talked a little bit about tradition and traditional cultures, and you addressed that in your paper on TradArch. And I wanted to touch on what you think is happening globally right now, with other traditions, and where that's all heading and should be heading. I'm thinking in particular of the idea that there is a huge reaction to the western modernist tradition around the world. And some of it is obviously murderous and horrendous and evil, and some of it is understandable, and something that we should perhaps pay more attention to.

CA: You mean 9/11? Oh, I think so. I think that there are two, kind of parallel courses. Of course, one of them is, that we've got this really incredible economic dichotomy. We've got five billion people who have a small income, and about one billion people who have what we consider a normal income, but it's actually a huge income by comparison. And of course it's absolutely inevitable that that is going to lead to consequences - which I've actually been waiting for since the middle of the twentieth century. So I wasn't particularly surprised by this event.

But I think that there's a second aspect which you essentially just alluded to very clearly. And that that of course is people feel that their birthright is being taken away from them. And that provokes a lot more anger than just being poor. Actually it's far more serious. And I don't think it's exaggerating at all to say that these things are manifest in what is called terrorism. And they need to be dealt with. I've done my

best to build in a number of different cultures, and to try to get somewhere close to cultural reality, in a pretty wide range of places. And occasionally, I've been successful.

I remember, when we did the project in Peru. I think there were 15 architects from different countries in the UN, site of the competition, and then there were 15 Peruvian architects, designing these houses for Peruvian families of low income. And the judges, who were largely Peruvian, actually concluded that we had done a better job than the Peruvian architects, by - you know, I don't know if you know the history –

MM: I recall that you studied very carefully the way those people lived.

CA: Well, yeah, we - absolutely, we became members of families. And so, you know, we really immersed ourselves in it.

MM: And isn't that the distinguishing feature of a human architecture? It isn't simply a form that is a piece of art that everyone should admire, it's something that addresses everything about a culture and their lives and the way they live?

CA: Yes, I think so. Actually one of the things I'm very proud of is that during the 70's and 80's I had students coming, you know, from India, from Japan, from Latin America, from the Soviet Union, every country you can imagine almost. And what was incredible was, they came to me to find out what it meant to be Chinese, or Indian, or Alaskan, or Greek. And what was so incredible was that because this process that you're talking about has gone so far, that there's - at least at that time - relatively little sympathy for it quite often at home. So for instance, in Greece, they don't want to know what it means to be Greek. Or in China, in fact, by the time the 80's rolled around, they started dismantling their respect for ancient Chinese culture completely, and trying to build - trying or actually succeeding, in building western

monstrosities.

MM: Right. The towers in the park, the Radiant City all over.

CA: Yes. Right. I think it has begun to change. And of course one of the parts of the world where it has actually changed most dramatically is in the Islamic countries - partly as the result of the Aga Khan's program. And partly for reasons I think that are different from that, possibly related to the whole apparent conflict between Islam and Christianity. You know, whether it's in Turkey or Iran or Jordan or Egypt, people have begun to repudiate the stuff that has been thrown at them. And I'd say it's probably made more progress in those countries than anywhere else on earth. And that's a very very important thing.

MM: In talking about what is happening around the world today and about human culture, of course one cannot separate what is happening in the natural environment. How do you think architecture must address the problem of the natural environment?

CA: I believe that the whole idea about the natural environment has been turned on its head actually in a very strange way. For about a quarter of a century, people have been in effect obsessed with saving the environment - which is of course a very sensible thing to do when it's being ravaged and destroyed.

But the real problem is that we won't be OK, in terms of building or in terms of nature or anything else, until we learn how to make nature.

There's nothing irreverent about saying that. What we think of as nature is a particular kind of structure. We feel tuned to it and we love it, and I think if one has a sort of romantic feeling about it, or a historical feeling about it, or emotional feeling about it, it kind of gets focused on bushes, water, sky, trees, the animal kingdom and so forth. And no one really stops to say, well, what is it about that stuff - why do we love that so? Why are we singling it out in that way?

Now all of what we call nature is marked by the way that the whole system keeps on differentiating itself and unfolding and adapting, so that every piece of it is adapted in some utterly incredible way to the things that are immediately near it or the things that are somewhat further away.

It sounds a bit abstract when I say that. But really that is the crux of the problem. Because in the artifacts that we produce - and I'm not only speaking of buildings here - we have no clue how to do this.

We don't know how to do it actually any longer even on a farm. At one time farmers took it for granted that they knew how to create versions of nature-structure. But the farms that have grown up in the last 50 or 60 years have really abandoned that, and have essentially been commercialized - going to massive production techniques which are very largely damaging. And the key thing again is that even these farmers no longer know how to create this intricately beautiful, infinite adaptive system, which gives us joy, pleasure, comfort, relaxation, wisdom, and so on, even when we rarely come in contact with it.

So, people who built buildings certainly used to know how to do this kind of thing at one time. There really was an era when buildings were very gently inserted into nature, and whether people were making towns, or villages, or fields, or simply looking after the forest or the ocean, they were always making nature.

Today, if you say to somebody, we should be making nature, it has a completely zany kind of ring. Because starting around 1970 there was this - I wouldn't call it a movement, really, it was just an inclination of people, who were so sick of Skidmore Owings and Merrill and things like that, that they started wanting to make organic shapes. And so one started to see hexagonal houses - god knows why people thought that was organic, maybe because of bees or something - Buckminster Fuller domes, hippie buildings, made of earth and sticks, that kind of thing. I

think the majority of people didn't really like the products of this kind of thinking. And in fact it never really went anywhere. But when you talk about nature, and trying to make things that are related to nature, that stuff is one of the things that comes to mind.

Making nature is really an incredibly different thing.

At the Monterey Aquarium, there's an artificial beach. It's very very amazing. It's entirely indoors; it's like a cross-section through a beach, it has the water, they have a wave-making thing. And then it has the sand going up and the little dunes and then the big dunes and all that.

The fascinating thing is that all the animals stay there. I mean they actually can escape. But it's so perfectly tuned to the realities of what such a beach is and what it does for its inhabitants and so on, that all of the various creatures - of course they vary across the cross-section - are basically OK, and want to be there, and recognize it and are part of it. I remember when I first saw that thing, I was absolutely staggered that anybody knew enough to do that. And in fact I visited again a few months ago, and I had exactly the same feeling.

So going back to the question - because your question as you first posed it has to do with, well what do you think about forests and animals and whatever, all being desecrated, unfortunately.

But the idea that one has to actually be in the position of those people who made that tiny little beach in Monterey aquarium - I think that penny has really not dropped. But it is beginning to drop among what let's call ecological souls - people who like dealing with water and plants and natural cycle and that sort of thing. And that's becoming quite good, and there's a lot of careful attention to it.

But the thing is, that what has not happened, is that people understand that the same attitude precisely goes, must go, into the making of buildings, or a wall, or a window, or anything else.

And if you say, well that sounds fine, but what does it really mean, how do you actually do that? - the whole of architecture opens up before you.

Now earlier we talked about the traditional architecture enthusiasts, Classicists and all of that. And I told you then that I was somewhat uncomfortable with that.

The reason is that although I think for the very very large part their hearts are in the right place, and so indeed are the New Urbanists, and various other kinds of people... all doing their best to think about better ways of building and so forth....

But the idea that a building when correctly made is going to be given the kind of structure that makes us practically fall on our knees when we see it in a fir tree or in a bit of moss - that has actually not materialized. Because of course the processes needed to do it are so remote from the processes that are currently available, in contracts, and in production of materials, and in - well every aspect, almost, of the way that architecture is done. So that it is a very far reach indeed to reach towards that, very difficult to think about.

But as we now are beginning to have this genuinely scientific theory of what architecture is and what to do, then that will be obvious to us, and that's what we'll be doing. And we won't have to worry about Doric columns, or classically proportioned windows, or any of a very many many other kinds of things that are like that.

Now, the idea that it's actually possible to make a building or parts of a building that really and truly have that sort of resonance, is stunning and fascinating and fabulous. It does require paying attention to absolutely different sorts of structures. It does not require getting into weird kinds of geometry, which is what I alluded to a moment ago - which is what people think of when they start talking about "well we've

got to make buildings like nature." Because it doesn't mean "like nature" in some simple-minded geometric way - it has curvy shapes, and therefore we should have curvy buildings, or any of that.

It has to do with the grain of the adaptation. All the different structures.

And I am quite certain that as one learns how to do that, discovers how to do it, discovers what it really means, the so-called "classical" shapes - and I'm now using it in a very much more embracing sense, I'm not just talking about sort of Greco-Roman heritage, I'm talking about all of what we know as traditional shapes - will turn out to be the kinds of things that you have to do to make well-adapted space. So that all of it has to do with nature. All of it has to do with "being-nature". Of course once one has that perspective, there's no need to seek union between buildings - i.e. bricks, mortar, concrete, wood, glass, and so on - and on the other hand, chlorophyll, cell structures, flowing sap, hydrology and so on. Because it is actually all governed in the same way.

So really, in a way the answer to your question that I would like to give is, it isn't a question of finding a union. The union will follow automatically, if we get inside from underneath and come up inside the glove. And actually know what it is. Then we'll be doing it. Whether we're doing it, you know, in planting a rose bush outside a window, or in dealing with a patch of grass, or in laying up a certain kind of wall in a completely new and previously unknown technique.

MM: We were talking before about the idea of what happened around 1600; we've had this historic period for 400 years that has been marvelous in many ways, it's created this incredible abundance and so on. But it's also done something rather horrendous, in creating a relationship with nature - "nature" in the broadest scientific sense - that nature is something that's dead, essentially. That's been a very powerful illusion, a very productive and useful illusion, but still an illusion.

CA: The thing that I'm struggling with is, trying to elucidate what it really means to make nature when, for example, you're building a building. I mean it is of course connected with what you just said. What I'm concerned about is that this can so easily become a kind of mantra without having a substantial enough content.

Let me give an example of an exercise one might give to a student, perhaps. If you say to a student, OK, I want you now to draw an abstract drawing which has the character of nature. An abstract drawing of - actually could be almost anything. So it might be a frieze running around a room. It might be of a plan of a couple of rooms in a very small house. It could be a wall with a bottom and a top, or whatever. And if you simply say to that student, please draw this so that it has the character of nature, and can you do that, and do you know how to do that - my experience is that students have a very great difficulty doing that kind of things. Because essentially they don't understand what the question really means. And so there'll be various attempts, different things will be tried. It'll be - OK, what about organic shapes, will that get what the professor wants? Or it could be tried, what about integrating it with rock gardens and water, is that what he's talking about? Or, it could be is it sustainable in it's, you know, a piece of sustainable ecology? Or then we can obviously go in for the weird shape thing.

But of course all of these will be wrong. And actually even the better of them will have only a little bit that is actually true and worth holding onto, in guiding the students' pencil as this person who is trying to draw something which actually is a part of nature, which has the character of nature.

This is something that is actually really quite clear, and if we were sitting together, I could draw you something in a couple of moments that would be like that. But its main feature would be that it has this peculiar and distinguishable structure. And that gradually, what happens is, you learn, somehow in your bones, to do that - that is to

shape things that way, and not some other way. And it really is a morphological characteristic.

You know, the Bauhaus had as part of their original curriculum, exercises which had to do with just drawing the shape of certain things. And one later I think began to be a bit doubtful about those, that they were too formalistic, and so on. But actually this activity that I am describing might be taken also as very formal, formalistic even, because it does have to do with, well what kind of shapes are actually, recognizably, natural in that sense. And it's a knack about how to do that. It's a knack of course that can be learned. It can be learned, and it must be learned by observation. You have to try to do it, and then find out what it is about it that you can't do and then try again and keep on until actually you are drawing stuff that is like that.

I remember when I was about 30, I began to notice that some of Wright's plans had this quality in them. I didn't know what it was at that time, I just noticed that they had a very soft and gentle quality, in the bones of the drawing. And that was actually probably about as close as any of the so-called modern group of architects ever actually came. But it was fascinating, because I realized that I was looking at something that I could recognize, didn't really know how to produce, didn't even have a name for it, had never in my studies ever been given by anybody some sort of notion that would enable me to name it, recognize it, talk about it, emulate it.

And unfortunately, for example, with CNU - which I think is fascinating, because this is such a powerful movement, and it's just sort of taken hold in a good way, I mean it's great really that so many people are enthusiastic. So I'm proud of them, because they've really done something to help change things. But when you say, well, what are the rules that they actually live by? I'm talking about "live by" when they're shaping something, modeling it, drawing it, planning it, building it, and so forth - the concepts that they are living by there are not those which I've just been speaking about, having to do with

whether you're making part of nature. They're actually something highly artificial, and in fact, some of those folks I think pride themselves on being quite deliberate creators of artifice. Because they almost enjoy the fact that the man-made artifice is something in its own right and of wonder and so on, and then they say, well, that's what we are trying to do. And we're trying to discover the old rules about that artifice.

But this knowledge about making something so that it is nature, is a much deeper thing than that. And it needs to be understood differently, and it needs to be practiced differently. And once you can do it, you don't make that many mistakes. So I think that if we recognize that it is primarily a morphological issue, and that it is not the morphology that has been traditionally associated with nature by architects - you know, all those examples I gave a minute ago. But it is a morphological awareness that we need to develop, and it could be developed.

MM: One of the criticisms of new urbanism is that it does not account enough for process. It tends to be designed all-of-a-piece, and as you put it, master planned through the conventional developer process. And that process is the characteristic of the natural morphology you spoke of? That's how it arises - through the process?

CA: Absolutely. Completely, and that is the fundamental aspect of it. And it actually cannot be faked. You cannot produce it any other way.

I remember when I was at Berkeley, sometimes my colleagues would get mad at me because I said I didn't want to come to juries, I didn't like them, and I thought that they were the work of the devil! (Laughs). Of course the reason is that if you believe in what you're seeing or attempting to do in a typical jury and so on, that's completely at odds with those sort of processes, so you will never be able to get it by that form of teaching. So it actually is a very bad thing to do, and a very unfortunate thing that has been inculcated in schools. And yet for instance, they have, you know, all the vocabulary about the parti - and

the very terminology there is dead wrong, and supports just the whimsicalities of the Beaux Arts, not that they were terribly bad, but they're certainly not about nature in the sense that we're talking about.

But it is a really massive task to replace those concepts with concepts that are nature-oriented and that are profound.

One of the difficulties, I think, in these last decades, has been that the people who liked ecology or who wanted to take seriously those sort of things, were always in a funny sense on the periphery in architecture schools. And they were always vaguely looked down on by the people who had all this stuff about the Beaux Arts and so forth, because it wasn't sufficiently morphological. Now, you see, it's funny there because actually I think that criticism was correct. But I don't believe that what the Beaux Arts had to offer was correct. But the more general statement that the morphology is the foundation of the whole thing - it has to be.

MM: The result was incorrect. But it so happens that the process that the Beaux Arts people were assuming was also incorrect?

CA: Absolutely. The Beaux Arts people were right in saying, "look, really, morphology is everything. Don't try to be an architect and not deal with morphology." As you say they had a very peculiar and very narrow view of morphology. But the problem is that the ecologically minded people of our time, even though one might want to embrace them and say, you're brethren, you're trying to do the same thing I'm trying to do and so on, but actually they are not dealing with morphology sufficiently. Therefore, in a certain sense they're not even allowed into the dialogue very much.

So that if there's a group which is sort of NU based, and then ecologists come along, and say we like you, we like what you're doing and so forth - but actually the ecologically minded person hasn't got the vocabulary of morphs, of shapes and forms and the generation of

shapes and forms, just happens to know a great deal about plants and animals and insects and water and so forth. But that isn't far enough to achieve the kind of thing I'm speaking about at all. Because until you can say, no, look, let me hold your hand and show you how to move the pencil here - and this is the kind of thing which is for real, and is actually making nature when one is in the sphere of buildings, this is a different activity. And once that becomes crystal clear, then everything will change.

And I am extremely much hoping that these interviews and what this interview is about will help to make that change. Are there things you would like me to speak about that I haven't gone to?

MM: I would like to relate this idea back to the idea that nature is something much broader than the woods and the foxes and so on and so forth. It is the structure of things, in the broadest sense. And we have an understanding of that structure of things that is really revolutionizing the way we've looked at the world in the last 400 years.

CA: Yes.

MM: And I personally think, and I think the other three [editors of Katarxis] feel the same way, that this is an incredibly powerful tool to use as a critique of what's been happening, and a recognition that there has to be that process, that hand, that goes through the iterations, goes through the process of creating the structure. Instead of taking an abstract structure - as you put it in A City is Not A Tree so beautifully - a simple mental structure that you begin with, and you pretty much end with.

CA: If one takes seriously the idea that it all resides in process - and that that's not just an empty phrase, but really, the kind of morphology that we're referring to here as nature, is produced only when certain kinds of processes go forward, they've got definite sequences, they

unfold in certain ways, and so on - if you take all that seriously, then you would expect in a sense never again to see an architectural studio where students try to lay out an entire urban design project or a subdivision.

Instead what would be mandatory and natural, is that every student would be struggling with a generative process, the class would be struggling with simulations, where everything is going forward step by step. And the question is whether the regulation of those processes that go forward step by step leads to coherent and beautiful results. And that's a very concrete thing.

It just at one stroke would say, OK, we're going to stop 500 classes in different architecture schools in the world today, and we're going to replace them with that today. Of course the same thing can be said about engineering structure, about the plan of a house, it can be said about anything. But it's particularly vivid and clear, because one can certainly imagine simulations in which step-by-step processes can be tackled by a group of students, and you can either get chaos or you can get good results, you can get in-between results. And to get really profound results, and to ask, well, what processes will achieve that, then you say, well, we've got this class, and these people are putting buildings one by one, bringing them in balsa wood or in cardboard or in whatever, on this group model. And we're going to keep doing this class until they've come up with something which is as good as the Piazza del Duomo in Florence.

And then you've finally got a process which is actually going somewhere.

Appendix: Author Biographies

Christopher Alexander is one of the seminal figures of 20th Century design theory, and an author of highly influential works including *Notes on the Synthesis of Form, A Pattern Language, The Timeless Way of Building, A New Theory of Urban Design,* and *The Nature of Order*. He has also designed and built many structures as a practicing architect and contractor. As a teenager he received a prestigious scholarship to study physics and chemistry at Trinity College, Cambridge, and he subsequently earned degrees in architecture and mathematics at Cambridge before earning the first Ph.D. in architecture ever granted at Harvard University. He was later elected a Fellow at Harvard University, and a Fellow of the American Academy of Arts and Sciences. He is the recipient of many other honors including the first AIA Gold Medal for Architectural Research, and the Vincent Scully Prize of the National Building Museum (USA).

Dr. Alexander's work has proven surprisingly influential in many fields outside of architecture, including computer science, sociology, biology and others. In computer software his work spawned the pattern language movement, producing well-known innovations such as design patterns, wiki and Wikipedia, and later, Agile methodology.

Dr. Alexander is currently Emeritus Professor at the University of California at Berkeley, where he served in a long and distinguished teaching career. He was the recipient of the Association of Collegiate Schools of Architecture (ACSA) Distinguished Professor Award in both 1986 and 1987. His latest book is *The Battle for the Life and Beauty of the Earth,* a case study of the Eishin School project which he completed with his colleague and co-author Hans Joachim Neis. That project won the Best Building in Japan award by the Japan Institute of Architects in 1985.

Michael Batty is Bartlett Professor of Planning at University College London where he is Chair of the Centre for Advanced Spatial Analysis (CASA). His research group is working on simulating long term structural change and dynamics in cities as well as their visualisation. He has worked on computer models of cities and their visualisation since the 1970s, and he has published several books including *Cities and Complexity* (MIT Press, 2005) which won the Alonso Prize of the Regional Science Association in 2011, and most recently *The New Science of Cities* (MIT Press, 2013). Dr. Batty is also editor of the journal *Environment and Planning B: Planning and Design.*

Prior to his current position, Dr. Batty was Professor of City Planning and Dean at the University of Wales at Cardiff and then Director of the National Center for Geographic Information and Analysis at the State University of New York at Buffalo. He is a Fellow of the British Academy (FBA), the Academy of Social Sciences (FAcSS) and the Royal Society (FRS), was awarded the CBE in the Queen's Birthday Honours in 2004 and is the 2013 recipient of the Lauréat Prix International de Géographie Vautrin Lud. Most recently he received the Founders Medal of the Royal Geographical Society for his work on the science of cities.

Luís M.A. Bettencourt is a Professor of Complex Systems at the Santa Fe Institute.

Dr. Bettencourt was originally trained as a theoretical physicist and obtained his PhD from Imperial College, University of London, for research in statistical and high-energy physics models of the early Universe. Afterwards he followed his passion for better understanding human social life and its transformative potential. He has worked extensively on cities and urbanization with an emphasis on creating new theoretical interdisciplinary synthesis that describe them in quantitative and predictive ways, informed by the growing availability of empirical data worldwide. His research interests also deal with

issues of innovation and sustainability in developing human societies, the dynamics of infectious diseases and general mechanisms for information processing in complex systems. His research has brought new perspectives into how we view human social life in cities and the processes of urbanization and human development and has been featured extensively in the scientific literature and by the media.

Robert Campbell is architecture critic for the *Boston Globe*, and winner of the Pulitzer Prize for Criticism. For eight years, he wrote a regular column, "Critique," for the magazine *Architectural Record.* With photographer Peter Vanderwarker, he is the author of *Cityscapes of Boston: An American City Through Time,* of which the Chicago Tribune wrote that it "belongs on the bookshelf of anyone who cares about the fate of the American city."

Mr. Campbell has been in private practice as an architect since 1975 as a consultant to cultural institutions and cities. Repeat clients have included the Boston Symphony Orchestra and its Tanglewood Music Center, the San Francisco Planning Department, the American Academy of Arts & Sciences, and the Isabella Stewart Gardner Museum. He is a Fellow of the American Institute of Architects, a Fellow of the American Academy of Arts and Sciences, and a former artist-in-residence at the American Academy in Rome. He received the 2004 Award of Honor of the Boston Society of Architects, "in recognition of outstanding contributions to architecture and to the profession."

Howard Davis is Professor of Architecture at the University of Oregon and co-director of the Collaborative for Inclusive Urbanism. He is co-author, with Christopher Alexander and others, of *The Production of Houses*, and author of *The Culture of Building* and of *Living Over the Store: Architecture and Local Urban Life.*

Professor Davis has a particular interest in the cultural and geographic contexts of building, and his current research and teaching are

concerned with the relationships between architectural and urban space and the small-scale urban economy. His work has a particular emphasis on the city as a locus of production and manufacture, as a vehicle to furthering understandings of the city as a complex adaptive system, and of expanding definitions of urban sustainability to fully incorporate social and economic factors.

Professor Davis is currently doing research work in Portland, Oregon and in London, where he is associated with the Space Syntax group at the Bartlett School of Architecture. He was a founding co-editor of Buildings & Landscapes, the journal of the Vernacular Architecture Forum. He has been on several editorial boards of professional journals, and is a frequent participant in conferences about urban form and the cultural contexts of building. His book The Culture of Building was named Best Work in Architecture and Urban Studies by the Association of American Publishers. He was also awarded the Distinguished Professorship of the Association of Collegiate Schools of Architecture as well as the Thomas F. Herman Teaching Award of the University of Oregon.

Jaap Dawson is a practicing architect and educator who has spent his life trying to discover how to build physical spaces that reflect our own inner space. His search led him through English and Spanish literature at Cornell and pedagogy and depth-psychology at Union Theological Seminary and Columbia.

After moving to the Netherlands, the home of his maternal ancestors, Dr. Dawson studied architecture and taught for 30 years at the Technische Universiteit Delft. He continues to read, write, and design.

Bruce Donnelly, AICP is a planner and strategic urban consultant based in Cleveland, Ohio. He has worked extensively with Andres Duany and the Center for Advanced Transect Studies, contributing to several projects, including the development and implementation of their open-source development code, the SmartCode. He has also worked on

a “generative module” for the SmartCode that would incorporate Christopher Alexander's ideas on generativity and pattern languages.

Mr. Donnelly has written a chapter for the forthcoming *The Transect,* edited by Brian Falk of the Center for Applied Transect Studies, and contributed a chapter to *Landscape Urbanism and its Discontents: Dissimulating the Sustainable City* edited by Emily Talen and Andres Duany (New Society). His Viewpoint piece, “Foot Logic,” appears in the September 2015 issue of the *Journal of Urbanism* (Routledge).

Bill Hillier is Professor of Architectural and Urban Morphology in the University of London, Chairman of the Bartlett School of Graduate Studies, and Director of the Space Syntax Laboratory in University College London.

As the pioneer of the methods for the analysis of spatial patterns known as ‘space syntax’, Dr. Hillier is the author of *The Social Logic of Space* (Cambridge University Press, 1984, 1990) which presents a general theory of how people relate to space in built environments, *Space is the Machine* (CUP 1996), which reports a substantial body of research built on that theory, and a large number of articles concerned with different aspects of space and how it works. He has also written extensively on other aspects of the theory of architecture. He holds a DSc (higher doctorate) from the University of London.

Charles Jencks is a widely influential architecture theorist and critic, landscape architect and designer. His books on the history and criticism of modernism and postmodernism are widely read in architectural circles. He studied under the influential architectural historians Sigfried Giedion and Reyner Banham.

Dr. Jencks studied English literature at Harvard University and later earned a Master of Arts degree in architecture from the Harvard Graduate School of Design. He earned a PhD in Architectural History from University College London.

Bin Jiang is Professor in GeoInformatics and Computational Geography at University of Gävle, Sweden. He is also affiliated to Royal Institute of Technology (KTH) at Stockholm via KTH Research School.

Dr. Jiang worked in the past with The Hong Kong Polytechnic University and the University College London's Centre for Advanced Spatial Analysis. He is the founding chair of the International Cartographic Association Commission on Geospatial Analysis and Modeling. He is the major coordinator of the Nordic Network in Geographic Information Science. He was formerly Associate Editor of international journal Computer, Environment and Urban Systems (2009-2014), and is currently Academic Editor of open access journal PLOS ONE, and Associate Editor of Cartographica. His research interests center on geospatial analysis and modeling of fractal urban structure and nonlinear dynamics, e.g., topological analysis, scaling hierarchy, and agent-based modeling applied to streets, towns, cities, and geospatial big data. Inspired by Christopher Alexander's masterful work, he has developed a mathematical model of beauty, which helps address why a design is beautiful, and can actually help to quantify how beautiful the design is.

Fred Kent is President of Project for Public Spaces, and a leading authority on revitalizing city spaces. He is widely recognized as one of the foremost thinkers in livability, smart growth and the future of the city. As founder and president of Project for Public Spaces, he is known throughout the world as a dynamic speaker and prolific ideas man. Traveling over 150,000 miles each year, Fred offers technical assistance to communities and gives major talks across North America and internationally. Each year, he and the PPS staff give presentations or train more than 10,000 people in Placemaking techniques. Since 1975, Fred has worked on hundreds of projects, including Bryant Park, Rockefeller Center, and Times Square in New York City; Discovery Green in Houston, TX; Campus Martius in Detroit, MI; Main Street in Littleton, NH; Granville Island in Vancouver, BC, Canada; and a City-

Wide Placemaking Campaign in Chicago, IL. In addition to projects, Fred has led trainings across the world for audiences such as the Urban Redevelopment Agency and the National Parks Board in Singapore, representatives from the City of Hong Kong, the Ministry of Environment in Norway, the leading Dutch transportation organization in the Netherlands, Greenspace in Scotland, UK, numerous transportation professionals from US State DOTs, and thousands of community and neighborhood groups across the US.

Before founding PPS, Fred studied with Margaret Mead and worked with William H. Whyte on the Street Life Project, assisting in observations and film analysis of corporate plazas, urban streets, parks and other open spaces in New York City. The research resulted in the now classic, The Social Life of Small Urban Spaces, published in 1980, which laid out conclusions based on decades of meticulous observation and documentation of human behavior in the urban environment. In 1968, Fred founded the Academy for Black and Latin Education (ABLE), a street academy for high school dropouts. In 1970, and again in 1990, Fred was the coordinator and chairman of New York City's Earth Day.

Most recently, Fred has led some of the largest projects at PPS including Cape Town Waterfront, Crystal City in Alexandria, VA., Museumplein in Amsterdam, Downtown Detroit, Harvard University's main plaza, and Harvard Square for Cambridge and Harvard. He is also overseeing major projects with Southwest Airlines as part of the Heart of the Community campaign. A recent partnership between PPS, UN Habitat, and The Ax:son Johnson Foundation has resulted in a global campaign (The Future of Places) and the establishment of a Placemaking Leadership Council (600+ members) aimed at bringing Placemaking to countries around the world. Fred has also been intimately involved with the expansion of Placemaking into a global agenda, helping to achieve a level of international engagement that rivals other major international development efforts. With over 150,000 people around the world following the work of PPS through emails,

Twitter and Facebook, he has witnessed interest in Placemaking grow exponentially.

Michael Mehaffy is Executive Director of the Sustasis Foundation and editor for Sustasis Press. He is a former student and colleague of Christopher Alexander, and an associate at the Center for Environmental Structure, the research and practice center where Dr. Alexander and colleagues developed *A Pattern Language, The Nature of Order,* and other landmark works.

Dr. Mehaffy is also an author, researcher, educator, and practitioner in urban design and strategic urban development, with an international practice based in Portland, Oregon. He has held teaching and/or research appointments at six graduate institutions in five countries, and he is on the editorial boards of two international journals of urban design. He is also on the boards of four NGOs in sustainable development and livability, including the Portland-based Sustasis Foundation, and the London-based International Network for Traditional Building, Architecture and Urbanism, a patronage of the Prince of Wales, where he is Chair of its international body, the INTBAU College of Chapters. He is also a prolific contributor to professional and trade journals including *Urban Land, Metropolis, The Atlantic's CityLab, Traditional Building,* and many others. He is a popular lecturer and has been interviewed by publications and media outlets as diverse as *Newsweek, The Wall Street Journal, The Guardian, The Atlantic, Mother Jones, Voice of America,* and many others.

Dr. Mehaffy is author or contributing author of over twenty books, including *Design for a Living Planet* and *Urban Form and Greenhouse Gas Emissions.* He holds a Ph.D. in architecture from Delft University of Technology.

Hans Joachim Neis is a Professor of Architecture and Director of the Architecture Program at the University of Oregon in Portland. He also directs the Portland Urban Architecture Research Laboratory (PUARL).

He is a long-time colleague of Christopher Alexander, and collaborator on the award-winning Eishin School project near Tokyo, Japan. He is also co-author, with Christopher and Maggie Alexander, of the book *The Battle for the Life and Beauty of the Earth*, a case study of the Eishin project, and also *A New Theory of Urban Design,* with Christopher Alexander, Artemis Anninou and Ingrid King.

Dr. Neis previously taught at the University of Applied Science in Frankfurt, Germany, and the University of California at Berkeley, as well as being awarded the DAAD visiting professorship at Technical University of Dresden. He was also a tutor for the Prince of Wales Urban Design Task Force Program. He is a founding member of the architectural organization 'School of Seeing.' As a professional, he is practicing architecture, urban design and planning internationally, mostly in Germany, Japan and the US.

Dr. Neis earned his Ph.D. at the University of California at Berkeley, where he studied and worked with Christopher Alexander. He also studied at Technical University of Darmstadt with Thomas Sieverts. Together with Christopher Alexander he is a founding member of the Building Process Area of Emphasis at the University of California, which he taught from 1990-2000. Every two years he conducts the popular 'International Pattern Language Conference.'

Dellé Odeleye is is Course Leader of the MSc Urban Design at Anglia Ruskin University. She earned her Ph.D. at Oxford Brookes University, following a town planning MPhil at the Bartlett, UCL and a BArch in architecture from Cardiff.

Dr. Odeleye is on the Steering Group of the *'Changing Chelmsford'* initiative, involving the Academy of Urbanism, the RSA, County & City Councils and university. It has pioneered an informal, open-ended, approach to creatively engaging key stakeholders and local communities about the future of the city - influencing decisions on key buildings and challenging spaces. This experiment in *collaborative*

urbanism has generated a community-led, Chelmsford Ideas Festival and a creative 'Ideas Hub' (with a programme of community workshops, and start-up co-working spaces) established within the city centre. These are seeding new, self-organising, local organisations and initiatives.

Dr. Odeleye previously worked in the private, third and public sectors – initially as an architect, then as a community planner, and as a principal planner in local government, in the policy & projects team responsible for planning the Wembley regeneration area. She was seconded to the Greater London Authority (GLA) with responsibility for formulating the urban design & sustainable construction policies in the first London Plan (Regional Spatial Strategy). She was part of the first Mayor of London's Task Group on Sustainable Construction for major development projects.

Dr. Odeleye's research interests include sustainable urban design, the complexity implications of time and space concepts underlying the planning of indigenous settlements, and the spatial justice outcomes of urban regeneration projects.

Elizabeth Plater-Zyberk a professor and former dean of the University of Miami School of Architecture, where she has taught since 1979. She received her undergraduate degree in architecture and urban planning from Princeton University and her Master's of Architecture from the Yale School of Architecture. She is a founder of the Congress for the New Urbanism, and a founding principal of Duany Plater-Zyberk & Company, Town Planners and Architects (DPZ). DPZ is a leader in the movement called the New Urbanism, which seeks to end suburban sprawl and urban disinvestment. The firm's award winning method of integrating master planning with design codes and regulations is being applied in over 200 regions, towns and cities throughout North America as well as in Europe and Asia. She co-authored the book *Suburban Nation: The Rise of Sprawl and the Decline of the American Dream,* and *The New Civic Art.*

Sergio Porta is Professor of Urban Design and former Head of School at the Department of Architecture, University of Strathclyde, and head of the Urban Design Studies Unit. He conducts joint research on street networks and spatial centrality, urban evolution and morphometrics, the "400 metre rule", "plot-based urbanism," resilience in urban design and masterplanning for change.

Dr. Porta has authored dozens of articles on peer reviewed journals such as Nature Scientific Reports, European Physical Journal, Urban Studies, Urban Design International, Progress in Planning, International Journal of Urban Sustainable Development, Environment and Planning B, Environment and Planning A and others. His research in the work of Christopher Alexander has led to ongoing experiments in "Construction & Therapy", where the involvement of end-users throughout three phases (Land Exploration, Pattern Language, Conception and Construction) is a crucial step towards "healing the people and healing the land". He sits in the editorial boards of leading international journals like Environment and Planning B, Urban Design International and Urban Studies Research. He is member of the Environmental Structure Research Group and the Academy of Urbanism.

Yodan Rofé is a Senior Lecturer of Urban Planning and Design at Ben-Gurion University in Israel, founder and former Board Member of the Movement for Israeli Urbanism (MIU). A graduate in Environmental Design from Belzalel Academy of Art and Design in Jerusalem, he completed his Masters in Architecture and his Ph.D in City and Regional Planning at the University of California at Berkeley. After post-doctoral study as Lady Davis Fellow at the Faculty of Architecture and Urban Planning at the Technion, he served for 5 years as Head of Urban Design Section at Israel Ministry of Construction and Housing.

Dr. Rofé's research interests include urban form and movement, accessibility and equity, cognition and feeling in the built environment and urban public space and street design. Together with Allan Jacobs

and Elizabeth Macdonald he wrote *The Boulevard Book: History, evolution, design of multi-way boulevards,* published by MIT Press. His recently published papers reflect the full variety of these interests.

Witold Rybczynski is Emeritus Professor of Urbanism at the University of Pennsylvania, and an acclaimed author of books including *Home, The Most Beautiful House in the World, City Life,* and *A Clearing in the Distance.* He has written for *The Atlantic, The New Yorker, The New York Review of Books, and The New York Times.* He has also served as architecture critic for *Saturday Night, Wigwag, and Slate. F*rom 2004 to 2012 he served on the U. S. Commission of Fine Arts.

Mr. Rybczynski first attracted wide attention with the publication in 1980 of his first book, *Paper Heroes*. "Appropriate technology" (AT), of which he is hailed as one of the founding fathers, is described by the architect as "part lay religion, part protest movement, and part economic theory." AT has as its aim the humanization of technology, which includes adapting methods of industrialization to the particular countries to be developed. He has designed and built houses as a registered architect, as well as doing practical experiments in low-cost housing, which took him to Mexico, Nigeria, India, the Philippines, and China. He studied architecture at McGill University in Montreal, where he also taught for twenty years.

Mariapia Vidoli is a Ph.D. student at the Urban Design Studies Unit (UDSU) of the University of Strathclyde in Glasgow. Her undergraduate work in Italy was in philosophy. Her research centers upon movement and therapy, applied to a new form of live-build construction process inspired by the work of Christopher Alexander, and called "Costruction and Therapy".

John Worthington, MBE is co-Founder of the London-based international architecture firm DEGW; Director of the Academy of Urbanism (2009- 15); Past President (1989-91) and current Patron of

the Urban Design Group. He is currently a Commissioner of the Independent Transport Commission, leading the review of the spatial impact of High Speed Rail.

Mr. Worthington studied at the Architectural Association, London (1960-64) and subsequently as a Harkness Fellow at the University of Pennsylvania and UC Berkeley. Previous positions include Professor of Architecture and Director of the Institute of Advanced Architectural Studies at the University of York (1993-7) Visiting Professor Chalmers University of Technology, Gothenburg (1999-2002); the University of Sheffield (1998-2008) and Professorial Fellow at the University of Melbourne (2006-2010). He was chairman of the Rotterdam High Rise Commission (2001-2004) and chair of the City of Dublin Urbanism Advisory Panel (2001- 2011), from 2003-7 he was chairman of CABE/RIBA Building Futures and from 2004-9 a Board member for London Thames Gateway Development Corporation (2004-9).

Mr. Worthington's recent publications include *Reinventing the Workplace* (2nd Edition, Architectural Press 2006, co-author with Alistair Blyth) and *Managing the Brief for Better Design* (2nd Edition, Routledge 2010).