Weil ich annehme, dass der in der Konklusion an zentraler Stelle zitierte Artikel eventuell nicht mehr ohne weiteres zu beschaffen sein wird, schließe ich hier die wesentlichen Passagen der zu Grunde gelegten, vom Autor überarbeiteten Version im Original an, wie sie 1966 in der Nr. 206 der in London erscheinenden Zeitschrift *Design* publiziert wurde (gekürzt wurde der Artikel nur in Bezug auf die reichhaltig angeführten architektonischen Beispiele, die zur Erläuterung der Folgerung auf ein analoges Konzept der „Sozialarchitektur“ in Baumstruktur wenig relevant erschienen):

A city is not a tree

By **Christopher Alexander**

Christopher Alexander, a member of the faculty of the University of California College of Environmental Design, is author of *Notes on the Synthesis of Form* and co-author with Serge Chermayeff of *Community and Privacy*. He received his bachelor's degree in architecture and master's degree in mathematics from Trinity College, Cambridge, and his doctorate in architecture from Harvard.

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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 semi-lattice. The city is a semi-lattice, but it is not a tree. In order to relate these abstract structures to the nature of the city, I must first make a simple distinction.

Natural and artificial cities

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 recognised 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-artloving 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 semi-lattice; but that when we organise a city artificially, we organise it as a tree.

Trees and semi-lattices

Both the tree and the semi-lattice 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 most naturally restrict ourselves to considering sets which are collections of material elements like people, blades of grass, cars, bricks, molecules, houses, gardens, water pipes, the water molecules that run 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. In Berkeley, at the corner of and Euclid, there is a drug store, and outside the drug store a traffic light. In the entrance to the drug store 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.

This effect makes the newsrack and the traffic light interdependent; 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, traffic light, the electric impulses which make the lights change, the sidewalk which the 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 sidewalk 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.

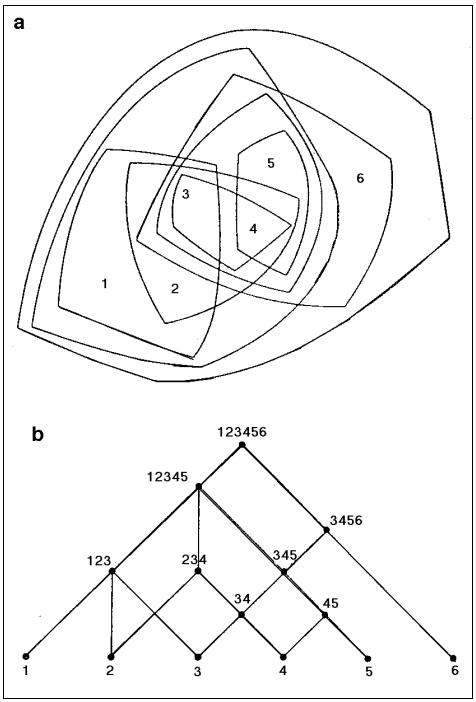
Now, a collection of subsets which goes to make up such a picture is not merely an amorphous collection. Automatically, merely because relationships are established among the subsets once the subsets are chosen, the collection has a definite structure.

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 these 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).

We can see these relationships displayed in two ways**.** In diagram **a** 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).

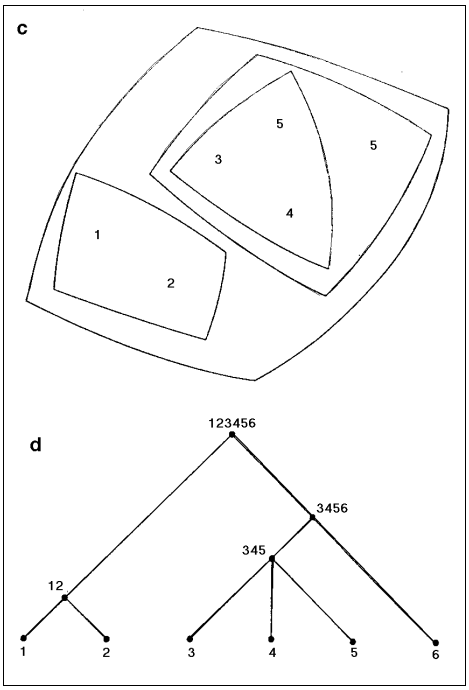


As we see from these two representations, the choice of subsets alone endows the subsets as a whole with an overall structure. This is the structure which we are concerned with here. When the structure meets certain conditions, it is called a semi-lattice. When it meets other more restrictive conditions,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

> The semi-lattice axiom goes like this: "A collection of sets forms a semi-lattice if and only if, when two overlapping sets belong to the collection, then the set of elements common to both also belongs to the collection."

The structure illustrated in diagram **a** and **b** is a semi-lattice. 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 recognisable entity and hence a unit also. In the case of the drug store example, one unit consists of the newsrack, sidewalk, and traffic light. Another unit consists of the drug store itself, with its entry and the newsrack. The two units overlap in the newsrack. Clearly this area of overlap is itself a recognisable unit, and so satisfies the axiom above which defines the characteristics of a semi-lattice).

> 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** is a tree. Since this

axiom excludes the possibility of overlapping sets, there is no way in which the semi-lattice axiom can be violated, so that every tree is a trivially simple semi-lattice.

However, in this paper we are not so much concerned with the fact that a tree happens to be a semi-lattice, but with the difference between trees and those more general semi-lattices 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 semi-lattice is potentially a much more complex and subtle structure than a tree. We may see just how much more complex a semi-lattice 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 semi-lattice based on the same 20 elements can contain more than one million different subsets.

This enormously greater variety is an index of the great structural complexity a semi-lattice 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

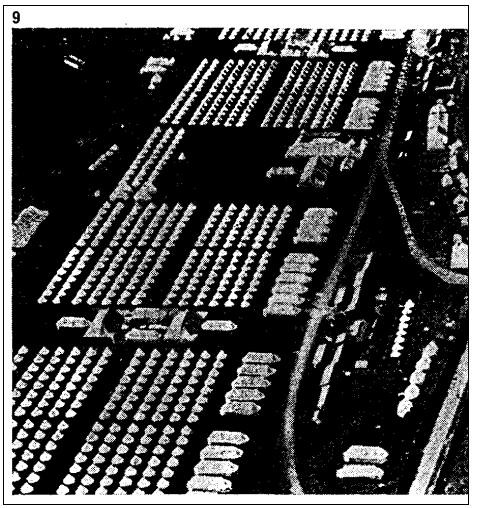
To demonstrate, let us look at some modern conceptions of the city, each of which I shall show to be essentially a tree. It will perhaps be useful, while we look at these plans, to have a little ditty in our minds:

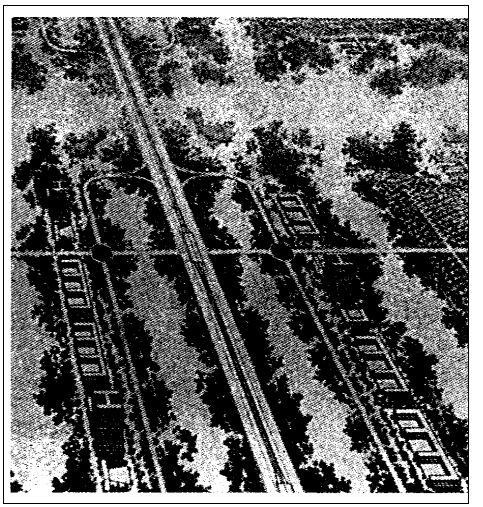
"Big fleas have little fleas
Upon their back to bite'em;
Little fleas have lesser fleas,
And so ad infinitum".

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

...[Beispiele 1-8: Columbia, Maryland; Greenbelt, Maryland; Greater London plan; Tokyo plan; Mesa City; Chandigarh; Brazilia; Communitas]...

9





9 The most beautiful example of all I have kept until last, because it symbolises the problem perfectly. It appears in Hilberseimer's book called *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 organisation of the army was created precisely in order to create discipline and rigidity. When a city is endowed with a tree structure, this is what happens to the city and its people. The lower photo shows 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 semi-lattice, 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 semi-lattice, 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 semi-lattice.

A living city is and needs to be a semi-lattice

Each unit in each tree that I have described is the fixed, unchanging residue of some system in the living city. A house, for instance, is the physical 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 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 those real systems, whose existence actually makes the city live, have been provided with no physical receptacle.

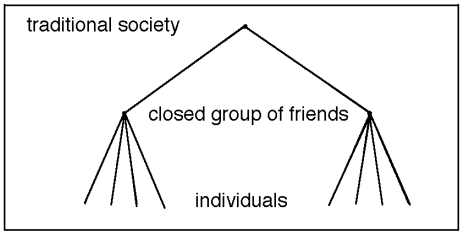
Neither the Columbia plan nor the

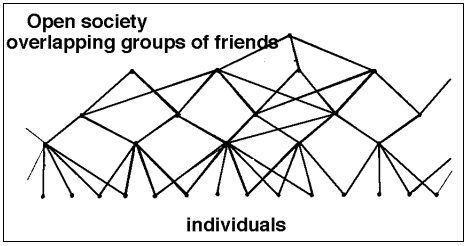
Stein plan, for example, corresponds to social realities. The physical layout of the plans, and the way they function, suggests a hierarchy of stronger and stronger closed social groups, ranging from the whole city down to the family, each formed by associational ties of different strength. Yet this is entirely unreal.

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 of a number of separate closed groups of this kind.

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 semi-lattice, not a tree, 10.

10





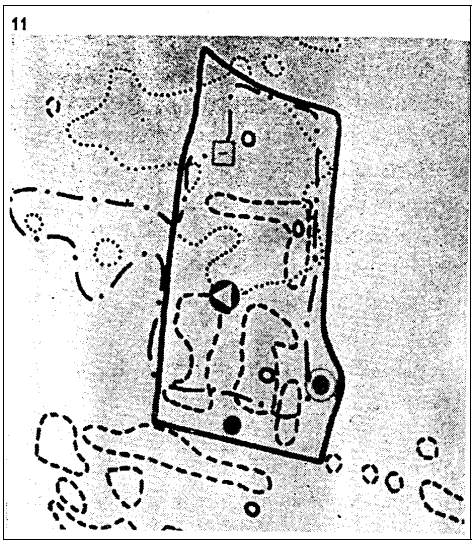
In the natural city, even the house on a long street (not in some little cluster) is a more accurate acknowledgment of the fact that your friends live not next door, but far away, and can only be reached by bus or automobile. In this respect Manhattan has more overlap in it than Greenbelt. And though one can argue that in Greenbelt, too, friends are only minutes away by car, one must then ask: since certain groups have been emphasised by the physical units of the physical structure, why are they socially 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 Middlesborough, a city of 200,000, which she recommends be broken 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, they do not".

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 paper. The

units corresponding to different kinds of centres for a single neighbourhood, Waterloo Road, are shown in 11.

11



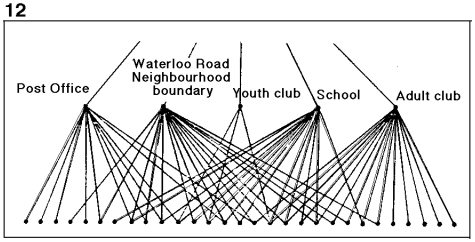
The hard outline is the boundary of the so-called neighbourhood itself. The grey spot stands for the youth club, and the small solid rings stand for areas where its members live. The ringed spot is the adult club, and the homes of its members form the unit marked by dashed boundaries. The white square 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 Middlesborough 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 neighbourhood to which they themselves belong. Ruth Glass herself shows clearly that this is not the case.

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

12



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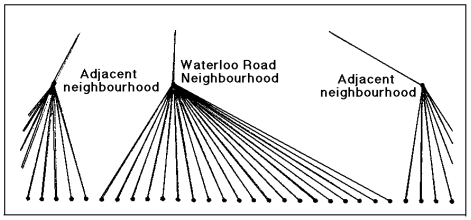


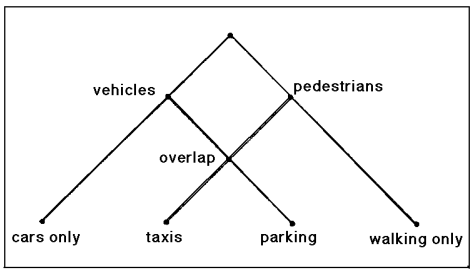
There is nothing in the nature of the various centres which says that their catchment areas should be the same. Their natures are different. Therefore the units they define are different. The natural city of Middlesborough was faithful to the semi-lattice structure they have. Only in the artificial tree 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 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 prowling 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, 14.

14



Another favourite concept of the CIAM theorists and others is the separation of recreation from everything else. This has crystallised in our real cities in the form of playgrounds. The playground, asphalted and fenced in, is nothing but a pictorial acknowledgement 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 everyday. One day it may be indoors, another day in a friendly gas station, another day in a derelict building, another day down by the river, 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 in the city. The different systems overlap one another, and they overlap many other systems besides. The units, the physical places recognised 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 a child become filled with his surroundings in a fenced enclosure? He can't. In a semi-lattice, he can; in a tree, he can't.

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

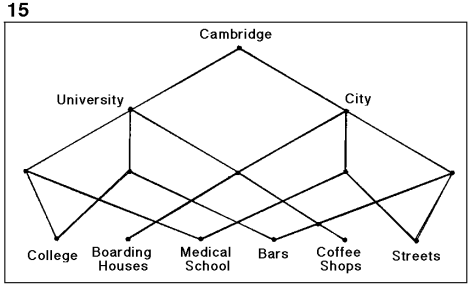
What is the reason for drawing a line in the city so that everything

within the boundary is university, and everything outside is non-university? It is conceptually clear. But does it correspond to the realities of university life? Certainly it is not the structure which occurs in non-artificial 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.

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, 15.

15



Let us look next at the hierarchy of urban cores realised in Brazilia, 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 concert in the other? In Vienna, London, Paris, each of the performing arts has found its own place. 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 by it.

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

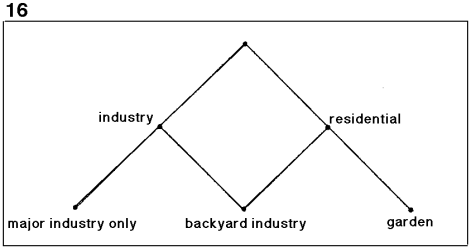
But this tree, and the idea of a single hierarchy of urban cores (which is its parent), do not illuminate the relations between art and city life. They are merely born of the mania every simple-minded person has for putting things with the same name into the same basket.

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 both to the residential zone, and to the industrial zone-these zones need to overlap. In Brooklyn they do, 16. In a city which is a tree, they can't.

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. Yet the individual communities have no reality as functioning units. In London, as in any great city, almost no one manages to find work which suits him near his home. People from one community work in the factories which are in other communities.

There are, therefore, many hundreds of thousands of worker-workplace systems, each consisting of a man plus the factory he works 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 semi-lattice. Only in the planner's mind have they 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 to spend it on, while 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 shape of schools, hospitals, etc. Clearly, to resolve this inequity, the worker-workplace systems must be anchored in physically recognisable 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 organisation.

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

Edward Banfield, in a recent book called *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 *adhoc* lines of control which arise naturally as each new city problem presents itself. These *adhoc* 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 organisation chart in the mayor's office is a tree, the actual control and exercise of authority is semi-lattice-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.

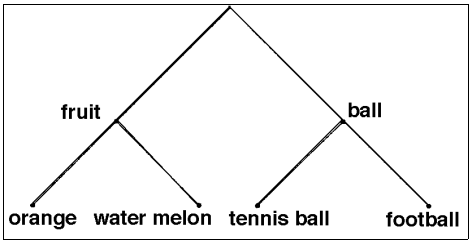
Now, why is it that so many designers have conceived cities as trees when the natural structure is in every case a semi-lattice? Have they done so deliberately, in the belief that a tree structure will serve the people of the city better? Or have they done it because they cannot help it, because they are trapped by a mental habit, perhaps even trapped by the way the mind works; because they cannot encompass the complexity of a semi-lattice 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 it 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 semi-lattice in a single mental act.

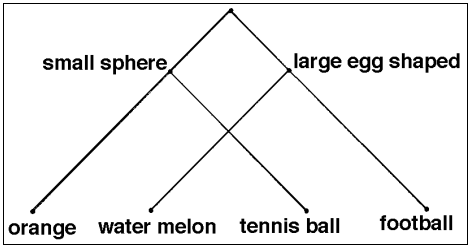
Let me begin with an example.

Suppose I ask you to remember the following four objects: an orange, a watermelon, a 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.

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.

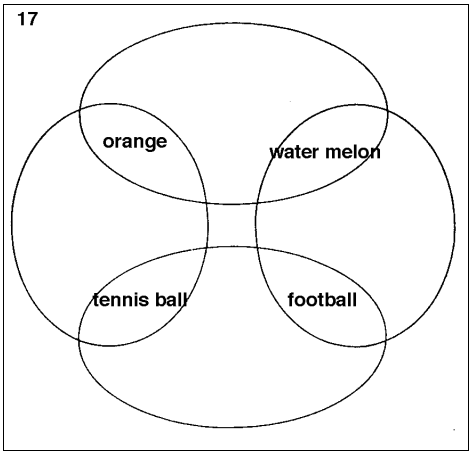


Those of you who tend to think in terms of physical shape may group them differently, taking the two small spheres together – the orange and the tennis ball, and the two larger and more eggshaped objects – the water-melon and the football.

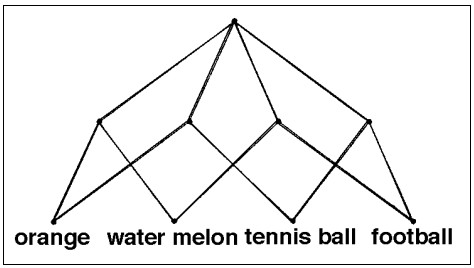


Some of you will be aware of both groupings.

Either grouping taken by itself is a tree structure. The two together are a semi-lattice, 17.



Now let us try and visualise these groupings in the mind's eye. I think you will find that you cannot visualise all four sets simultaneously – because they overlap.



You can visualise one pair of sets and then the other, and you can alternate between the two pairs extremely fast, so fast that you may deceive yourself into thinking you can visualise them all together. But in truth, you cannot conceive all four sets at once in a single mental act.

You cannot bring the semi-lattice structure into a visualisable form for a single mental act. In a single mental act you can only visualise a tree.

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

It is known today that grouping and categorisation are among the most primitive psychological processes. Modern psychology treats thought as a process of fitting new situations into existing slots and pigeon holes in the mind. Just as you cannot put a physical thing into more than one physical pigeon hole 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 which 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

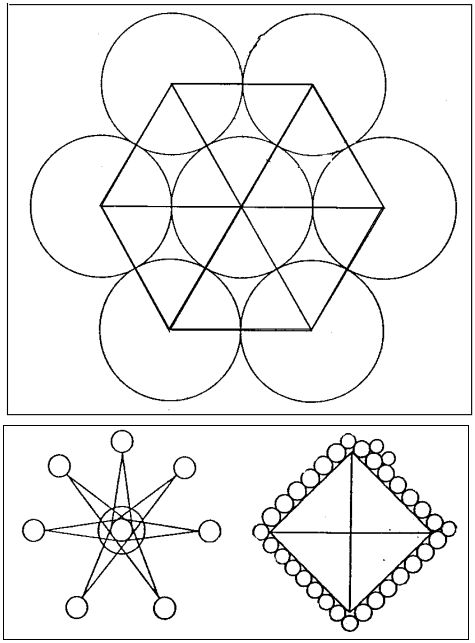
ambiguity – that structures like the city, which do require overlapping sets within them, are nevertheless persistently conceived as trees.

The same rigidity dogs even the 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 invented a way of seeing the pattern as a tree – even when the semi-lattice view of the patterns would have helped them perform the experimental task.

The most startling proof that people tend to conceive even physical patterns as trees is found in some experiments of Sir Frederick Bartlett's. He showed people a pattern, for about $^1/_4$ 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 in them. 18 contains two fairly typical redrawn versions of the pattern shown above them. 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 organisation, to reorganise it mentally in terms of non-overlapping units. The complexity of the semi-lattice is replaced by the simpler and more easily grasped tree form.

18



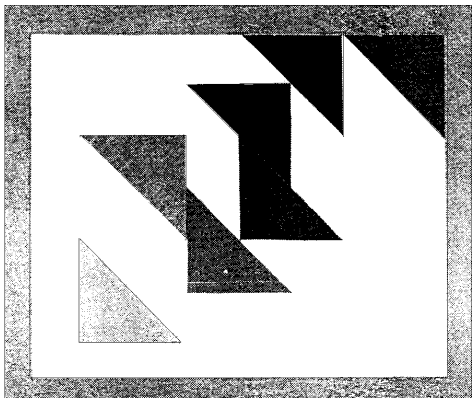
You are no doubt wondering, by now, what a city looks like which is a semi-lattice, but not a tree. I must confess that I cannot yet show you plans or sketches. It is not enough merely to make a demonstration of overlap – the overlap must be the right overlap. This is doubly important, because it is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

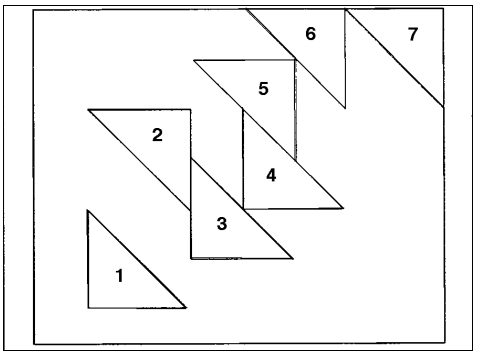
The work of trying to understand just what overlap the modern city requires, and trying to put this required overlap into physical and plastic terms, is still going on. Until the work is complete, there is no point in presenting facile sketches of ill thought out structure.

However, I can perhaps make the physical consequences of overlap more comprehensible by means of an image. The painting illustrated is a recent work by Simon Nicholson, 19.

19



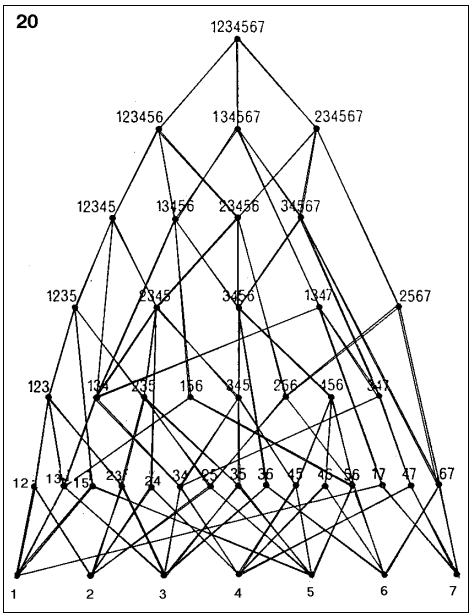
The fascination of this painting lies in the fact that although it is constructed of rather few simple triangular elements, these elements unite in many different ways to form the larger units of the painting. If we make a complete inventory of the perceived units in the painting, we find that each triangle enters into four or five completely different kinds of unit, none contained in the others, yet all overlapping in that triangle. If we number the triangles and pick out the sets of triangles which appear as strong visual units, we get the semi-lattice shown in 20.



Three 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, like 5 and 6, and form a sort of off-centre reflection of 5 and 6; 3 and 6 because they enclose 4 and 5; 1 and 5 because they enclose 2, 3, and 4.1 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.

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, 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 semi-lattice 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 semi-lattice, being part of a large branch of modern mathematics, is a powerful way of exploring the structure of these images. It is the semi-lattice 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, administrators and developers. Every time a piece of a city is torn out, and a tree made to replace the semi-lattice that was there before, the city takes a further step toward dissociation.

In any organised object, extreme compartmentalisation 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 tree-like 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 yourself pass into Sun City, and into old age, your ties with your own past will be unacknowledged, lost, 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.