A CITY IS NOT A TREE

BY CHRISTOPHER ALEXANDER

The tree of my title is not a green tree with leaves. It is the name for a pattern of thought. The semi-lattice is the name for another, more complex, pattern of thought.

In order to relate these abstract patterns 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 myelf, I trust this conservatism. Americans 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 neighbor, the roofs jut in and out at picturesque angles.

A third suggested remedy is to get high density back into the city. The idea 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.

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.

What is the inner nature, the ordering principle, which distinguishes the artificial city from the natural city?

You will have guessed from my title what I believe this ordering principle to be. I believe that a natural city has the organization of a semi-lattice; but that when we organize a city artificially, we organize it as a tree.

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 such as 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 cooperate or work together somehow, we call the set of elements a system.

For example, in Berkeley at the corner of Hearst 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, 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 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

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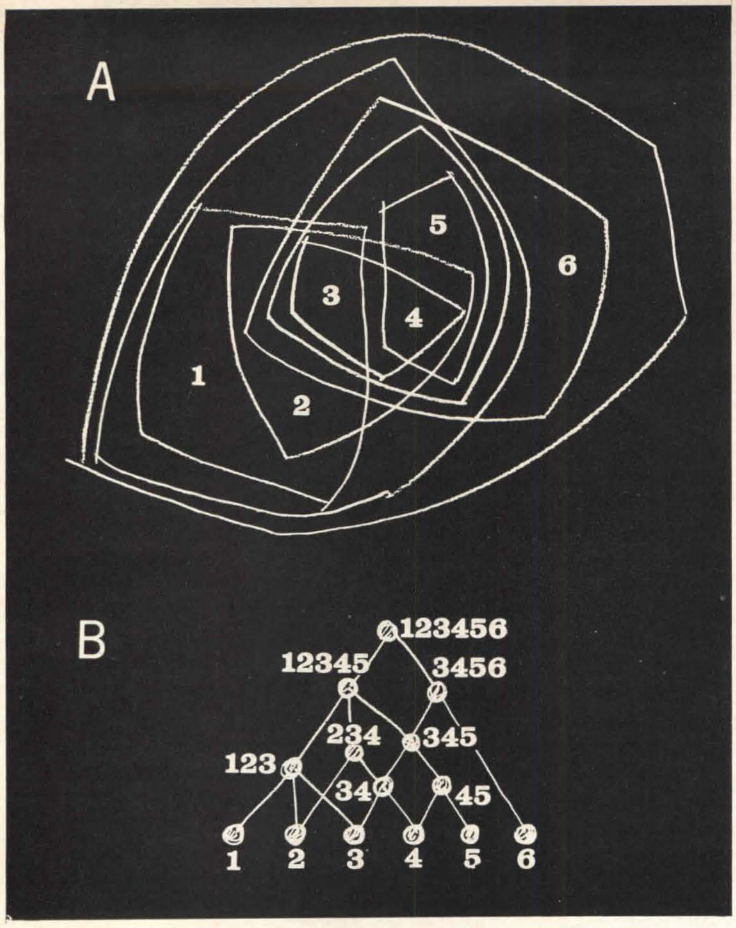
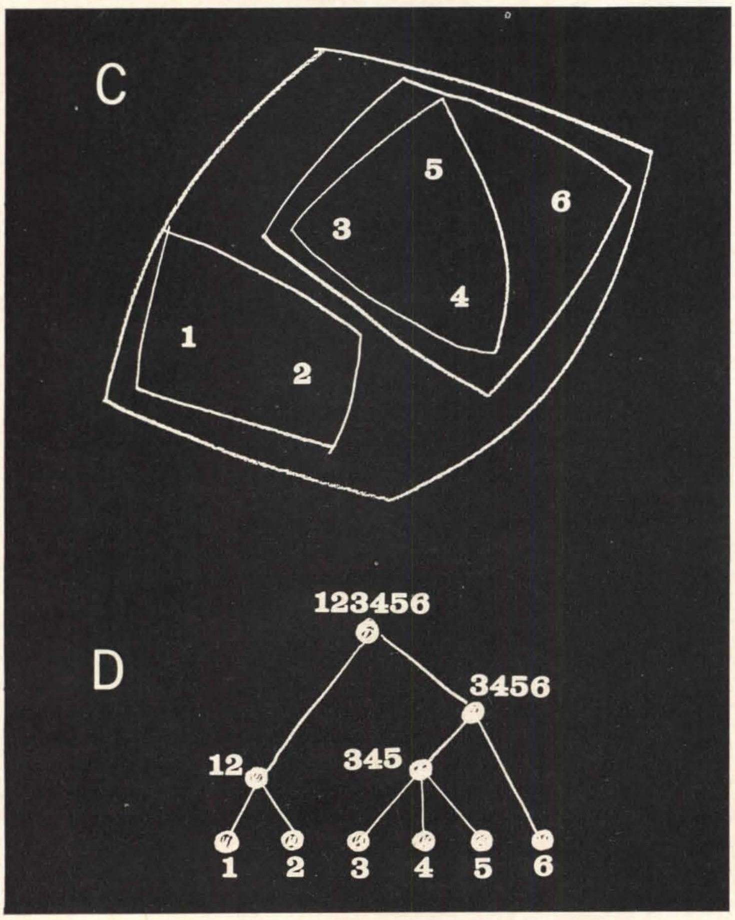




the larger living system which includes it as a fixed invariant part.

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].

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 unecessary 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 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 diagrams 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 recognizable 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 recognizable unit, and so satisfies the axiom above which defines the characteristics of a semi-lattice.)

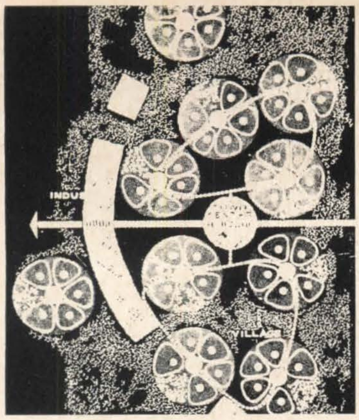
The tree axiom states:

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



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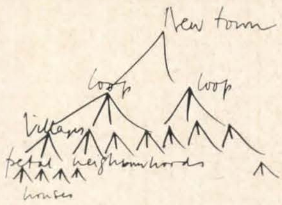

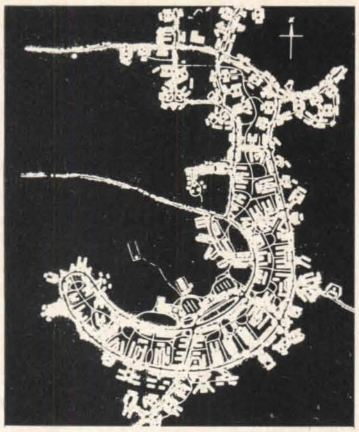

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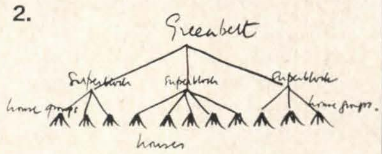

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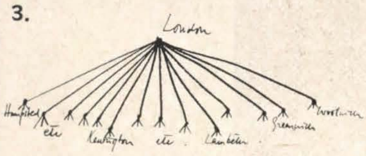


more important is the fact that the semi-lattice is potentially a much more complex and subtle structure than a tree. We may see just how much more complex a semi-lattice can be than a tree in the following fact: a tree based on 20 elements can contain at most 19 further subsets of the 20, while a semi-lattice based on the same 20 elements can contain more than 1,000,000 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.

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:

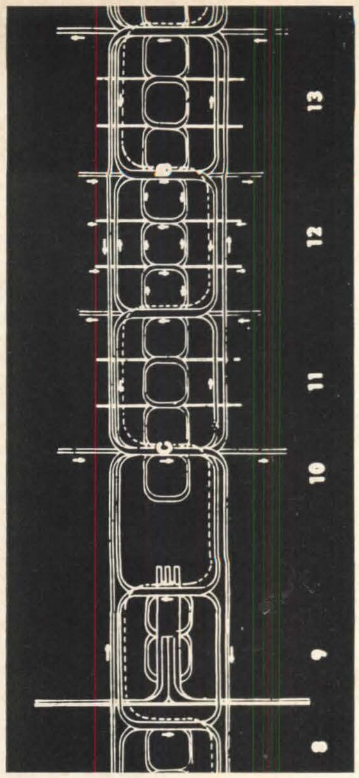
Big fleas have little fleas
Upon their back to bite 'em,
Little fleas have lesser fleas,
And so ad infinitum.

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

Figure 1. Columbia, Maryland, Community Research and Development Inc.: Neighborhoods, 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 superblock 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 reorganize 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 neighborhood units." The city is conceived as a tree with two principal levels. The communities are the larger units



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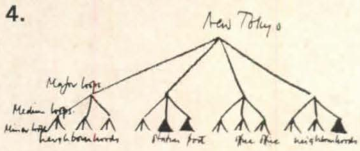

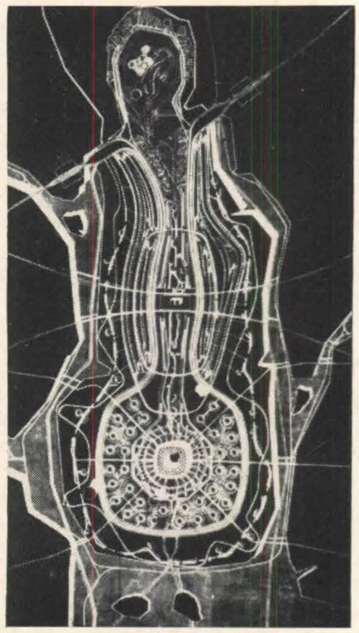

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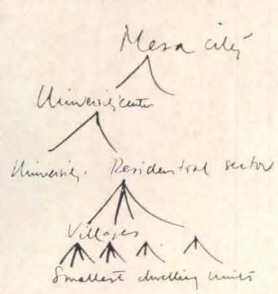


of the structure; the smaller subunits are neighborhoods. There are no overlapping units. The structure is a tree.

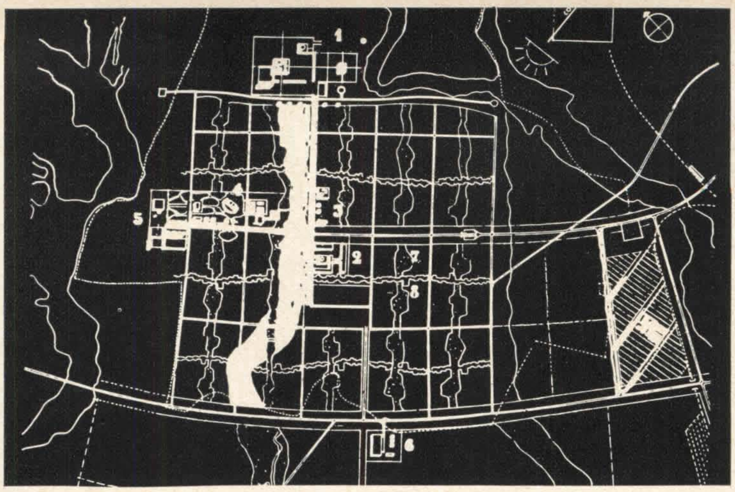
Figure 4. Tokyo plan, Kenzo Tange (left): This is a beautiful example. The plan consists of a series of loops stretched across the Tokyo Bay. There are four major loops, each of which contains three medium loops. In the second major loop, one medium loop is the railway station and another is the port.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

Figure 5. Mesa City, Paolo Soleri (left): 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. Take, particularly, the university center. Here we find the center of the city divided into a university and a residential quarter, which is itself divided into a number of villages (actually apartment towers) for 4,000 inhabitants, each again subdivided further and surrounded by groups of still smaller dwelling units.

Figure 6. Chandigarh (1951) by Le Corbusier (top right): The whole city is served by a commercial center in the middle, linked to the administrative center 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 centers, one for each of the city's 20 sectors.

Figure 7. Brazilia, Lúcio 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 center, the next a university, the third residential and medical, and fourth open country. Each of these is further subdivided: the commercial center 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 neighborhoods of 4,000 people each, not



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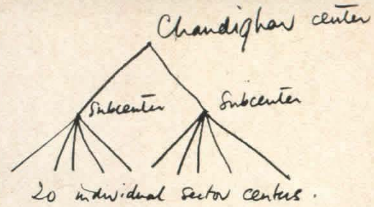

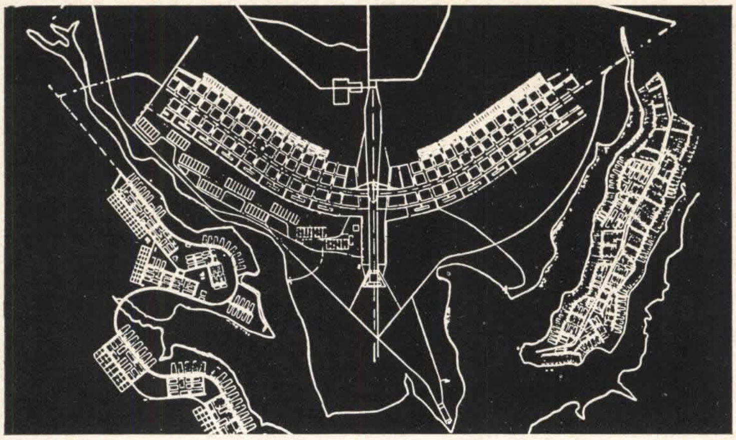

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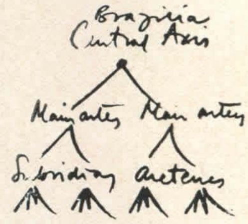

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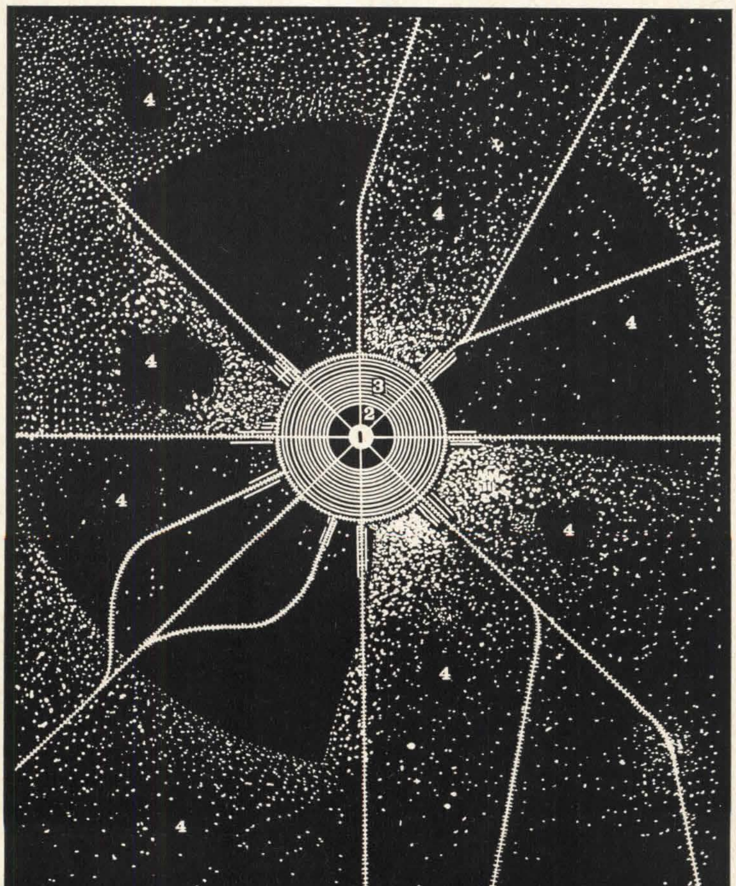
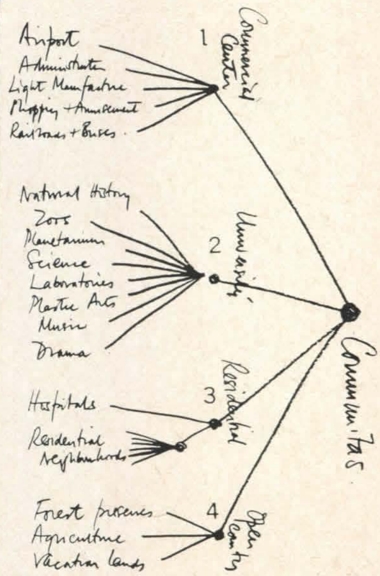




consisting of individual houses, but of apartment blocks, each of these containing further individual dwelling units. Finally, the open country is divided into three segments: forest preserves, agriculture, and vacation-lands. The over-all organization is a tree.

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 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.

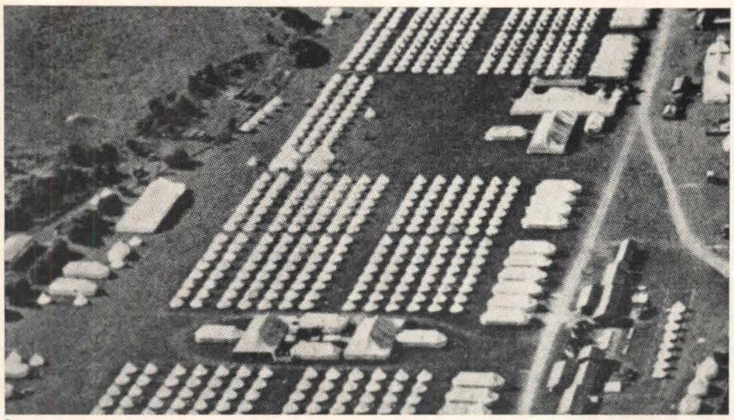
The symbol is apt, for, of course, the organization of the army was created precisely in order to create discipline and rigidity. When a city is endowed with a tree structure, this is what happens to the city and its people. The lower photo, is Hilberseimer's own scheme for the commercial area of a city based on the army camp archetype.

Each of these structures, then, is a tree. Each unit in each tree that I have described, moreover, is the fixed, unchanging residue of some system in the living city (just as a house is the residue of the interactions between the members of a family, their emotions, and their belongings; and a freeway is the residue of movement and commercial exchange).

However, in every city there are thousands, even millions, of times as many more systems at work whose physical residue does not appear as a unit in these tree structures. In the worst cases, 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.

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.



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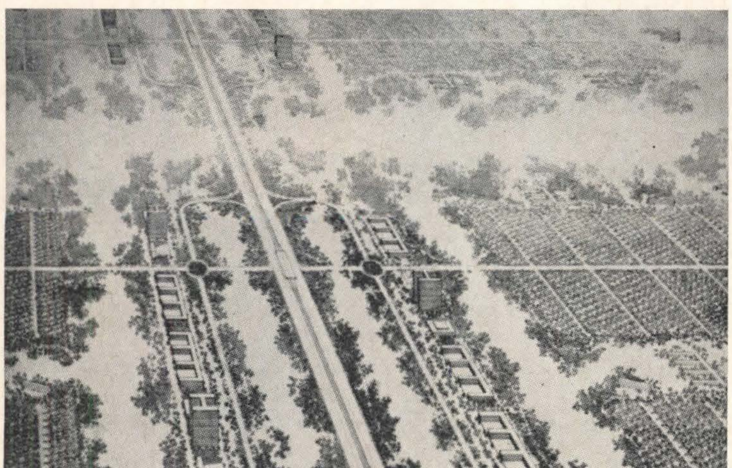

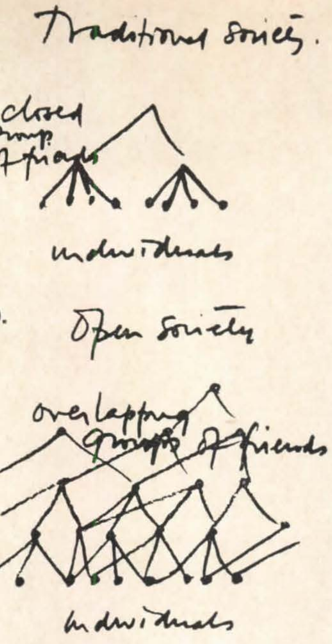

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But today's social structure is utterly different. If we ask a man to name his friends and then ask them in turn to name their friends, they will all name different people, very likely unknown to the first person; these people would again name others, 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 **(Figure 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 emphasized by the physical units of the physical structure, why are just these the most irrelevant ones?

In the second part of this paper, I shall further demonstrate why the living city cannot be properly contained in a receptacle which is a tree—that indeed, its very life stems from the fact that it is not a tree.

Finally, I shall try to show that it is the process of thought itself which works in a treelike way, so that whenever a city is "thought out" instead of "grown," it is bound to get a treelike structure.

(The balance of Mr. Alexander's article will appear in May. Ed.)

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