



THE COORDINATION OF THE URBAN RULE SYSTEM

Christopher Alexander

Center for Planning and Development Research
University of California, Berkeley
July 1966

University of California, Berkeley:

Institute of Urban and Regional Development
Center for Planning & Development Research

[Preprint for Limited Circulation]

[Please do not quote without written permission]

INTRODUCTION

How can we create a blueprint for the whole physical environment?

My argument will run as follows:

The environment gets its spatial structure, not by sudden design, but from continual growth and change. The spatial structure it has now is the product of past changes and replacements and accretions. The spatial structure which it has tomorrow will be the product of the changes and replacements and accretions which occur today.

These changes are far from random. They are controlled, at any given moment, by a system of rules--legislative rules, rules of incentive, and unspoken rules of habit. At this very moment the spatial structure of the region we are sitting in is being formed by such a system of rules.

The environment which the present rule system is producing is thoroughly inadequate. The rule system must therefore be changed.

This is not as easy as it seems. First of all, it cannot be changed all at once: it must be changed gradually. In other words, it must evolve.

But its evolution is difficult. We cannot accomplish the evolution by changing one rule at a time. For successful evolution, the rules must be changed in a coordinated manner. This is only possible if the rule system, as a system, has a specific kind of internal

coordination. The rule systems in operation now do not have this kind of internal coordination.

Worse still, the rule system cannot be furnished with this kind of internal coordination, until we have an explicit description of the rule system. At present, there is no region in the world which has an explicit description of the rule system operating in it.

It is therefore necessary to take two steps. First, the region must create an agency which maintains an explicit description of the current rule system. Second, this rule system must be given a particular kind of internal coordination, which allows it to evolve successfully. Under these circumstances, it will be possible, over a period of years, to develop a rule system which generates a functionally adequate spatial structure for the region.

Let me go over the argument again:

If we wish to create an effective operational blueprint for the whole physical environment, we must recognize the following facts:

1. The blueprint must be a rule system.
2. The rule system cannot be created all at once; it must evolve.
3. The successful evolution of the rule system requires that the system have an appropriate kind of internal coordination.
4. In order to endow the system with this coordination, we must create an agency responsible for coordinating the rules.

THE EXISTING RULE-SYSTEM

Let us begin by simply trying to describe a city or an urban region. We cannot hope to improve it, if we do not understand it as it is. Let us look at it as we know it every day, but with the cold eye of the scientist, asking what gives it its characteristic structure.

Most often when a scientist tries to describe an object, say an atom, or a table, or an orange, or a dog, he will find all kinds of permanent geometrical relations which give it its characteristic structure. An atom has a nucleus and electron shells, a dining table is square, and has four legs, one at each corner. An orange is round, an outer skin around an inner skin, around a collection of segments which share a common axis. A dog has a head at one end of its body, at the other end a tail, four paws, a stomach, muscles, heart, all in their proper places.

These objects are characterised by the geometrical relations among their parts. Certain scientists have tried to do the same for urban regions. Christaller has shown that every urban region contains a pattern of subcenters based on a hexagonal lattice.¹ Kain has shown that its density falls off from the center according to a characteristic curve.² Burgess has tried to show that it consists of a series of concentric zones,³ Hoyt, that it develops characteristic sectors fanned out from the center.⁴ These studies are useful. But they cannot lead to a complete description of the urban region. The city does not have a characteristic overall geometry of any interest. Its characteristic spatial structure is of another kind.

Suppose you are travelling over a city in an elevated train. As you look out of the window, what you see is unmistakably a city. Houses are arranged in rows; between the houses and the streets there are sidewalks; small streets open into larger streets; the buildings have a characteristic pattern of windows which reveal the fact that they have rooms in them; the corners of the blocks have stores on them; certain streets, usually a little wider than the others, are entirely lined by stores; where large streets intersect, pedestrian crossings are marked on the asphalt; close to the center of the region there are larger buildings, further out the buildings are smaller, and surrounded by gardens; periodically there are mail boxes on corners; every community contains a school; somewhere within the school property there are playing fields. Somewhere, towards one side of each of the suburban towns, there is a railway station; next to the railway station there is a hotel; outside the station, and outside the hotel, there are extra parking lots; . . .

We can go on indefinitely. Yet though we shall encounter all of these relationships, none of them can be located exactly, according to any overall geometric rules. The city has almost no characteristic overall geometry. It is not like an atom, or an orange, or a table, or an animal: it is more like the pattern of pieces on a chess board, half way through a game of chess. In the middle of the game, each piece bears definite relations to all the others. Thus, for instance, two queens will not be facing each other, unless both of them are protected by other pieces. Someone who knows the game can look at an arrangement of the pieces on the board, and say at once whether they have been randomly placed, or whether they bear the relations to one another which the game creates.

The city is the same. Its overall pattern is unpredictable; yet nevertheless it has a characteristic structure--visible in the form of the recurrent relationships among its parts. Just like the recurrent patterns on a chess board, the recurrent relationships within an urban region are formed by a system of rules.

Unlike the rules of chess, the rules which form an urban region operate at many different scales. Some rules govern the relations of geographical scale; other rules govern the relations between communities; other rules govern the relations between neighborhoods and street patterns and industrial plants; others govern the relations between individual buildings; others govern the relations between rooms and walls and roofs and service systems; others govern the relations between furniture, or between the individual manufacturers components.

Besides their different scales, the rules differ from one another in a second way. They are enforced by many different means. Sometimes the relationships are enforced by law. The square cut pyramids of office blocks along Park Avenue, are given their shape by laws which specify the relation between height and angle so as to safeguard the quality of daylight in adjacent buildings.⁵

The characteristic San Francisco house, one floor off the ground, above a garage, is given this relation to the garage and the ground by a local bye-law which insists that each house have its own garage.⁶

The earlier houses, whose front facade is covered by a filigree of iron staircases, were given this relation to the street by fire laws.⁷

The fact that houses are built parallel to the street in Basel is caused by a bye-law which insists that all houses within 10 feet of the street, be built parallel to the building line.⁸

The existence of front gardens, even when they are a nuisance and not often used, is due to bye-laws which insist that houses must be set back from the street.⁹

The fact that modern cities contain huge areas where there are only houses, and other huge tracts where there are nothing but industrial uses, is caused by the existence of a zoning law.¹⁰

The fact that every office building with an elevator, also has a staircase, near the elevator, and usually wrapped around it, is caused by a bye-law.

Other relations are enforced by habit.

The idea that each house should have a front door facing towards the street, and a back door not visible from the street, persists from force of habit, even though the existence of servants and delivering tradesmen which caused this pattern has long passed, and many people never use the front door now.

The fact that pedestrians cross city streets just where the streets intersect, is caused by force of habit--even though we can see that it causes many traffic hold-ups.

The fact that windows have a window sill inside, is force of habit.

The fact that bedrooms are large, and bathrooms small, and dressing rooms non-existent, is force of habit, reinforced by bye-laws which assign a minimum square footage to each bedroom.¹¹

The fact that exterior doors open inwards--habit.

The fact that people put lawns and flower borders in their gardens is a habit.

The fact that bedrooms are upstairs and living rooms downstairs, is a habit, sometimes reinforced by law.

The placing of a fireplace in the center of a living room wall, is habit.

The office building made of layers of little offices, each layer served by a central corridor, is habit.

Other relations are enforced by incentives.

The new interstate highways in the United States conform to certain specifications of dimension and material, because the federal government pays 90% of the cost of any highway which conforms to them. It is not enforced by law; but there is a strong incentive.¹²

Town houses are built in terraces because the savings on external walls provides a strong incentive to the builder to build them this way.

Taxation of land according to its potential value, makes people sell large property because they cannot afford taxes on it, and thus forces higher density use, or industrialisation, on zones which permit it.

The fact that city centers now contain enormous office buildings, built by individual companies who can invest excess profits in this manner, is enforced by the incentive which the tax laws provide.

The fact that houses are built with extra bedrooms, two-car garages, and extra bathrooms, is enforced by the incentives which re-sale provides.

Parking regulations in the central city encourages stores which want to provide parking for customers to move to the suburbs.

Developers submit urban renewal projects which will qualify for maximum federal grants and loans.

The rules about a zoning variance often encourage people to maintain extra density on a site, in the hope of getting the zoning changed, thereby making the site more valuable.

Other relations are enforced by rules of technology.

The fact that every road has a camber on it, and drains or gutter at the side, is a rule of habit and technology.

The edge of a tiled sloping roof, tiles overlapping each other, rafters ending in a horizontal fascia board, halfround gutter, tangent to the fascia, falling along the fascia, fascia deep enough to allow the gutter to fall 1-1/2" in ten feet, and yet stay on it.

Houses may be sited towards the front of sites, so that the connections to the sewer can maintain the necessary gradients.

Windows are built with large areas of glass, and opening hinged.

So far, I have given examples where the relation being enforced is more or less isolated, and therefore easy to see.

Far more often, many relations, enforced by different kinds of rules, overlap and interlock within a single situation.

Take, for example, the lavatory in a house.

There is a bye-law which says that every lavatory must be entered from a ventilated lobby.¹³

There is a technical rule which says that, since waste is deposited in a common sewer, the lavatory must be located within reach of a vertical stack close enough so they can reach the stack, at acceptable rates of fall, within the available floor thickness.

There is a cultural rule, which demands that the lavatory should be unobtrusive.

In the United States, there is an incentive rule: the re-sale value of the house will be increased by the provision of two lavatories, so two may be provided, even if the first occupants have no need for two.

I shall now define the rule system.

The rule system of a region is the totality of all those rules operating at a given moment, without regard for the particular instrumental form they take. In other words, it is the totality of all those rules of habit, and tradition, and economic incentive, and manufacturing know-how, and federal law, and state law, and local law, which are at any instant shaping those parts of the region being built.

The web of all relationships which we know as an urban region, is generated by continuous and random growth, within the limits set by the rules. To the extent that there is a structure, it is generated by the rules.

There is not one characteristic of a city or a region which cannot be ascribed to the operation of one rule or another. We can say confidently that the whole urban structure as we know it, is generated by the operation of these rules.

THE EVOLUTION OF THE RULE SYSTEM

The environment does not function properly. This is well known. This is what prompts planning and construction and renewal. What is perhaps less obvious is that, even when the planning and construction and renewal are undertaken, the environment they produce still does not function properly, because they are governed by an obsolete rule-system. In other words, it is not merely the physical age of the environment which makes it obsolete. It is not enough merely to rebuild it. If we rebuild it with the present rule-system in operation, it will end up just as bad as it is now. The rule system itself is obsolete, and it is above all this which must be changed.

Let us look at some of the environmental problems which can be attributed to spatial structure. We shall see that the present rule system perpetuates these problems: and that to solve the problems, new rules need to be created.

The residential areas round airports are not protected from aircraft noise. There ought to be a rule relating what can be constructed near an airport, to its distance from the nearest flight path.¹⁴

There are no rules which support the economic growth of industry. There ought to be rules which govern the creation of industrial complexes, by making sure that the distances between industrial plants are proportional to the amount of goods and information which flow between them.¹⁵

The location of superhighways is often inefficient: for example, there is a possibility that Germany and Switzerland are each going to

build an autobahn along the Rhine, on their respective sides. There ought to be a rule which governs the efficient spacing of the autobahns within a region.

The community centers provided for new communities do not work--so the residents have no way of getting together. Experiments at the Peckham Health Center showed that one of the most effective ways of developing real community in a young family, is to combine a medical center, pre- and post-natal clinic, swimming bath, dance floor, and cafe, in a single center. There ought to be a rule assigning such a center to each community of an appropriate size.¹⁶

Hospitals, are often overcrowded, and unable to expand; yet it is difficult to construct new hospitals as the need arises. Recent work has shown that each hospital should be given a loose organization on the site, with each piece of the building so planned that additional space can be built on to it.¹⁷

The garden of a house on a small lot is so small, and so close to its neighbors, that people do not enjoy it, and therefore effectively have no private open space. There should be a rule which assures that every house built on a lot smaller than a certain size, should be built as a court house, so that its open space is internal, and therefore usable.¹⁸

Apartments are noisy, but the presently accepted methods of construction of apartment blocks, and those prescribed by present bye-laws, still do not guarantee floors and walls thick enough to provide the required acoustic insulation.¹⁹ There also ought to be rules which relate the noise producing areas in one apartment to the bedrooms, in such a way

that it is impossible for the noisy room of one apartment to be next to the bedrooms in the next apartment.²⁰

Old people are often isolated, and unable to drive their own cars even if they could afford them. There should be a rule placing all old age homes within walking distance of public transit.²¹

Certain areas in cities, like subway stations, railway stations, alleys, unlit streets, and back entrances to buildings, and elevators, are particularly dangerous and attract a greater proportion of criminal assault than other places. There should be rules which guarantee the high illumination, openness and visibility of all stairs, alleys, underground passages, elevators, entrances to buildings.²²

It has been shown that certain arrangements of seats in the wards of mental hospitals can double the recovery rate, because they induce the right kinds of social interaction. There should be rules which promote these kinds of arrangement.²³

Houses still have too little storage: there should be rules fixing the amounts of storage which must be related to each part of the house. Further, it is known that storage is not used unless the relationships between height off the ground, and depth are carefully controlled. There should be rules describing these relations.²⁴

Enormous hardships are caused by slum clearance; the people whose economic and social circumstances cause the slum, are forced to move, with the result that new slums grow elsewhere. Yet at present, federal grants and subsidies encourage this kind of urban renewal.²⁵ They must be replaced by rules which create circumstances of gradual improvement inside slums, and which provide belts of insulation between the slums and

downtown areas, so that the pressure from business interests to clear the slums is minimized.

The pedestrian is still threatened by fast moving traffic on high speed arteries: there should be a rule such that when vehicular traffic reaches a certain level of speed and volume, all pedestrian paths should go up one level, above the traffic.²⁶

I have mentioned the unconscious rule, which places pedestrian crossings immediately next to traffic lights, with the result that traffic turning right is held up by pedestrians crossing, and holds up the traffic behind it, even when the traffic lights are green. In order to prevent this happening, there ought to be a rule which places the pedestrian crossings at least one car length from the intersection, so that the cars that turn right, can make the turn before they are held up, and so do not interfere with the through traffic behind them.

In the United States, the centers of the larger cities are turning into slums. At present efforts are being made to redevelop the centers by building new buildings and more luxurious buildings there. Alonso has suggested that the trouble may go deeper; it may be because the wealthy families want more land than they can have near the center of the cities, and therefore go to the peripheral suburbs: and that the only remedy would be to create a rule which forced lots to be larger in the center of the cities than in the suburbs.²⁷

It is well known that the freeways flood traffic into parts of cities which cannot cope with it. It has been suggested that parking structures should be built as part of the freeway itself, at those points where the freeway gives easiest access to downtown areas, or rapid transit.²⁸

In areas where both adults in a family work, the problem of looking after children becomes acute. There should be a rule that every area with more than a given density of working women, should contain a creche.²⁹

Every region runs the risk of water shortage. There ought to be a rule protecting the heaviest rain catchment areas from building development.³⁰

Also, there ought to be a rule which places any smoke or fume producing industry in such a position that local winds disperse it rapidly, and prevent the build up of particle concentration in the air, and smog.³¹

Why are these changes not being made? If they are made at all, they occur in isolated projects. They are treated as "design ideas", but not built into the rule system. At present they cannot be. There is no single agency, responsible for the rule system, which could undertake the task of integrating these rules with the existing system.

I have stated each of these rules in its relational form. That is, in each case I have described a relation between elements, which is required to make the environment function properly. I have said nothing about the instrumental form each rule must take. Obviously, these rules will all take different instrumental forms. One will be enforced as planning law; another may be stated as a bye-law; another may be achieved through tax incentives; another may be enforced by a directive to the banks; another may be best achieved by encouraging the manufacturers' cooperation when they develop building products; others, which require a change of habit or tradition, will have to be taught to the public

through mass information services, home-building magazines, and TV programs.

This is an enormous job. To do the job, a full time agency must be created. This agency will be responsible for the rule system as a whole. It will have no power of implementation of its own; it will act in an advisory capacity to all the agencies which have any control of the rule system.

As I have described it so far, the agency responsible for making changes in the rule system could not succeed.

University research and practical experience will create a growing, changing picture of the relationships which the environment requires. This process is a piecemeal one. It is obvious therefore, that the rule system itself can be created only gradually. It will never be finished. It is essentially dynamic and evolutionary. The agency must therefore also work piecemeal. It will make one change at a time, each time a new rule is invented.

Unfortunately, under present circumstances, this process of evolution is doomed to failure. Long range improvement of the rules--the "evolution" of a successful rule system--can only take place when the rule system, as a whole, has a certain kind of internal coordination. At present, rule systems do not have this kind of internal coordination. This is not a fault in individual rules; it is a fault in the rule system as a system. It is a far more serious, and more far-reaching fault, than the functional inadequacy of individual rules.

The argument is simple. Every time one rule is changed, a number of other rules must also be changed, in order to maintain the proper functional relations between the elements concerned.

Suppose you introduce a rule which says that every house must provide off-street parking on its own lot.³² This is very sensible. But introduced alone, it has bad consequences. It means that every house will have a driveway or a carport or a garage. Present rules of habit require that the kitchen should be placed next to the garage, and, in a one story house, that the bedrooms should be on the far side of the house. When similar houses are placed side by side, the bedrooms of one house lie next to the neighbors car, with the result that sleeping children get woken by the revving of the engine.

A second thing. When the car is driven alongside the house, or into a garage, space is cramped, getting in and out of the car is hard, and getting packages in and out of it is even harder. Here again, existing rules perpetuate the situation. The front door, facing the street, gives a direct path to the car when the car is on the street, but makes it devious when the car comes to the side of the house. The back door, originally designed for tradesmen, with access to the kitchen, is also cramped. The existence of bye-laws which restrict access between garage and house, for reasons of fire safety, aggravate the situation.³³

If there is to be a rule providing off-street parking, then the rules I have described must be replaced by two new rules. One of them, applicable only when the whole house is at ground level, places the bedrooms in the center of the site, so that they cannot be next to the neighbors car. The other provides that the car stand in a space large

enough for the doors to open, and that this space in turn is directly connected to the main entrance of the house (which will therefore no longer be a front door or a back door in the conventional sense).

At present the rule system is uncoordinated and fragmented. When one rule is changed, there is no way of assuring the correlative changes that must be made in other rules.

The rule system is fragmented in two ways. First, as we know, different rules are enforced in different ways--bye-laws, master plan, incentives, habits and technology. There is no coordination between rules which are enforced by different means. Secondly, rules are divided according to the physical scale at which they operate. At the largest scale we have the rules of regional economics; at the next scale down we have the urban planner, and the rules of master plans and zoning; at the next scale we have the architect, and the rules of bye-laws and traditional architecture; at the smallest scale we have interior designers and manufacturers, and here the rules are largely technological and habitual. The fact that each scale is defined by a profession, has convinced us, wrongly, that the relationships at any one scale are self contained, and can be changed without regard for changes in relationships at other scales.

It is easy to give countless examples of instances where the lack of coordination between rules of different instrumental type, or rules of different physical scale, has been disastrous.

A rule is written to encourage multi-story buildings, ~~fifteen~~ stories or more.³⁴ These buildings, when they are built, induce special wind conditions. The winds are a tremendous nuisance at ground level, and half way up the building they force rain water up the building's face, penetrating windows which have been designed only to keep out falling rain. One new rule must be written restricting the relation of high buildings to one another on the ground to protect pedestrians,³⁵ another rule must be written to replace the standard details for joints between windows and glazing bars, on the upper floors of such high buildings.³⁶

There is an unspoken rule that small stores should be at ground level. If this rule is changed, and multi-level shopping precincts are created, like the recent Elephant and Castle scheme, then there must also be a new rule which guarantees that the upper levels are going from "somewhere" to "somewhere else", so that pedestrians will use these levels--without this rule, the upper levels attract too little traffic, and the stores remain unrented, as they are at the Elephant and Castle.³⁷

The unspoken rule that I mentioned earlier, that a house is a compact block in the middle of its lot, cannot be replaced by a rule encouraging court houses, unless the rules which govern set backs from property lines are also changed,³⁸ and unless the rules which restrict fences to a minimum height of 2 meters, are changed.³⁹ At the moment these rules create waste space at the edge of the property, in order to prevent the spread of fire: they must be replaced by rules which specify kinds of fire-proof construction that will serve the same end, but be compatible with the form of organisation in which the house is at the

edge of the lot, and its open space is in the middle.

There is a rule in the model bye-laws which says that every room must have opening windows equivalent to one twentieth of the floor area.⁴⁰ This rule was written at the time when windows were sash windows. Now the technological rule has changed--the majority of windows are metal frame side hung windows. This kind of window has openings neither so low, nor so high up, as a sash window, and therefore ventilates far less efficiently. But the rule remains in the bye-laws in its original form.

There is a rule which governs the open space round buildings, for the use of the inhabitants.⁴¹ A rule of this kind was necessary, at a time when there was a technological rule giving each house a pitched roof. However, that rule has changed. There is a new technological rule, which gives many buildings flat roofs. On such a building, it is wasteful to insist on open space around the building, when the roof itself can be used for the same purpose. The rule about open space should be re-written to encourage the use of the roofs for open space.

Consider the English New Towns. One rule that was changed, implicitly, in the construction of these new towns, was the rule governing density--the number of dwellings per acre was reduced. However, there were other rules, the relation of front of the house to the street, and the relation of the pub to a given number of houses, which made sense at the high density, because they provided the opportunity for community which the inhabitants required. At the lower density, the front step was unusable, and the pub, still serving the same number of houses, was too far away from most of them. But the rules were not changed; so the community in the new towns broke down.⁴²

If the rule system is to evolve successfully, it must be coordinated. It is clear from the examples, that it is not enough merely to improve or change the rules. The rule system must have a structure, which coordinates the evolution of the rules.

It will not get this structure, unless the structure is deliberately imposed upon it. Like the job of translating new rules into an appropriate instrumental form, this job must be in the hands of a central agency. To do it, the agency must maintain an ongoing description of the entire rule system operating in the region; and it must define a structure on the rules, so that each rule is connected to those which are dependent on it. When one rule changes, the structure itself will then define the other rules which must be changed along with it.

THE STRUCTURE OF THE RULE SYSTEM

In the first two sections, we have established, one: that the environment is formed by a rule system, and two: that the evolution of the rule system must be coordinated. It remains, in this third section, to say exactly how it must be coordinated.

As it stands today, the system's evolution could not be coordinated. The rules are stated in too many different ways, and it is not possible to get a clear idea of the connection between rules, or of the structure of the system as a whole.

The interdependence between rules, which makes coordination necessary, is caused by the fact that different rules prescribe relationships which interfere.

We shall only see the structure of the rules, and be able to coordinate them, when we state them in a form which underlines the physical relationships they generate.

Unfortunately, the instrumental statement of the rules, which we know best, often hides the physical relations which the rules prescribe.

The zoning law is an example of an instrumental rule. It prescribes that buildings of a given functional type shall be adjacent to other buildings of a similar functional type.⁴³ The relationship, as I have stated it, seems rather odd and arbitrary, as indeed it is. Its normal form obscures it. If it had ever been stated in this explicit relational form, it would probably have quickly been replaced by a relationship with greater functional power.

The bye-law which prohibits building within six feet of the property line, is another example of a rule in instrumental form.⁴⁴ It does not

draw attention to the fact that it creates a certain sort of arrangement of the buildings with respect to streets, and usually generates a garden in between the two.

The very fact that instrumental rules so often do not bring out their own relational character, is a symptom of the very lack of coordination which we are trying to cure. To construct the rule system explicitly, we shall have to state each rule in its relational form. Often this relation will need considerable re-writing to make it an effective instrument for communication or enforcement. However, since the agency we are concerned with will not be trying to enforce the rules directly, but is only trying to coordinate the system, this is perfectly in order. Starting with a relational definition which covers every possible kind of rule, regardless of its scale or instrumental form, I shall now define the abstract structure of the rule system.

Let us begin with the definition of a rule.

1. Every rule expresses a spatial relation between a finite number of named elements. We may always write a rule in the form:

$R(E_1, E_2, \dots, E_n)$, where the E_i are the elements,
and R is the relation.

The relation need not be simple: it may specify distances between elements, relative sizes, the position of the elements with respect to one other, betweenness, sequence collinearity, angles between linear elements, curvature, the orientation of one element with respect to

others, the fact that one element is outside another or surrounds it, etc. In short, each relation specifies the spatial arrangement of its elements with respect to one another.⁴⁵

There are no restrictions of the scale of the arrangement specified. One rule will specify the arrangement of open spaces with respect to freeways. Another rule will specify the arrangement of the windows in an office block. Another rule will specify the arrangement of the sink and cooker with respect to cupboards in a kitchen.

The definition of a rule, so far puts no restriction on the elements E_i . But if the elements E_i are unrestricted, it will be impossible to tie the system together, and maintain its coordination.

The rule system gets its structure in two kinds of ways. It gets a "horizontal" structure from the fact that any particular element will enter into several different rules; so that these rules are tied together by their common elements.⁴⁶ And it gets a "vertical" structure from the fact that each element is part of some larger element: so that the smaller element appears within the rules which define the larger element.

We make sure that the system gets its structure, by defining each element itself as a complex of relations defined on smaller elements.

Each element may therefore be written thus:

$$E_i = (R_1, R_2, R_3, R_4, R_5).$$

where the R_j are rules which themselves specify the smaller elements on which they are defined.

A house, for instance, viewed as a relational complex, is defined by all the rules which specify the relations between rooms, between appliances,

between door, garage, and street, between roof and ceiling, etc.

To avoid an infinite regress, we also allow certain elements which are not defined: we shall call these elements, atomic elements.

An element may be atomic only when it has the following special property: it always enters into relationships with other elements, as a whole. Its parts enter into no relation with the system, except through the medium of the element as a whole. Thus a brick, or a tree, are elements; but parts of the brick, or branches of the tree, will never appear in any rule alone; these elements may therefore be regarded as atomic. Most elements are not atomic: the house for instance. Its plumbing system enters into a relation which specifies its connection to the city sewer, and to the water main: the house, as a whole, does not appear in these relations.⁴⁷

As we shall see now, the relational complexes change naturally, during the evolution of the system. On the other hand, though changes in atomic elements can be recorded in the system, such changes cannot be generated by the evolution of the system.

A rule system is defined by three collections. First, a collection of rules, second, a collection of elements, each defined by a set of rules, third, a collection of undefined atomic elements.

The rule system will therefore have the following form:

- | | | |
|---|---|--|
| <p>I. $R_1(E_1, E_2, E_3, E_4)$
 $R_2(E_1, E_5, E_6, E_7)$
 $R_3(E_2, E_3, E_7, E_8)$
 $R_4(E_9, E_{10}, E_{11}, E_{12})$
 $R_5(E_9, E_{13}, E_{14})$
 $R_6(E_3, E_{10}, E_{15})$</p> | <p>II. $E_1 = (R_4, R_5, R_{10})$
 $E_2 = (R_1, R_6, R_7, R_{13})$
 $E_3 = (R_2)$

 $E_j = (R_m, R_n, \dots)$</p> | <p>III. Certain E_j, not defined as relational complexes, but described in any way that is appropriate.</p> |
|---|---|--|

.....
 $R_i(E_j, E_k, \dots)$

Such a system is easy to coordinate.

Every environmental innovation has at its core, a rearrangement of existing elements. The core of the innovation can therefore be described by rules. Sometimes this core of the innovation will be a single rule--like the rule that every house must provide its own off-street parking. More often the core of the innovation will be a relational complex, consisting of a set of rules. The invention of the supermarket is one example. Here there are rules which govern the internal layout of the supermarket, like the relation between display and circulation; there are rules which govern the relation of the supermarket to its immediate surroundings--like the fact that every supermarket requires parking, and the fact that supermarkets are close to major traffic arteries; and there are rules which govern the fact that supermarkets serve larger populations than local grocery stores, and are therefore more widely spaced throughout the region.

It is easy to coordinate the introduction of a new relational complex. The new complex is a set of rules. Let us call it C . This set of rules defines a larger set of rules $R(C)$:- the set of all those rules which share an element with any rule in C .

The rules in C can only cause inconsistencies in rules that are in $R(C)$. If all the rules in $R(C)$ are revised when C is introduced into the system, we can be sure that the system maintains its coordination.

R(C) can sometimes be very large. My colleagues and I recently tried to define a set of relational complexes for the rapid transit stations in San Francisco, in such a way that they would be reasonably coordinated with the existing rules. The complexes contained almost a hundred rules in all.⁴⁸

The complete rule system for an urban region will contain thousands of rules. If it is not given an explicit structure, there is no hope of coordinating it. If it is given the structure I have described, and every innovation is coordinated properly, the evolution of the system as a whole will be successful.

Now, there is no doubt that it will be a very difficult task indeed, to undertake what I have outlined. It is one thing to sketch the rule system abstractly, it is quite another to develop its full concrete details, and to create an agency which can communicate the rules to all the other agencies within the region who will implement them.

Some of you must be wondering whether it is worth the trouble. Let us take a look at history.

Up until the nineteenth century, the rule system in any given region was entirely traditional. What was allowed, what was encouraged, what was profitable, and what was technically possible, were all prescribed by culture. All the rules were part of a single system of tradition. The rule system was integrated.⁴⁹

During the nineteenth and twentieth centuries, the rule system became fragmented. The building industry became specialized, and took control of technical rules. The first fully developed bye-laws came into being. The first zoning ordinances were created. The Government made its first attempts to control development through incentives.

As the rules were written down explicitly, they became more disconnected. The rules were based on the idea that isolated relationships in the environment served functionally independent purposes. The thickness of a wall made it fireproof; the size of a window controlled light and air; the size of a room-size prevented dirt and crowding. Since each rule defined a characteristic which could be varied and controlled independently, no attempt was made to coordinate the rules.

Now compare the history of the rule system with the history of the physical environment itself. Up until the nineteenth century, towns and buildings were marvellously integrated. In Georgian Bath, or Copenhagen, or any medieval town, the physical relationships are perfectly coordinated. Even though these places are functionally obsolete today, we still sense their coordination.

In the nineteenth and twentieth centuries, the physical integration of the environment vanished. That is why this conference is being held today. The environment became obsolete; it does not work.

Usually we blame this difficulty on the abrupt and overwhelming social and economic changes which came with the nineteenth century. But regional planning, city planning, and modern architecture, have been trying to adapt the city to these changes for decades. They are still failing. They have not succeeded in giving any region a structure which makes it function properly. Ugliness and chaos, the marks of functional disorder, are visible in every urban region.

Is it a coincidence that this chaos began at just the same time that the rule system lost its coordination. It seems unlikely. The environment does not work, because its physical relationships are not coordinated.

It is not so much the obsolescence of individual relationships which stops it working: it is the fact that the relationships are obsolete with respect to one another. They are uncoordinated. And because the rules which govern reconstruction are uncoordinated too, the lack of coordination is impossible to mend. That is why the present failure of the environment is so deep and overwhelming, and apparently incurable.

I believe that a rule system of the kind I have described is a natural and necessary part of a developing society. In principle it is an age-old mechanism. But circumstances today, require that this mechanism should exist in an explicit form. I believe that architecture, and city planning, are no more than naive attempts to create such a mechanism, now obsolete, because they cannot give the rule system the coordination it requires.

The coordinating agency which I have described, responsible for the construction of a rule system, and responsible for channelling coordinated sets of new rules to the various agencies which can enforce them, is the modern and explicit version of a mechanism which existed in an unselfconscious form for centuries.

FOOTNOTES ARE NOT AVAILABLE AT THIS PRINTING*