NOTES ON HIERARCHY IN FORM

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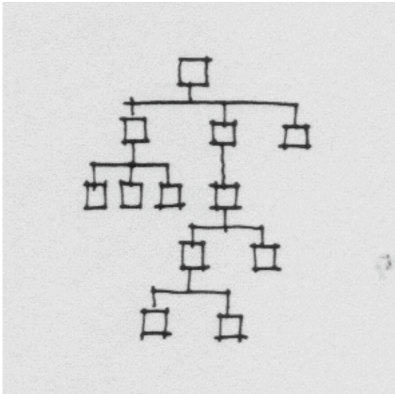
This is an edited version of a paper written in Januari 1984 for participants in the project on form hierarchies at the Department of Architecture, Massachusetts Institute of Technology

The figures 1, 6, 7, 8.1, and 9 are all of the same hierarchical expression as the diagram given here:



But, being forms in space they have different meanings to the actors making, designing or using them.

This paper looks at the various manifestations of form hierarchies in the material world and considers how they influence the relations among actors using, designing, and making them.

The examples given are diagrammatic. From time to time similarities are given with familiar real life configurations in environmental design. Nevertheless, the reader is encouraged to substitute real life examples he/she is familiar with for the diagrammatic examples offered and to discover how real life situations fit into the more general representations given.

1. HIERARCHY

1.1 Suppose there are two forms, called A and B, and we observe how they may change their shape or their position in space relative to one another. When it appears that when A changes B always changes too adjusting to the new situation, but when B changes, A does not respond, we say that the form A is **dominant** over B.

1.2 Suppose that we now have a form C and we find that B dominates C in the way stated under 1.1 and also that A dominates C. We now can speak of a **dominance hierarchy** of forms. When a form hierarchy is mentioned in this paper we speak of such a dominance hierarchy.

1.3 We are particularly interested in hierarchies where the dominance between forms is the result of the properties of the forms in question. Consider a game of checkers. Watching a game being played we may find, from the changes we observe, that ‘white dominates black’ because black is forced by white to adjust to white’s moves. This kind of dominance is also clear from observing changes in the configurations of black and white, but depends on the ability of players and has nothing to do with the shape of the pieces on the board. However, while the pieces are moved, the board remains where it is while, when we move the board, the pieces must go with it. Thus the board dominates the pieces and this dominance is embedded in the properties of the forms relating and independent of the ability of players.

1.4 More generally we may say that, in the case of the checkers game, we have two classes of elements: boards and pieces. These two classes of elements constitute different **levels**. A configuration of a higher level class will always dominate one from a lower level class. (In this case the class of pieces allows for configurations composed of several elements while the class of boards allows of ‘configurations’ of one element only.)

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2. FIRST EXAMPLE

2.1 A tree form (fig.1) is perhaps the most basic of form hierarchies. Figure 1 is not a living tree branch, but an artefact that looks like a tree. It is a configuration of elements out of which we can make tree-like forms.

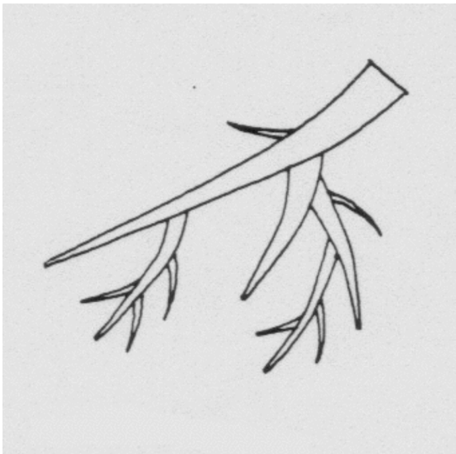

fig.1

2.2 The shape of all elements is basically the same. They are triangles with one side much shorter than the other two. The relation of elements of different levels is such that the shortest side of the triangle is always attached to a long side of a larger triangle. Such an attachment is one of dominance. We can move the smaller branch freely, but when the larger branch is displaced the smaller must go with it. This means that each size of element is a class in a five level hierarchy(fig. 1.1) It is characteristic for this tree form that elements of the same level cannot be combined among themselves like could be done with the pieces of the checkers game. Here an element of one level can only connect to elements of another level. (fig.1.2)

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3. RANK AND LOCATION

We can build many tree-like forms from these five classes of elements. Because an element on one level can combine with any higher or lower level element, a configuration need not have elements of all classes. We can skip a class. In figure 1 we find one route from A to E including all five classes and others where there are only three or two classes involved. Thus we can have an element D connected to an element A as well as to an element C. (fig.1.2)

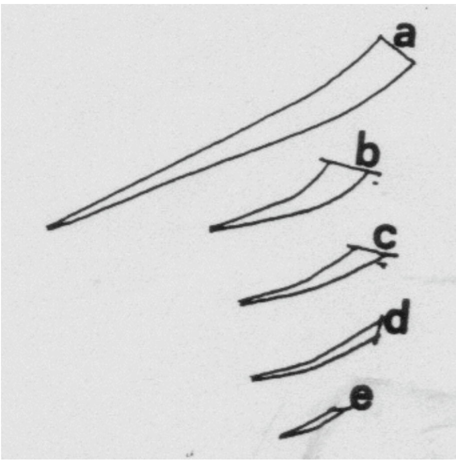

fig. 1.1

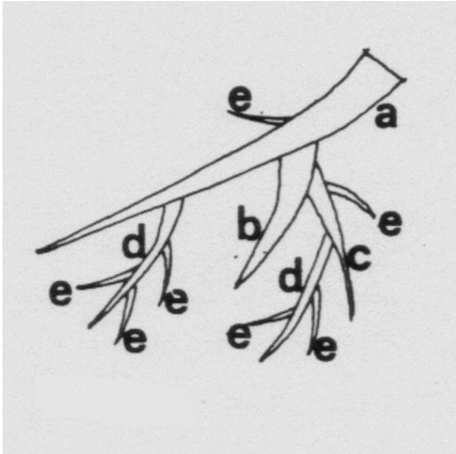

fig. 1.2

3.2 This property to skip levels tends to create confusion unless we distinguish the ranking order of classes of elements from the actual position order in the form. If we take, for instance, the element E, which is directly connected to A we could say that it is located on a high 'level' in the form because it is connected directly to an element of the highest level class. In terms of its place in the configuration it is on an equal footing with the element B, which is also attached to A. We must therefore distinguish '**rank**' in the hierarchical order of element classes from '**location**' in the hiearchical order of the form at hand.

3.3 The ranking is a pecking order. We will say that the classes of elements that make the hierarchy are '**nominal**' classes and that they occupy 'nominal levels' in the ranking order of the hierarchy. In the actual forms configured from the elements out of the nominal classes we will find 'location levels' that do not violate the hierarchy of nominal levels but are obtained by skipping classes in the nominal order. In this way a an element of a low ranking class may be located at a high level in the form.

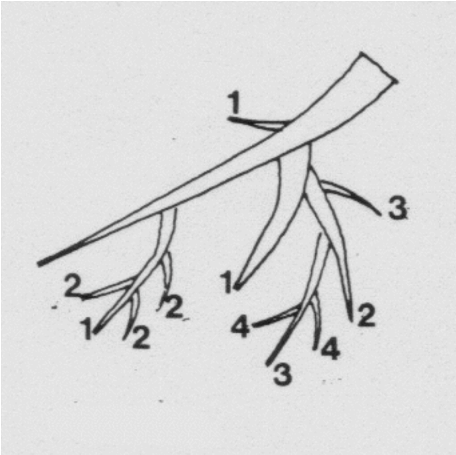

fig.1.3

3.4 We can mark the location levels in the form as is done in figure.1.3.
In this case the notation of location levels starts with the highest level, called 0, and, looking downward in the form, proceeds to 4. (compare with te nominal levels in figure 1.1)

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4. ABSTRACTIONS

4.1 Element A in our example, is related to one element E, one element B, and one element C. Seen from the level of A, looking downward in the form, we find the three connections lead to very different configurations. Element B, for example, represents a large branch that itself consists of various levels. We could say that the element B stands for a configuration CB that can act as a single entity in the hierarchy. From the point of view from A we have a 'branch' CB that behaves as if it was one element. (fig.1.4)

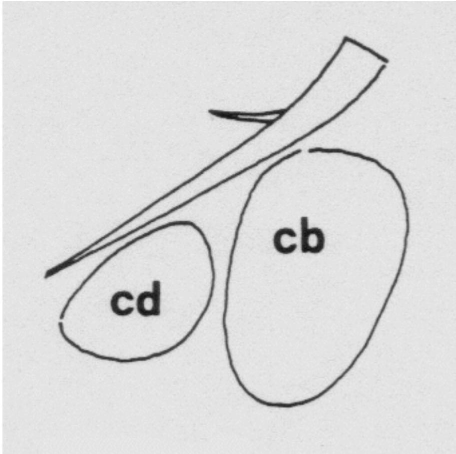

fig.1.4

4.2 This is the principle of 'abstraction' which we often apply to deal with complex forms. It allows us to observe the form strictly from one level. Using abstraction, we can describe fig.1 as an element A related to three lower elements E, CD, and CB, in such a way that the latter two are abstractions of unspecified configurations.

4.3 CB relates to A as a single entity. We now can regard CB in turn as a configuration in its own right. When doing so we can again apply abstraction and represent CB as an element B to which a part CC is attached. (fig.1.5)

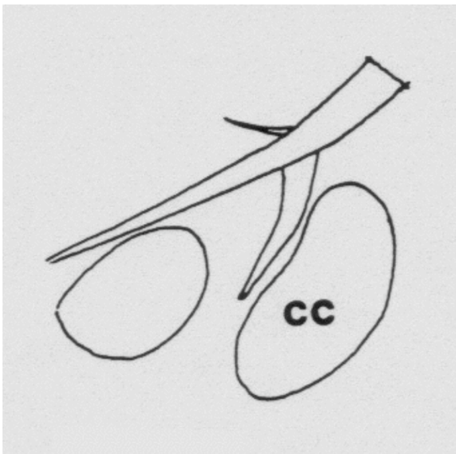

fig.1.5

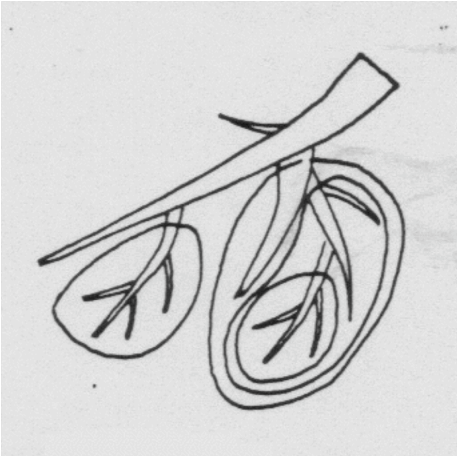

fig.1.6

In this way we can go down the entire form hierarchy in various steps. Each step looks downward from one level and sees lower level configurations only as abstracted into single elements. The advantage of this way of seeing things is of course that we only have to deal with a limited number of parts at any time.

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5. CONTROL

5.1 When we think of an artefact moving or changing we assume a controlling party in action. The form of figure 1.1 could be controlled by a single player (able to change the configuration) but it could also be the result of a variety of players. A being controlled by one player, each of the three forms attached to it could be controlled by another player. And branch B in turn could be the result of several players as well. Looking at the form in this way we find it to represent a hierarchy of players. This hierarchy is purely the result of the properties of the form they play with.

5.2 Given the principle of dominance in hierarchical forms, A in figure 1 dominates the attached branches. We can think of a player B freelu composing a different branch CB by a different selection from the nominal classes, but likewise attached to A. We can also think of player B its form at another part of A. Following the dominance relations implied by the hierarchy of nominal classes of elements, lower level players can act freely as long as they attach to A, but when A moves, the lower level configuration must adjust maintaining its previous position relative to A to remain in play.

5.3 It is characteristic of form hierarchies that they determine player's relations. Dominance among them is the direct result of the forms they control. We can see from the form (and its transformations) what relation parties have to one another. This relation is independent from the specific identity of the parties in control.

6. PUBLIC ELEMENTS

6.1 On different levels in the form we see how a number of parts (elements or or abstracted configurations) 'share' a higher level element. Or, conversely we can say that a specific element 'serves' a number of lower level elements or configurations of elements. In the case of a living tree the higher level element does not only carry the attached elements but also feeds them. (fig.1.7) In our artificial tree-form the only reason for connection was a rule of connection, but with real life artefacts higher level forms perform specific services for lower level forms. The kinds of services (feeding, supporting, enclosing, etc.) can vary with the forms.

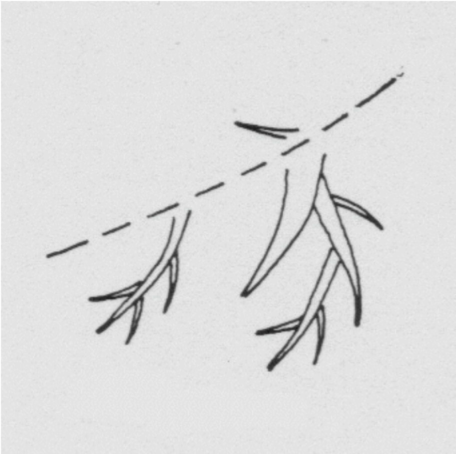

fig.1.7

6.3 In general terms we can say that the higher level element is a 'public' element to those at the lower level. It serves as an 'infrastructure' to those attached to it. This relation, in which the higher level serves, in one way or another, the lower level is typical for form hierarchies in the real world.

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7. DESIGN

7.1 Control, as the ability to change a form, implies design. Designers are ineviably involved in control patterns. Complex forms usually require the involvement of diverse players designing their own. Hierarchical form offers a way to distribute design responsibility. Once a higher level is determined, different designers are still free to design the abstracted parts. Fig.1.4, for instance, could be the result of a design by a principal designer who has designated spaces for two branches, the actual specification of which can be delegated to other designers. The only constraint, in our example, applying to lower level designers is that their configuration must connect to A and remain within the boundaries of the designated space. It may also be that player A has not only determined the location and the size of the abstract elements, but also decides what class of element must attach to A to begin with. (in fig. 1.4 classes C and B.) We can think of other constraints given by the higher level design. for instance, if it was a real physical tree-like form, instead of delineating the space available to branch B, a maximum weight for the branch might be given. Or if the tree-like form stands for a supply system, the amoumt of supply available to B might constrain its size.

7.2 In general terms we can say that CB and CD are 'known' to A in the design of level A by their expected performance; and by the interface - in terms of connection, supply and available space - with A.

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8. CAPACITY

8.1 Looking at it another way, we can say that design on the level of element A offers a certain amount of freedom to the next designer. It is a freedom limited by the space available and by the interface needed with A. From the point of view of the lower level party, this freedom is known as the '**capacity**' offered by configuration 1.4. The capacity of a form is the range of different variant solutions it allows on the lower level. A form with a large capacity gives more possible lower level variants than one with a small capacity. (of course, this comparison assumes the same norms and standards applied on the lower level)

8.2 Note that we are speaking

of the capacity of 'the design at the A level'. This is not the same as the capacity of the A element. The latter is a techinical capacity having to do with the properties of the A element only. (If A is a supply line it has to do with how much it can supply, etc.) The former as to do with setting constraints for lower level design as related to the A element, such as, in the example of 4.1, the space made available to lower level configurations and the elements allowed to be used, etc.

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9. SECOND EXAMPLE

9.1 We may think of a nominal hierarchy of classes, the elements of which are again similar in kind and variable in length, but that are differently related. For instance beams to build a floor from, or streets to make an urban network. The classes of this example are given in fig.2.

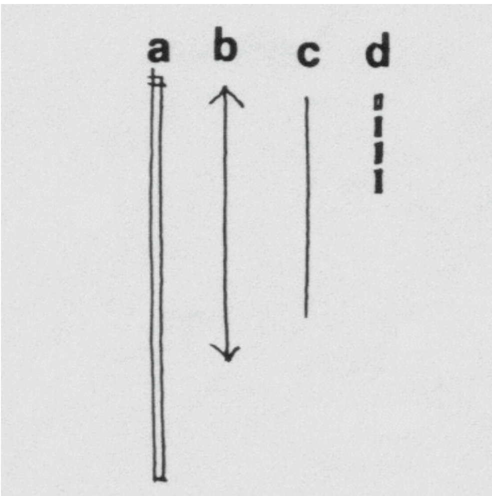

fig.2

9.2 The interface between classes is now determined in such a way that each element spans between two higher level elements. Hence we have a double connection for each element. The length of the elements depends on the distance they must span. (fig.2.1)

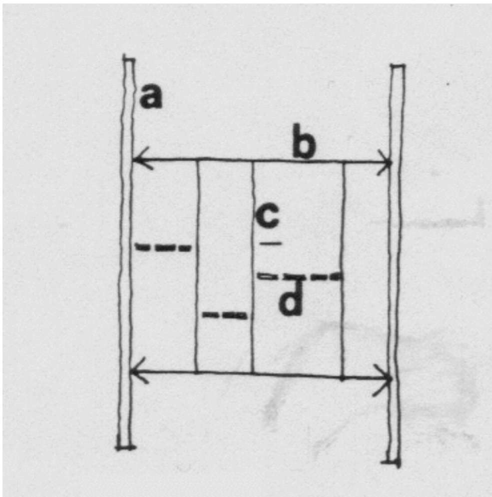

fig.2.1

9.3 Thus we have a nominal hierarchy of four levels and we have in fig.2.1 an example of a form within that hierarchy. We see again that the location of an element may not correspond with its ranking in the nominal classification. In this case an element D connects to an element A on one end and to an element C on the other, while two elements D span between c elements.

9.4 We have no trouble to discover here the possibilities of abstraction. Here the

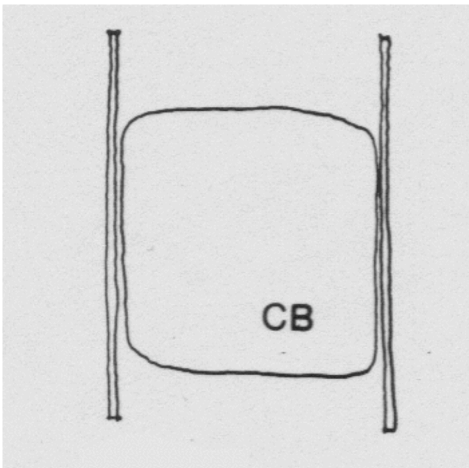

fig.2.2

configuration that becomes a single part is a network. The highest level presentation of fig.2.1 gives us the two elements A with between them the entity CB (fig.2.2) The configuration CB that we have abstracted is given in fig.2.3. Here we see however a configuration that has one element, D that does not span between two others because, in the full form of fig.2.3 it is connected to A. So one A element connects to two elements B of the next lower

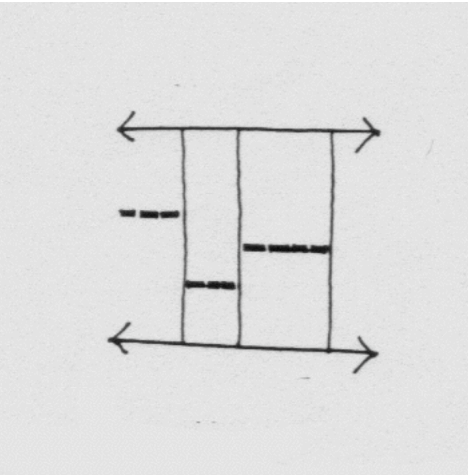

fig.2.3

level in the nominal classes ranking while one element A also connects to an element D which is much lower in the nominal class order.

9.5 When we consider the issue of capacity we find that we can speak likewise of the capacity given by the design of fig.2.2. Again, we have a given space and interface conditions. In this case, however, the interface conditions are more complex because they are not only between A and B elements but can be between A and all classes lower than A. Obviously if this was a real design situation the designer of fig.2.2 could have stipulated that only interfaces with B elements are allowed. In that case the configuration of fig 2.3 could not be allowed as a specification of CB in fig.2.3.

9.6 Many other specifications of the abstracted part are possible. We see again how these specifications are the result of capacity determined by the constraints set by the higher level design and the norms followed by the lower level design.

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10. REAL LIFE INTERPRETATIONS

10.1 The last diagrammatic example gives a hierarchical form principle found in real life in very different ways. We can think of a street network for instance, but we can also think of a floor construction. It would also be possible to think of a hierarchy of walls built in the A through D sequence.

10.2 Variable interpretation is also possible for the first example. The tree form is found in nature in many ways: it can stand for a real trees and plants of all kinds, but also for a river and its tributaries. Among human artefacts we can think of channels distributing water to irrigate the land, or utility lines bringing water or gas into dwellings, or sewerage systems collecting wastes, etc.

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11. THIRD EXAMPLE

11.1 We can think of a network of A elements. In this case laid out in an orthogonal way. This network makes spaces bounded by four A elements. Within such a space we can make another. lower level, network attaching to the first. (fig.3) The smallest lower level

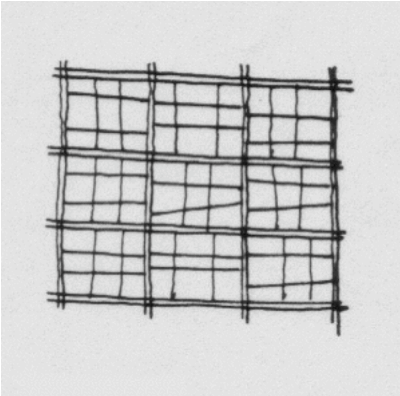

fig.3

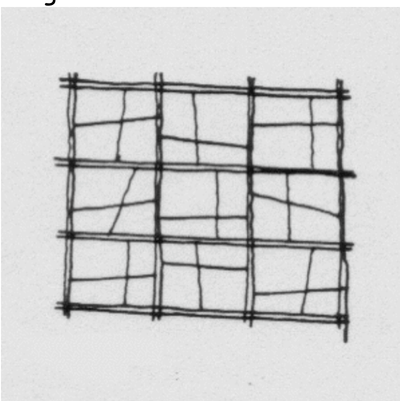

fig.3.1

‘network’ can be thought to be two elements crossing.(fig.3.1 This hierarchy can be continued by introducing more levels in the same way. In figure 3.1, for instance, each space bounded by two A elements and two B elements, can contain another network form.

11.2 Here again we can abstract the final complete form. (fig.3.2)

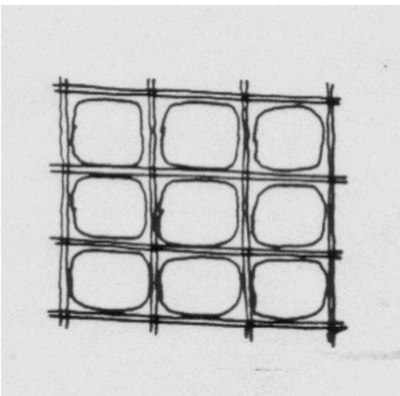

fig.3.2

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12. CONFIGURATIONS ON A SINGLE LEVEL

12.1 In the first example elements of a same nominal class, operating on the same nominal level can not combine among themselves, but only with elements on another level. In the second example this is already different because elements of a same class arrange parallel to one another to allow lower level elements to span between them. In the third example elements of a same nominal class can combine in a network filling a space formed by a higher level network.

12.2 In the figures 3 we find on each level entire configurations composed of elements from a same nominal class. Each such configuration fills a space formed by a higher level network and provides several spaces to be filled by lower level networks.

12.3 This topography of single level configurations providing space for other single level configurations on a lower level is not limited to the network form type. We can, among other examples, think of a three dimensional framework of floors and load bearing walls providing spaces to be filled in by partitioning walls, for instance.

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13. CO-ORDINATION ON THE SAME LEVEL

13.1 If different designers would make networks in the spaces offered by a higher level network, the result can be expected as shown in figures 3 and 3.1

13.2 We can think of an interface rule, however, that says that neighboring lower level configurations must meet the shared higher form at a same point. This would create a continuous lower level network. The result could be as if two continuous networks are super imposed as is shown in figure 4.

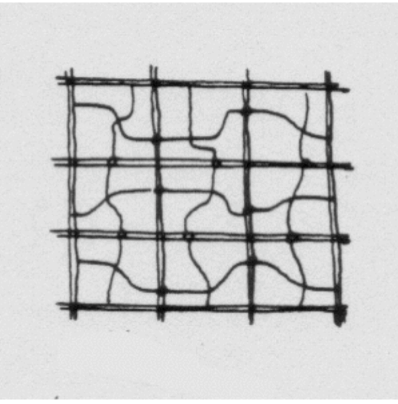

fig.4

13.3 It is unlikely that the result of such an interface rule would be like figure 5. This suggests rather a single designer for the entire lower level network instead of a distributed design responsibility. If no design responsibility is distributed an interface rule between the two levels is not needed.

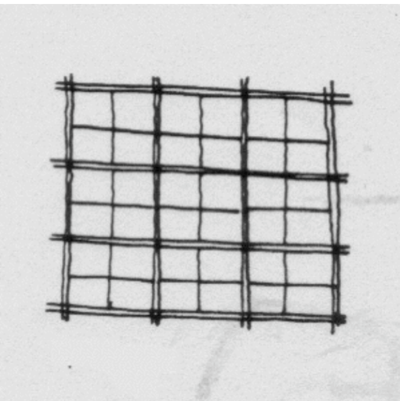

fig.5

13.3 In case of design distribution on the lower level the interface rule might operate in different ways. It could demand that lower level designers choose among themselves where to connect to the higher level, coordinating case by case among themselves and with the higher level design. Alternatively the higher level design could decide where the connections must be made.

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14. FOURTH EXAMPLE

14.1 In the previous example we found for the first time spaces, formed by the higher level configuration, within which lower level forms had to be made. In the tree-like form space available for lower level configurations could be indicated by the designer on the higher level (thus settling capacity in terms of space) but they did not follow inescapably from the higher level form themselves.

14,2 We will now consider a case where the objective is to subdivide a space, given on a higher level,into smaller spaces. (fig.6)

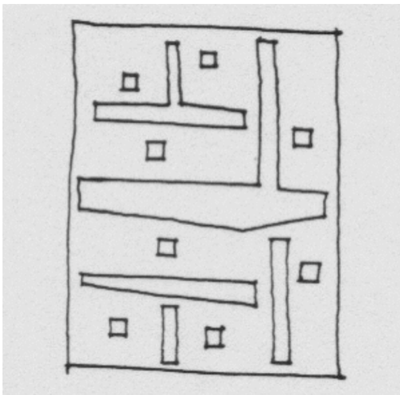

fig.6

Although space is the objective, the subdivision is done by making a configuration of walls. We deal with configurations of solid elements.In this case we have a good deal of freedom to make configurations within on nominal class of all kinds of shapes. There are however, two rules that govern the relation to the higher level configurations. First that a given space must be subdivided in smaller spaces. Secondly that - although the diagrams representing the example does not show this - lower level configurations must be attached to the higher level ones.

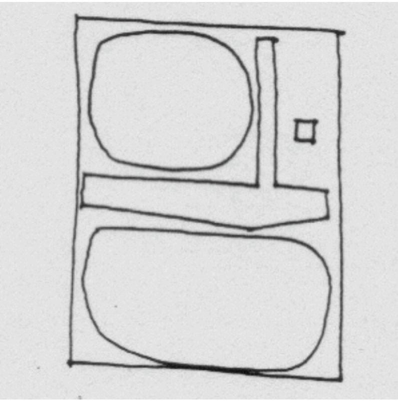

fig.6.1

14.3 Figure 6 gives an example. We see five levels of elements. The lowest levels are the squares. They should be wall-like forms as well but are easier read when diagrammed as just small squares. For the same reason the other elements on different levels are shown un-attached although they are supposed to fully subdivide spaces they are placed in.

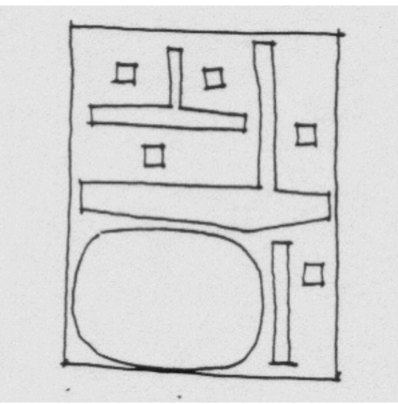

fig.6.2

14.4 The issue of capacity is self evident. There is always a well defined space for the lower level configurations. (figs.6.1 an 6.2)

14.5 In this example the public infrastructure shared by lower level elements is one that makes space. We could say that we have here a 'form of enclosure', the inhabitation of which takes place by configurations of the same kind, but produced in a next round of design.

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15. TWO LEVEL ORDER, FIVE LEVEL FORM.

15.1 We see that this form allows us to abstract as well as the previous examples.

15.2 An interesting aspect of this form is that the walls that divide the spaces need not be different in size on the different levels. If we assume that all walls are of the same thickness and height the hierarchy of figure 6 would not change. It is the walls distribution in space that settles their hierarchy. Looking, for instance, from the highest level space which is the rectangle encompassing the entire figure 6, it can only be the configuration shown in fig. 6.1 that divides that space in two or more smaller ones. Given that first configuration, it are again only the configurations added on in fig.6.2 that divide the resulting spaces. The hierarchy is established by means of interface an distribution rules for each move, but not necessarily by means of a nominal hierarchy of elements.

15.3 Thus, assuming the squares also stand for walls, we have here an example of how an entire hierarchical form can operate on the same level in the nominal order of things.

15.4 In that case, because this form has only one nominal class its hierarchical depth is solely the product of the number of moves made. The maximum hierarchical depth is not predetermined. We could say that it is the product of the separate design moves made.

15.4 If we take, however, the diagrams for what they show, the squares must be of a nominal class different from the walls. In that case we have here two nominal classes. The location level of the elements of the class of squares is entirely determined by their form. They do not make configurations and cannot divide space. Therefor they can only be on the lowest location level. In contrast to the wall elements they derive their place from the nature of their class rather than from the distribution rules.

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16. HIERARCHIES OF ENCLOSURE

16.1 The previous example was of interest particularly for its lack of nominal classes. In the examples through 3 we always had a nominal order of elements that were alike in kind and shape, but different in size. In the last one we found that hierarchical forms can be made out of a single nominal class. But we also found, with the introduction of the squares that the nominal order can be composed of classes of elements that are completely different from one another. What brought them into one form order was the fact that they both were placed in, or enclosed by, the higher level configuration. It was the relation of enclosure that allowed the ordering of diverse elements in this case.

16.2 The order of enclosure is very powerful in built environments. Its very nature, of making spaces that can be inhabited by other forms that, in turn, will make new spaces, suggests environmental qualities.

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17. GENERIC FORMS

17.1 We have now found three powerful generic hierarchical forms. The first one, the tree form, is found in nature as well as in some artefacts of supply. The second, the network form is found mostly in human artefacts having to do with circulation and communication. the enclosure form, finally is particularly found in human artefacts, but certainly not exclusively so.

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18. IN-HOMOGENEOUS HIERARCHIES.

18.1 In my book “The Structure of the Ordinary” I described in some length aspects of the order of enclosure that can be found in the built environment. We find on different levels of the nominal order completely different kinds of elements. (chart 1)

18.2 In this hierarchy the nominal order is in-homogeneous.. We see streets, walls, and furniture on different levels in one order. At the same time we also see, with the streets, various nominal levels determined by size, similar to figs.3, 4, and 5. Thus parts of the order are decidedly homogeneous. With walls we may also see, this time within one nominal class, more than one level as illustrated in figure 6 if, in that diagram, we would draw the wall elements all in the same thickness. The squares in that same figure representing the lower level could be considered in chart 1 as furniture in rooms.

Level	A Nominal Class	B Configuration Model	C Space Within
6	major arteries	city structure	
5	roads	district	block
4	building elements	building	"built space"
3	partitions	floorplan	"room"
2	furniture	int. arrangement	"place"
1	body & utensils		

chart 1

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19. FIFTH EXAMPLE

19.1 In example 4 we found the rule that the lower level configuration must lie in the space offered by the higher level configuration. Earlier, with example 1, for instance, when discussing capacity we already found spaces offered by the higher level. But the space within which a lower level branch had to be designed was not a physical space, but an abstraction serving as interface between the two levels. The elements with which the branch was made were not spaces themselves.

19.2 We will now consider a hierarchy of spaces. It is the property of a space that it can contain something else. It may therefor also contain another space. We will make this the order principle of the new example. The only relation allowed is that a space must lie within another space and may, itself, contain yet another space.

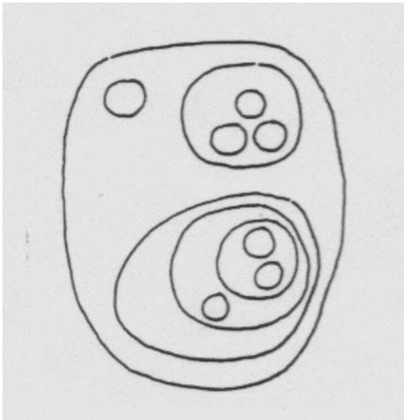

fig.7

19.3 In figure 7 we have a form of this kind. each space may contain several other spaces and the order is not difficult to understand. The only point that must be made is that the largest space encompasses all

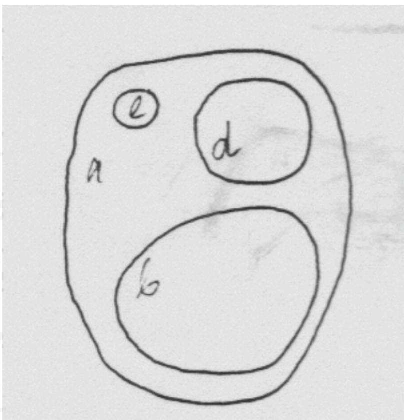

fig.7.1

there is within its outer boundary. In other words, space A pervades space B, and B pervades C, etc. This is something consistent with the properties of space. It could not be done with configurations of solid elements. The space taken by one solid element cannot be taken by another.

19.4 Abstraction is easy to see. Space B stands for a whole hierarchy of spaces located within it that may or may not have been specified. (fig.7.1) Within each space we may define a series of possible hierarchies dependent on our purposes and the performance expected. Hence capacity goes with this hierarchy as it went with the other forms.

20. PUBLIC AND PRIVATE SPACE

20.1 When we consider a higher level space as given in figure 7.1 we can distinguish two kinds of spaces in it. On the one hand the space taken by all lower level spaces and, on the other hand, the space outside the latter, but inside the higher level space. As with the public configurations discussed in 6, we can say that the latter space is the space shared by all lower level spaces. From the point of view of these spaces this is their shared environment. It is therefore to them 'public' space.

20.2 We will say that in this form any space that contains other spaces can be divided in public space and private space. The private space is occupied by the sum of the included spaces. The public space is the space not so occupied.

20.3 When we move into such a private space we will find in it other spaces. Here again we can say that the higher level space is divided in public and private space. The analogy with the public elements in the tree-form of figure 1 (which we called 'infrastructure') can be appreciated.

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21. CLASSES OF SPACES

21.1 In the spatial hierarchy of figure 7 the nominal order is defined by the size of the spaces only. One could think,

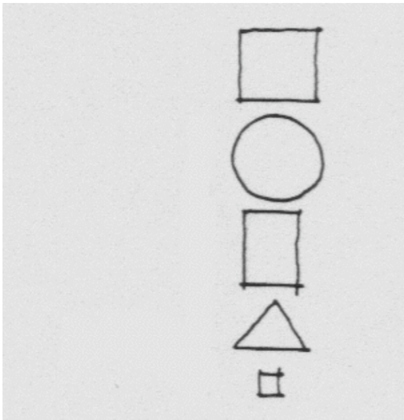

fig.8

however, of a nominal order of spaces defined by other properties of the spaces involved, if it is agreed that these determine a pecking order among them. For instance, we could think of spaces of a certain shape and say that they represent a nominal order as in

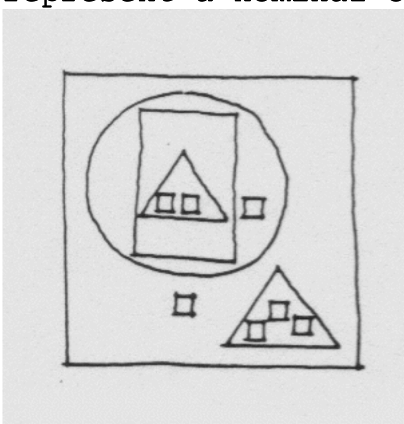

fig.8.1

figure 8. Any space in the order must be placed inside a higher level class of space. Thus the triangle can be located in a rectangle space or in a circular space etc. A possible form that honours this nominal order is figure 8.1. As a hierarchy. it is analogous to figure 7. A partial abstraction is given in figure 8.2.

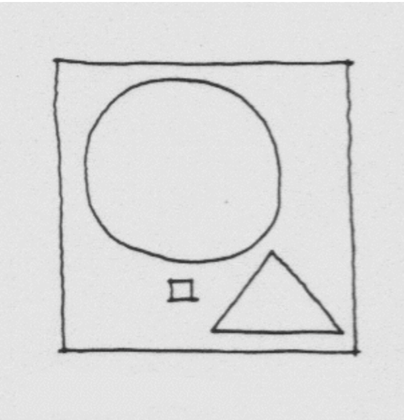

fig.8.2

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22. TERRITORY

22.1 A hierarchy of spaces can be understood in terms of of design control as well. A player can control a space and decide what other spaces, controlled by other players, may go in or not.

22.2 When we think of spaces as units of control we have defined a territorial order. Control of space is the ability to determine what goes into the space under control. (see also: “The Structure of the Ordinary”)

22.3 This territorial order can be depicted in a more abstract manner by diagrams as shown in figure 9. It gives a hierarchy of five levels. The diagram given here is again the same hierarchy as given in

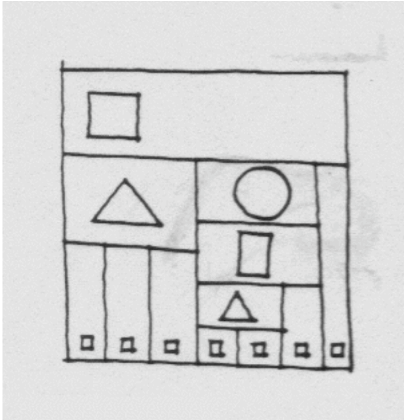

fig.9

figures 7 and 8.

22.4 By means of the diagram we have eliminated the particular position of the spaces in a form, but give only their hierarchy. The first space is divided in two: public and private space. (fig.9.1) We can abstract the sum of private spaces, leaving its subdivision to another player later on.

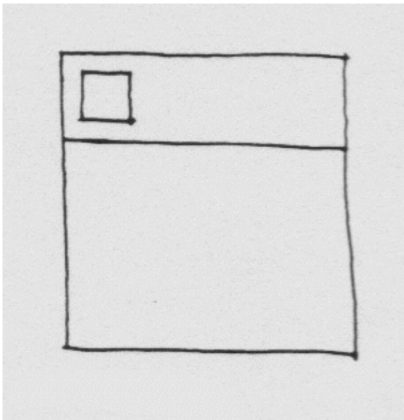

fig.9.1

This need not change the order. There still are only two levels. Figures 9.2 and 9.3, for instance, are both interpretations of figure 9.1. All three have only two levels and exactly the same public-private space ratio. This possibility to redistribute private space in different territories is compatible with real life. For instance, when we have a city block it is all private territory relative to the streets around it which are public space. but the block can be carved up in smaller lots in many different ways.

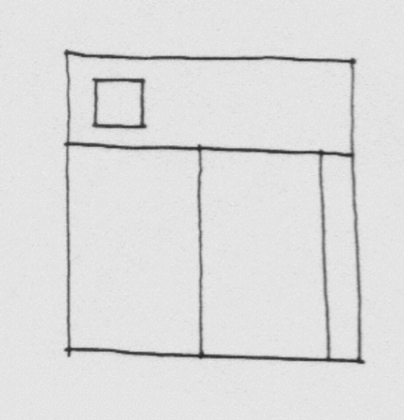

fig.9.2

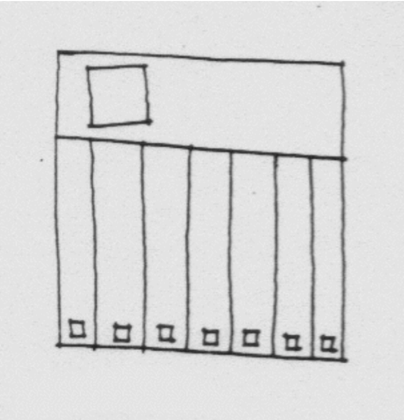

fig.9.3

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23 IN-HOMOGENEOUS LEVELS

23.1 So far, we have found orders of elements that were similar in kind but different in size and orders that had nominal classes of elements that were very different. But within a nominal class we always found the same kinds of elements. The only variation within a class that we allowed so far was the length of walls or streets. These were elements defined by their section only.

23.2 It is possible, however, to think of an order where we find very different elements within one level. Elements so different that they do not relate to one another in any way, nor do they form a hierarchy among themselves. The only reason for their being in the same class is that they all connect to the same higher level form.

23.3 We can think here of the concrete or steel frame of a building that supports floors, facade elements and ceiling elements. (fig.10) Or the chassis of an

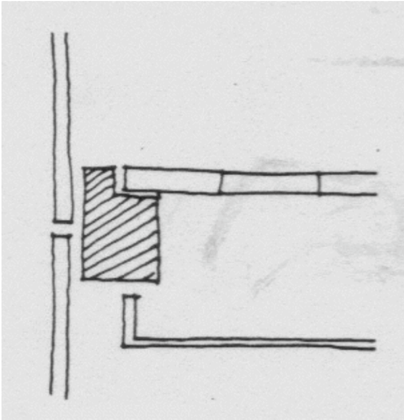

fig. 10

old fashioned car that supports the body, the engine, the axis with the wheels and other parts that make the whole. (fig.11).

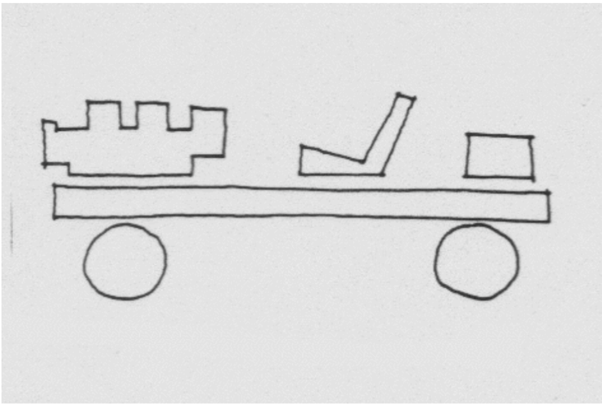

fig.11

Or we may think of the shell of a boat that receives engine, mast, sails, and many other elements.

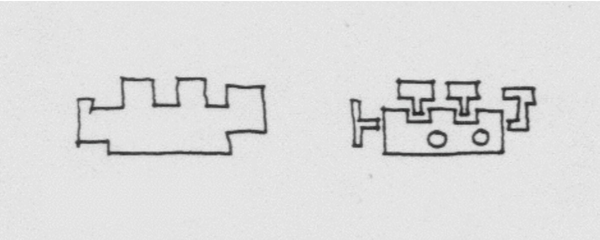

fig.11.1

23.4 The element that is attached to the first framework (the engine in fig.11.1 left) may, upon examination, consist of its own framework that supports also a set of very dissimilar parts, and so on. (fig.11.1, right)

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24. FRAMEWORKS

24.1 The force that justifies this kind of hierarchy is gravity. The lower level element is attached to the higher level element to be held up, to retain its proper position in space relative to the other elements similarly held in place. The framework principle is found in most engineering forms where very different elements must be brought in relation to one another to function together. Often these elements are related otherwise as well. For instance, the transistors and other parts that make a computer function are all attached to the mother board that acts as framework, but they also are connected among themselves by wires for functional reasons. In the same functional way the engine of the car (fig.11) is driving the wheels. The order of gravity we discuss here ignores those other relations. As with all hierarchies it must have only one relational principle.

24.2 The important function of the framework principle is that it separates elements from each other thereby limiting interface among them to those for functional purposes. The framework hierarchy is flexible since one part can be replaced without disturbing the position of other elements (not taking the functional relations in consideration).

24.3 The framework hierarchy is utilitarian by nature. Having little spatial quality it does not speak to architects as much as other forms may do. It is often out of sight since the functional and meaningful relations between parts are realised differently.

24.4 The chemist who constructs a framework to hold her glass vessels in the proper spatial relation to one another is most interested in the conduits that connect them. But gravity is always with us and framework hierarchies are found in many different forms.

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25. COMBINATIONS OF HIERARCHIES

25.1 The fact that, in the previous examples of framework hierarchies other connections are made between parts, outside the framework hierarchy so to speak, suggests that there are forms that embody several hierarchies. This is often the case. The study of compositions of hierarchies merits separate attention. We will not go into it here.

26. TOP TO BOTTOM

26.1 It is easiest to describe hierarchies in a top to bottom fashion. The form is described as a history of design phases. The first phase is the highest level. The configuration obtained at that level provides the context - the site- for the subsequent interventions on a lower level.

26.2 The higher level, as a context for the lower form, can provide space and interface conditions to the designer on the lower level. The abstracted spatial unit indicated by the higher level design can be filled in in many ways. Indeed, if space and interface conditions are the only constraints it may be highly unpredictable what form may emerge in the given space.

26.3 Usually there are certain expectations on the higher level. The tree-like hierarchy assumes that all levels are composed of tree-like configurations. Indeed most of the examples we have discussed had a homogeneous nominal class order. Knowledge of this order makes it possible to decide on the higher level form that will accomodate lower level forms best.

26.4 But in case the nominal classes of the hierarchy are not homogeneous - as is the case in urban design where a road network must accomodate buildings, for instance - it is still necessary for good higher level design to know what lower level forms need to be accomodated.

26.4 In other words: when we work top down we need to know how the hierarchy we are contributing to is composed: what nominal classes can be expected on the lower levels that yet have to be designed.

27 BOTTTOM TO TOP

27.1 In the real world we also find examples of hierarchies that emerge from the bottom up. In informal urban neighborhoods, for instance, people begin to build their houses before any higher level infrastructure or utility is available. Streets, sewer lines and water distribution only follow later. We may assume that this procedure was normal in the past before towns and neighborhoods became purposely planned and executed. For millenia, we may assume this bottom up process was the norm in human habitat.

27.2 Still, we may assume that those who acted on the lower level has some idea of the larger context that could emerge later on. A farmhouse may be built first, but the inhabitant knows what a village is like. Indeed, the settlers of todays informal neighborhoods usually have a good sense of the urban grid within which their house will perform. Although no streets are there yet, a plan for the streets is usually known and blocks and house lots are layd out according to it.

27.3 Different examples of historical processes are known where the action always was bottom up, but where something of a higher level order was known to all and often sketchily indicated in advance.

28.A COLLECTIVE IMAGE

28.1 The conclusion can be that materialisation of complex hierarchical forms like cities and towns can begin from the top as well as from the bottom, but that in all cases some collective knowledge existed of the way the entire hierarchy of the complex form was to be. The planner at the top must know what lower level infill can be expected. The individual at the bottom needs a sense of the larger context to act meaningfully.

28.2 A distinction must therefore be made between the actual physical realisation and the understanding of the overall hierarchical structure: the nominal order behind it all. The realisation can start from the top as much as from the bottom. But the overall image shared by all actors, but not yet implemented, is a necessary prerequisite.

29 AGENTS AND THEIR RELATIONS

29.1 Speaking about the emergence of a hierarchical form we have assumed that such an emergence is the result of the action taken by various actors operating on different levels. Levels in a hierarchy can only transform and come about if they result from different actors operating.

29.2 conversely, when a large number of actors seek to execute a complex form, they must create a hierarchical structure of decision making and control. Higher level and lower level depend on one another. A hierarchical distribution of design responsibility is needed for the creation of large complex forms.

29.3 It is therefor wise to see complex environmental form as a reflection of distributed design responsibilities and to see such distribution as the necessary prerequisite for the emergence of complex environmental form. The better such distribution functions, the richer and more varied the large form will be.

30 THE USES OF THIS REPORT

30.1 The examples given in this report cover only the most important different kinds of hierarchies to be found in environmental form and also in other complex artefacts. The student is invited to begin to look at real world examples and try to see in them the workings of hierarchical living form. Once we have aquired the ability and the habit to see in complex form their hierarchical structure, we begin to see how such a form can transform over time and how interventions on the different levels can be made; how levels can be strengthened or how they may change in character. When we have aquired this habit we see the actors in the transformations of the form and form and actor become one thing: a living form.

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