Lecture 11
October 25th

Now, we're on these conditions. I'm afraid the material is not quite in phase with the lectures so we'll take ten minutes to finish off those first two conditions or rather conditions four and five.

Now these two conditions are not concerned with the validity of patterns but with their usefulness, as I said. If you want to think about it this way, condition four says that the pattern insures that the pattern will be small enough, I'll explain what that means in a second, and condition five says that it will be general enough. Now small enough - what does that mean? As far as the description of the format is concerned and as far as conditions one, two and three are concerned it would still be possible to give as a pattern, a complete design. Let's say an entire house, an entire office building - a whole freeway. If you look over the conditions carefully you'll see that that will be quite compatible with what's been said so far. And obviously as elements of a language, those things will be quite quite useless because the chances that the exact configuration of a particular freeway or a particular house could be applied more than once - and let alone many many times - is very slender. So the elements of the language have got to be such atomic things that there's a real hope that by combining them and recombing them one will have a system which is rich enough almost to cope with any setting.

So the sense of this condition four is that it is attempting to split these fairly complicated wholes into sub-patterns each one of which has a different range of application. So that, let me try and make that clear with an example. Suppose that somebody were to propose this lecture hall as a pattern, the whole design of it. It is fairly clear that there are different sub-patterns here each of which is applicable in a very different range of settings. For instance, the configuration of the individual seat - that is the way which each seat has an arm on which you can write on while listening would be applicable under any circumstances where an audience is trying

in the other direction, but these kinds of schemes are extremely expensive in fact the interchanges would occupy almost all the land between the streets if one did that seriously. However, it's possible that something along those lines might work in very high density areas. The context of the patterns we're discussing - I've read out low and medium density areas. In those areas it's quite certain that people are not going to build elaborate multi-level schemes and there's no point in going along that path.

So we're faced -xaxaxxx analytically we're faced with the following problem. There are really four kinds of demands - 1. Origins and destinations are more or less randomly distributed. This is a feature of becoming more and more important in the way that metropolitan areas function today in space. 2. People like their cars and will insist on being able to use come equilavent form of individual vehicles specifically with the property that it can go door to door on any door to door trip and a moot point maybe is that people will demand some kind of individual vehicle simply because they can leave things in it and the difficulties of using public vehicles are too great. Now, that part may be questionable. Three economy required that streets be essentially at ground level. 4. Obviously people want to be able to travel as fast as possible - average speeds must be high.

Now, if we look at the problem of congestion carefully in the light of those demand remember we're talking about a two-dimensional sheet and we're trying to get high speed flows in all directions on this high speed sheet, the thing that becomes obvious is that it's the intersection which are causing all the trouble. It's not only straight intersections like that it is also known that for instance intersections where you are allowed to make a left hand turn across traffic xxxxx reduce the capacity of the intersection enormously and you'll find references to those things if you xx look the papers up

So, the question comes about, how can we create a pattern of streets essentially two-dimensional without intersections. Well, of course, the idea of a parallel pattern of streets is an answer to that question. At first sight it seems completely crazy because one - well, when it's just a whole lot of parallel streets of course it's impossible because you can't move across it. But if you then say - well in order to move across it we'll put in freeways at very very wide spacing, as I've said, two to three miles, the critical question which arises is will it not be true that the detours on such a trip will be so great that they make the solution quite invalid. Now, just let's look at those detours. If we imagine a system like this, the sort of case where there'd be a detour is a case where you have to go up all the way around like that and down there.. And that is the case which is bothering us and which seems like its going to hang this whole solution up.

Now, under statistically analysis it turns out that this is not so. Obviously, I'm not going to go into the mathematics here but I'm just going to try and sketch out the line of argument that leads to this conclusion. First of all, let's remember that there are essentially two kinds of trips in this pattern. One of the kinds goes like that and that doesn't have a length which is substantially different from a trip in a grid pattern, so the only kind of that is bugging us is this kind and the characteristic of those are what I call one band trips. If you imagine the whole area is devided into bands by the freeways, it's only the trips which are one band trips that have this detour built into them. You can do an analysis of the one band trips as follows. First of all, we know roughly what the distribution of trip lengths in a metropolitan area is. Just to be concrete I'll read out some of the --- Question ---- let's discuss that separately because I think the arguments are unclear. The approximate kind of distribution you get is 23% of the trips are less than a mile and a half, 20% of the trips are between a mile and a half and two miles, 12% bwtween $2\frac{1}{2}$-$3\frac{1}{2}$ miles and so on with different percentages up to 7% between $11\frac{1}{2}$ well more than $11\frac{1}{2}$ mkles. Anyway, so we can obtain a distribution of trip lengths for

a metropolitan areasxxxx as they are today. Now, somebody has already made the observation that that is of course the trip lengths for the things as they are today and its not certain that it will apply to a metropolis built according to these principles. Let's just take those figures. Now, you ask - of all the trips of a given length - on that distribution we can work with trips of different lengths - let's take a trip whose length is about 3 miles. Now we can ask - how many of the three mile trips are one band trips because x those are the only ones that are going to have a detour. Now, that problem is the same as the problem of throwing a match stick onto a whole lot of - parallel - let's look at the bands now. These are the freeways - and its a familiar mathematical problem given a set of parallel lines like that if you take a match stick of a certain length and throw it down on this thing - how much of the time will it fall inside a band and how much of the time will it cross a line?

So that - the proportion of trips which fall within bands can be computed by means of this function which is fairly well known in the probability theory and you obtain that separately for each xfxxxx trip length. Now, you can also compute by means of - by integrating here you can compute the detour in the case if this distance is M, you can compute the mean detour for a detour type trip within that band. Let's just see what the detour is. The normal trip would be that so the detour is that plus that. So it's twice the distance of the nearest one of these points to the nearest freeway. It turns out that that detour is M over 3 on the average, if this is M. Sorry, I forgot to say that the number of these that will fall within a band is also a function of M if M is that distance, and this has a given length L. As a result of all of this, one can - given the present distribution of trip lengths show that - no let me just - we're not going to compute the following function. We're interested in the total detour summed

over all trips that are taken in that metropolitan area. So, we're going to - we have a distribution of trip lengths - for each trip length we know how many of them are going to be one band trips, for each one of those we know that its going to have a detour of m over 3, so we can sum over all trips that are taken in that metropolitan region for different values of M. Now, it turns out that the overall detour for different values of M - for M equals one mile - the over all detour is 1%. The total increase for distance travelled is 1%. For M being two miles that is the freeway being two miles apart it is 5% and for M being three miles it is 10%. Now there is a correction to be made. Are there any questions, first of all?

Question:

Reply: That's an interesting point, no wait a minute - yes, that is true. I wonder how one could analyze that? Somebody at Michigan made an analysis based upon a finite arrangement of this kind but I don't think -- and came out with very very similar figures but it's true that in the special case where - if it happens that a city was that shape with respect to those freeways that you would be making this kind of detour a great deal. What that really seems to indicate is that relative to the shape of the area in question, one wants to make sure that the freeways don't get you into this bind. That's an interesting point though. It almost suggests that one should include as part of the context a statement of overall shape and include in pattern one something about the orientation of the freeways. That's a very good point.

Now, let me just make the correction. There are two sources of error in the figures that I've given. One of them is - as you saw on the slide - there are these loops and every time you make a trip you have to go around a loop like that. So this adds a constant amount to the total detour which is over and above what one would expect in a grid pattern. So that slightly increases the figures I've just given.

At the same time, you would expect the - it's fairly clear that the general commercial land use will occupy these bands and since a very large number of the trips in metropolitan areas - about 70% - have a commercial land use at one end or the other of them, this means - this will grossly reduce the number of trips which have this kind of character because it means that for those 70% they'll almost all be this kind of trip. When you take these two corrections into account - this one of course reduces the total of detour - the loop thing increases it - the figures actually become the increment for one - for M equals one is 3%; for M = 2 if 5%; and for M = 3 is 7%.

Question:

Reply: No, let's examine that when we come to the pattern concerning the loops - that isn't so. Now, at the same time, we've got a - we have a street pattern now which on you never stop - in other words except for massive freeway hold ups, those kinds of stops and there is nothing in this instance that has been said about those but there are no traffic lights, no stop signs, and its reasonable to think - and this is a pure quest that average speeds might be as high as 45 mph. It would certainly be as high as 35 or 40. But there is really no reason why vehicles would be moving at normal freeway speeds some where around 60 mph all the time on this system except when there just coming in on that last little stretch on the driveway where of course their moving at almost walking speed.

So that this system - although it does increase - it increases a overall distance travelled by 7%. It decreases the amount of time spent on trips - in fact if you take those two figures - if you say average speeds will now be 45 mph as opposed to 15 and the increase in distance overall is 7%, the total time spent on travel in vehicle hours per year will be 36% of the vehicle hours per year for a grid pattern.

Now, this is the argument which leads to sub-pattern 1. It does let's just look at to what extent it succeeds in meeting conditions one and two first of all. It is fairly clear that the problem exists in the context stated. The question is whether the various assertions that I read out are the correct ones. I said origins and destinations are more or less randomly distributed in the plane. That is not a very accurate statement. In fact it's slightly wrong the way it is stated there. Just because of the whole business of commerical uses influencing it but it seems that there is some kind of assertion about two-dimensional nature of movement in a metropolis is correct. It was said that people like their cars because of the door to door travel and possible for other reasons which are going to make transit solutions are not meeting the demands. It was said that economy requires that streets be essentially at ground level and of course it is the case that people want to travel as fast as possible. Now, those are not arbitrary objectives which have been inserted here by me. It seems that one could obtain those demands in an empirical way from - in that kind of setting. That is what condition one would hinge on. If somebody could demonstrate that one of these assertions was false - condition one would fail.

Condition two is really in this case hinges on the argument that I've just given about the statistics of trip distribution. In other words it has to be demonstrated that this pattern proposed solves the problem. Condition three is satisfied by this thing, as it stands, with all that we've done so far. Because it does raise a number of new problems. For instance, the freeway, assuming any kind of reasonable spacing of the streets there will be loops very very frequently along the freeways which would put kinds of stresses on drivers driving along the freeways which are unusual compared with the sorts of stresses that they experience today. Again, since vehicle velocities will be high, cars will be moving at 60 mph

on streets that are closely spaced the sound level in between the streets will be higher than it is today unless something is done about it. So those are two examples of a failure of condition three. This pattern is raising problems that are not solved within it - what we have to determine is whether they can be solved in a way that is compatible with this pattern. This is where we get into sub-patterns 2 through 7.

to take notes from a lecture. Now that would apply not only in the University lectures halls but also in a wider range. But that would be the key issue. On the other hand the pattern of spacing the seats - that is the clearance between rows and the distance from one seat to the next within the row, is applicable in a much wider range of circumstances - that is any auditorium, particularly and lets also take the fact that there are seven seats in a row here and that some such number is going to be an important maximum in order to solve problems of fire eggress and that again, the fact that your aisles have to come reasonable frequently is a pattern which will be applicable in any auditorium, though it will vary with size. On the other hand, the coat hangers in the back and their relationship to the door - in fact it's very badly thought out I think, but something of approximately that kind would be applicable in any place where people with coats were coming into a room and it was a large number of people. Again, the range of context in which that pattern makes sense is different from the range of context where each of the other patterns makes sense. So this is roughly what condition four is trying to do. It's trying to let us take the patterns apart and so that we have useful elements. Now the moment that you do that of course the question arises just how far should we split these things up. Because the process that I just described in a very vague way is quite unclear. One doesn't know - should one try and take this lecture hall apart into five patterns or into fifty thousand - I mean should one consider separately the actual shape of the hooks on that board and the fact that they are arranged in that kind of a zig-zag way and the fact that they are about the ehight off the ground that they are. These are all different features of that arrangement of hooks and should they be separate or not - not clear! Condition four says that you take two patterns apart when the problems that they solve have context which do not coincide. Let me give an example - the house entrance sign that I showed you, at one time happened to be written as two distinct patterns and those two patterns you could still discern them with sub-patterns/ - one of which dealt with the size

of the letter and the angle of the sign to the road - and the other one of which dealt with the fact that the size had to be far forward on the road and its height off the pavement. And in a sense those two things are dealing with different problems because one of them - the size of the letters and the angle of the sign - had to do with the whole problem of stopping distances and driving at a reasonable speed as you approached this thing - whereas the height and the fact that it has to be far foward on the lot dealt with the problem of not being able to move your head more than 10 degrees off the road. So that one culd claim that here we have a case where there are two sub-patterns Q and R - solving sub-problems - Problem Q and Problem R - now the reason for not splitting them apart in this case is that one could say with reasonable confidence that whenever one of these problems occurs the other one will occur. So that in that sense they hold these two problems - these two problems are always associated - they always occur together. Any context where one of those occurs the other one will also occur and for that reason there is absolutely no point in splitting them down any further. So this condition is actually doing two things. Let me just repeat them. On the one hand its guaranteeing that the patterns will be small enough - its avoiding the mess of thinking of whole designs of patterns but on the other hand its giving you a reasonable place to stop as you go down and down and down fragmenting the patterns further and further. Because since there were no contexts where one of those sub-patterns occured and the other one doesn't - one combines them and therefore the pattern is most sensible the way that I presented it. Now that is the content of condition four. Condition five is very much simpler to understand Harder to achieve. It simply says that the pattern that is presented should be so couched as to cover the full range of possible solutions to the problem in question and the context in question. I tried to make that clear as I was giving the example, to come extent. I pointed out that although you could draw it one way by bringing a

fascia out in a kind of weird 45 degree break that there are other ways of achieving exactly the same pattern. I gave an example of the column but to streach a pattern so that it covers the full range of possibilities is a very very difficult thing to do. It's particualy difficult to do it explicitly. I already mentioned the difficult of doing it with a drawing because a drawing tends to freeze the pattern and does not often convey the abstract characteristic well enough so that they have this full generality. It's very hard to do in words also, it seems fairly clear that when we remember such things in our own minds we don't do it in either of those two ways we do have a way of doing this which is very very powerful and at this moment its a secret - I mean one just doesn't yet know how the brain does this. It's quite clear that it's doing it all the time - the literature - for instance in mathematics one finds a terms to define with full generality some things that we can grasp intuitively very very fast. I'll give one example very quickly. Everybody here knows what an overhand knot is - and it's obvious that our brains have some way of representing an over hand knot which is perfectly general so that we recognize one whenever we see one. If you want to give a mathematical description of a over hand knot you'll take - it will take a fifty page book to explain the description - now this is a fact - there happens to be a branch of mathematics called knot- theory and in order todescribe an over hand knot in this mathematical language - you have to construct an abstract object called a group which is associated with the negative face of the knot - its not the actual piece of string but the air that the strings leaves and its - I'm only giving that example because its pretty clear that it's an unweldy business - its fairly certain that's not how we do it in our heads and I only want to bring home the terrible difficulty of meeting this condition five.

The trouble is that at the same time its being very difficult - its the crux of the whole idea of a language because if the patterns are too tight then obviously there not going to have the range of applicability that we want them to

have so people will just throw up their hands and say look - this pattern doesn't work in this situation as you've defined it. And it just won't work. Conditions four and five are working hand in hand actually - there's a sort of - there really after the same thin g because the idea of splitting patterns down is also part of the business of trying to make them general. So these two conditions must be satisfyed in order to make the element of the language completely general to be useful.

Now, in order to make these conditions fairly clear I'm going to give some more examples. I think some of you may be a little impatient at these examples judging by some of the comment that I had last time, but I'm going to go on giving examples otherwise we're not going to get any sense at all of what we're talking about. So I'm going to spend today and next time and possible the time after that continuing with examples. Now the example that I'm going to give today is at a very very different scale from the last one, it has to do with the pattern of streets in an urban area. This is a much longer and more complicated pattern than the one that I gave before. For those of you that want to look this up there is a published version of it - a preliminary published version of it in the Journal of the American Institute of Planners, September 1966 but that version is quite wrong in a number of details and is also not in the same format that we've been discussing, Now there is a revised version of it which is appearing in Architectural Design, I think its either just come out or just about to come out. It should be in the latest issue and that is exactly what I'm going to present to you today. So if you can get a hold of it it would be helpful.

Now, the context here is low and medium density areas in any urban region where the number of cars per capatia is greater than 250,000. The low and medium repeat Let's get this slide. I'm sorry I forgot to read the summary. I'm going to stick to the format obviously I can't didtate this whole thing - it's about 20 pages long - so I'll read parts and discuss other parts. The summary here is this: The present netlike pattern of streets whether it is a formal grid like Manhattan or an informal net like

London is so well fixed in our minds that it hardly occurs to us that city streets might have an entirely different pattern. Even the coming of the freeways has not changed our thinking. So far the freeways is superimposed on the existing street patterns - the pattern of ordinary streets below the freeway has not changed at all. Yet the net like pattern of street which we're use to of obsolete. Congestion is chocking cities - the demands that now exist require a totally new geometry with the relation between streets. This paper describes a new pattern for the streets in a metropolis - average speeds in an area laid out according to this pattern would be 45 mph as against 15 mph or 10 mph typical for urban areas today. Yet the main trip length is increased only by 7%. The principle features of the pattern are that all streets are paralell there are no cross streets, streets are connected by freeways three miles apart.

Now in this diagram - these are the streets and these are the freeways - now in detail - I've given you the context - and the pattern statement actually contains seven sub-patterns. And these I think perhaps you should write down. At least in brief form

1. All streets are parallel - there are no cross streets and no two streets intersect. At 2 to 3 miles multi-lane freeways run under the streets at right angles to them.

That should say approximately at right angles - you see every statement that you make in these pattern statements is always subject to this kind of nonsense. I had better discuss that for just a minute. In view of condition five there - because when I say at right angles there are really two ways of understanding that. There's the mathematician's way and he means rigorously 90° ~~and he means~~

and what I said could be interpreted that way and there's also the way in which we sort of understand that globally - which means at an angle that's not to acute. In other words somewhere around 75 to 110. And that is what I mean. That's exactly the problem which the brain has solved and which we have not. If somebody says to you that something should be more or less perpendicular to something else, that is what you understand but we just don't have elegant notations of that kind of thing.

2. The streets are one way, high velocity arteries often the streets run in opposite directions. Pairs of streets are connected to the freeways by clock-wise 360 foot diameter loops. There's a whole series of other drawings that I haven't had slides made of - anyway what we're talking about here is that for instance this street will be one way in that direction - this one will be one way in this direction - and this will be clock-wise loop. Again of course the 360 feet is approximate.

3. The streets are 500 to 1200 feet apart. Loops are placed at 1500 to 8000 foot intervals along the freeway. This is sub-pattern three.

Near the freeways alternate pairs of streets converge onto the loops. The two outer lanes of the freeway are reserved for weaving. The convergence is only barely visible in this diagram. But you see there is a kind of neck where the loops are necessary of course because the spacing of the streets that I just read out is not compatible with the drawing. I would like to make a point insidentially here. Just to throw more difficulties at you - there is a purely graphic problem here. If this drawing were made so that its actually is to scale. That is that the streets have the spacing that I just read out and the loops were to have the size that I just read out - it would be illegible as a drawing and this is another one of these unfortunate things. You see we are capable of constructing clear

images of these things in our heads but when it comes to trying to construct clear images on paper we sometimes have to distort the accurate statements drastically.

4. Neither pedestrians nor parked cars are allowed on the streets - the strips of land between the streets where the buildings are, are continuous pedestrian areas.

5. The buildings between the streets are on access driveways which go all the way from one street to the other. The buildings are on access driveways which go all the way from one street to the other - now what this means is the following: Suppose that you have two streets like that - there is a whole series of access driveways which could be there. The driveways meet the street in fishtails - now remember that this is an artery - a one way artery - and what I mean by fishtails is this kind of a situation. No two driveways face each other across a street. Another words a drive way on this section of land will not be in that location. It would be in some position like that.

6. The middle 200 to 400 feet of each driveway has a bumpy surface designed to slow vehicles to walking speed so there's a section in there which has a bumpy service. That could be done a number of ways. It could be done by corrigating the road surface or it could be done by putting cobblestones of various kinds in or it could be done by transverse slots - there are a number of different ways of doing it.

7. The streets themselves are sunken or separated by a raised earth mound from the area between them. Those buildings which are immediately next to the streets are oriented toward the inner area and made to form a continuous wall which shields the inside area from noise - referring to buildings particularly placed in those kinds of positions.

I may have to -- I want to give you this in some detail and I may have to again go into the next lecture. We'll see. Now the first thing that we're going to talk about is the first sub-pattern. Because that is the crucial pattern - which is really different from what is going on today. All the other six actually follow

from it in a sense - and are necessary adjuncts to it. In fact, I want you to think about conditions three here because as it will turn out in the argument the key argument about conjestion and how to solve it revolves around simply the idea of having parallel streets - just that with occasional freeways intersecting them. I mean running under them. As you'll see when we've gone through the argument for this initial pattern it fails to be independent in the sense that it is required by condition three because it raises special problems and it is not clear after you have made that statement that they can be solved without changing this. So that it is then necessary to discuss all these secondary problems and to bring forward further sub-patterns to make sure that this first pattern really is independent in the sense required by condition three.

There's one thing I haven't made quite clear - I am discussing seven patterns here. Not one but as we shall see there are ways of regarding linked theories of patterns as high order patterns. So that this is beginning to be an example of that but I don't want to anticipate it.

Now the argument for this parallel arrangement is roughly the following: First of all, it is quite clear that cities are choked by congestion. As I said, average door to door speeds in most urban areas today are somewhere between 10 and 15 miles an hour, inspite of the fact that vehicles are capable of travelling much, much faster. The ways of solving this problem which have been proposed so far really don't do the trick. Rapid transit is - both rapid transit and freeways speed up flow only along specially chosen lines. The way in which a modern metropolis works is essentially two dimensional and one must be able to get one one point to any other point with very very great ease - improving the flow along certain lines is just not enough - its not adequate. Thus its conceivable to think about some science fictionish sort of schemes where flow in one direction is at a different level from flow