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The Order of Nature

New Science, New Urbanism -- New Architecture?

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Conference Proceedings

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New Science, New Urbanism -- New Architecture?

Contents

Introduction

There were really two "new paradigms" contending with one another in this conference -- or so we asserted, and such was the logic of our design for the day's discussion. One, the use of the new sciences as material to fuel dynamic new architectural *expression* – so well articulated by our friend Charles Jencks. The other was the usage of the new sciences to inform a more intelligent *process* of city-making, and the role within it of methodology, pattern, precedent – all those things related to what Jane Jacobs called "the kind of problem a city is."

For all the fascinating new forms of iconic expression being produced by a new generation of architects – the blobs, terrafolds, Bilbao-style computer forms and other innovative expressions in architecture – we think the lesson of this conference was more sobering, and served in its own way as a powerful critique. It reminded us that to meet the challenges of the future, architecture must be more firmly rooted in the real patterns of human activity.

We also saw tantalising evidence that the new sciences offer promising new ideas and tools to improve the quality and sustainability of the human environment.

George Ferguson, president of the Royal Institute of British Architects, gave the introduction to the conference. He called for a broader leadership role for architects in meeting the challenges of the urban future. He welcomed a "new conversation" between science and architecture -- not aimed at creating ever more dazzling technological solutions, but rather at understanding the patterns that work and don't work in our cities and towns, in order to improve them.

"What I believe in most strongly," said Ferguson, "is that we should move forward with a much more thoughtful, analytical way of doing things. We have too often leapt into inspired solutions that have fallen flat on their face in only a few years. And an awful lot of what has happened in this country post 1945 comes under that description."

He described fascinating new work in the neurosciences to understand how humans perceive beauty. "I think the more we can uses science to prove to the politicians, and to all of us, that there is a real tangible benefit to creating beautiful places, then I think the closer we will be to stop messing about with failed experiments. I think it is failed experiments that we have been suffering from for an awful long time."

Brian Goodwin, a prominent biologist and former board member of the Santa Fe Institute for the Study of Complexity, pointed out that the new biology offers important lessons about how human building can integrate into the natural ecology. He noted that science can use a number of analytic and cognitive tools to identify quality in the built environment.

Philip Ball, Consultant Editor of the journal Nature, discussed the role of science in architecture and urban planning. He described what he called a "physics of societies," showing how patterns of movement and activity can inform a more robust approach to planning and architecture.

Bill Hillier, Professor of Urban and Architectural Morphology at University College London, picked up that theme and described his extensive work in the morphology of movement patterns. His scientific analysis of the patterns of movement around Trafalgar Square in London's heart,

for example, informed the recent redesign that has resulted in a 16-fold increase in use of the popular and thriving square.

Hillier believes there is great potential for the regeneration of other places using such methods. "We have to internalise this knowledge as designers, and try to, if you like, utilise the inevitable self-organisation potential of cities."

Hillier noted that the making of cities is both fully an art and fully a science. "The art of urban design, as I firmly believe it to be, does rest on the foundation of the science of space."

Charles Jencks, pioneer of postmodern thought in architecture, described a new "creation myth" coming from the new cosmological insights of science, and reflected in the new iconic architecture. He sees this as the beginning of a "new paradigm" in architecture. But he noted that the new architecture today is severely limited by the increasingly global corporate economy in which it operates, and that it is therefore increasingly remote from the local problems and challenges in much of the built environment today. He agreed with other panellists that the leading architecture has become a narrow fine art of "50 people building for 5,000 people around the world."

Other panellists joined in the critique of a global "novelty architecture" that has increasingly become a marketing arm of globalisation, while increasingly ignoring local needs and complex characteristics. Several speakers reminded the audience of the pioneering work of Jane Jacobs, who criticised the architectural and planning approach of the day, and described the need for new scientific models for understanding and acting upon cities.

Brian Hanson, architectural historian at London University, presented the recent work of the legendary architect and theorist Christopher Alexander. Hanson argued that Alexander incorporates and extends the lessons of "organised complexity" going back to other pioneers like Jane Jacobs, and he uses these lessons not for exuberant artistic expression, but to improve the real quality of the human environment. His new magnum opus, The Nature of Order, argues that order in architecture does not have to imply top-down political authority, but can "emerge" from the grass-roots acts of many individuals in a building culture. His argument is firmly rooted in insights of the so-called "new sciences" of complexity. Examples of his work show the successful results of this process in projects from the USA, Europe, Central America and Asia.

Alexander later co-led a "master class" on the detailed ideas of the new book, and his pioneering scientific work in architecture stretching over 40 years. He also described fascinating recent work in a new generation of so-called "dynamic coding." The master class was attended by planners, architects and PhD students from the UK, Norway, Germany, France, the USA and Australia.

A companion website for the conference is operated by the journal Katarxis, at http://www.katarxis3.com. A discussion forum is included at that website, and contributions are welcome. Proceedings of the conference are expected to be available through the Foundation in the spring.

Welcome
Michael Mehaffy

Good morning, and welcome to the Prince's Foundation. We have a very full day, and a very fascinating day, I think, so we'll go ahead and get started.

Now in planning this conference we posed some questions that I'd like to suggest we consider as we go through the day today. You'll see these in your delegate packs.

- How, if at all, does this "New Science" -- and to what extent is it a "New Science" -- change our world view, our culture and our art?
- What practical implications do these insights carry about the process of designing and building? Not just the ivory towers stuff, but what does is mean for all of us in this room that have careers and jobs and want to know how this is going to affect us?
- What reforms does it suggest are needed a sustainable future? Beyond the representation of an art form, what does it mean?
- Does it mean there is a new paradigm in any sense of the word? And if so, what does that mean?
- Perhaps most important, what -- if anything -- can science tell us about the quality of the built environment, and how we can raise that quality?

We're pleased to say that joining us here to kick off the discussion, our first speaker, is George Ferguson, president of the RIBA.

The Art and Science of the Public Realm

George Ferguson

Thank you Michael. Well, I only regard myself as very much at the beginning of the conversation. So I'm not going to use any complicated words like "paradigm".

Anyway, The Art and Science of the Public Realm…

I'm fortunate in having been involved in a project in Bristol that had one Richard Gregory as its client. R L Gregory wrote 'the Science of Perception' and was always a hero of mine at architectural school. He made me think about why we see things the way we do. What are those ingredients that make a place beautiful? What are those ingredients that inspire? I think all my life I've been trying to seek that. And I'm hoping that a few answers will come out of this conference.

I think a lot of us spend a lot of our time observing. To my mind that is the first rule of science. In architecture our laboratory is the city, the town, the village, the country. And most of all we need to observe how people react to the situations that they are in.

I think the next step after the observation – and we don't get all the answers from the observation – is one of experiment. And I believe the best is there in every situation; I believe there are answers lying in the environment everywhere. And the experiment is to pluck out these particular ingredients from the places we like: some that may be beautiful but not work very well; some that may be ugly and do work well; some that have a desirable social mix but don't turn into a proper community; and others that may be a monoculture but do work as a community of a sort.

Take somewhere like Brindley Place in Birmingham, which is a relative monoculture (it is a beautifully built office park). But it has developed a sense of community. What are those qualities that we can find and transplant? What are those qualities that we can extract and use to build on to make a better place?

And the third big step in the scientific process is the one of discovery through experiment. And I have a little experiment myself, which I hope is to do with art and science. I took a building not that unlike this one, and have turned it into an experiment about how you can revive a flagging community. This community happens to be in a relatively derelict part of Bristol. There I have tried to literally mix art and science as a tool for regeneration. The art is the performing arts and the science is the science of high-tech industry. Putting those two together you find there is a wonderful conversation that goes on between the 'techies' and the artists in the theatre. There is a tremendous vitality and genuine community that comes out of that relationship. So there is a literal mixing of Art and Science that has flowered a community that thought it was on it uppers.

Again in a literal sense, in this scheme with Richard Gregory, which was based on a new science centre, we made a deliberate attempt to mix physical aspects of art and science in the public realm. That has made a very vital and new place and a series of squares that families are very switched onto.

So, those are a couple of very literal examples. But what I believe in most strongly is that we should move forward with a much more thoughtful, analytical way of doing things. We have too often leapt into inspired solutions that have fallen flat on their face in only a few years. And an awful lot of what has happened in this country post 1945 comes under that description. So let us observe; let us find scientific ways like Bill Hillier does to observe the way people use the city. Let's find ways to react to that. Why is it that when we turn up to places that are really beautiful that you get the sort of surge you get when you fall in love? Why is it that those things happen? Can we use science to actually see what's going on in our brains when that happens? I know there are people in America looking at the neurological effect of the beautiful place. Can we prove that really inspiring hospitals make us better quickly? It doesn't take many anecdotes to realise that a beautifully designed school will get more children coming to it, a more inspired staff and better learning. It doesn't take a clever person to realise that. But what I do think we should do with the New Science is try and put some convincing analysis and near proof on the effect of good design and good planning.

I am always demanding better planning and better architecture. I think most of us know what it is. I think most of us know what is beautiful to a certain extent, although there will always be grey areas of disagreement. Most of us know what is ugly and depressing. I think the more we can uses science to prove to the politicians, and all of us that there is a real tangible benefit to creating beautiful places, then I think the closer we will be to stop messing about with failed experiments. I think it is failed experiments that we have been suffering from for an awful long time.

The only exception I would like to put in, is it would be a shame if such an approach prevented the odd dramatic thing happening. It would be a shame to prevent the Bilbao effect. There is a science that has to look way beyond the normal. We've got to look at not just simply the very most important thing of how we create good ordinary places (which is always the most important), but we mustn't have a science that becomes so rigid that it locks us into a particular way of doing things and prevents the great surprise. Because it is the great surprise that gives us hope and enables us to carry on saying that architecture and planning are above all, an art.

Thank you.

Toward a New Science of Qualities
Brian Goodwin

Well here am I like Atlas – astride the electronic world! I'll try and keep my balance.

Thank you very much everybody for coming. This is my first exposure to the world of architecture in this particular form. I've known Charles Jencks very well for many years, and I've interacted with architects from the point of view of saying things about complexity and its relationship to architecture. But I think this goes much further.

I want to start with my origins, and locate the New Science within the perspective that I experienced. I was at the University of Sussex for many years, in the School of Biological of Sciences working with John Maynard Smith, the Darwinian scholar and polymath who recently passed away. It was there that I pursued attempts to understand biological form, and by that I mean both morphology of the natural world and behaviour.

So, I started with this kind of question: how are we to understand the particular forms in the natural world? Because they are not arbitrary: they belong to certain generic categories. And I was very interested in trying to understand these from the point of view of the generative processes involved. That is, what is going on in the organism? What are the forces? What's the array of physics, chemistry, biology that gives rise to these beautiful forms?

Now I'll come back to the word 'beautiful' later on.

Richard Gregory is someone I've interacted with for many years. He and I were at the Waddington Conferences in the Seventies where these issues were raised. The thing about biological form is it is always in the process of change – it's not static.

Here (*referring to slide*) is the chestnut tree at Schumacher College, where I currently teach. The philosophy of the college is 'small is beautiful'. This is a big chestnut tree though. It's expressing itself rather beautifully, and the life cycle goes from bud to leaf, to the expression of what are called philatelic patterns (the arrangements of leaves on the tree), which belong to certain categories. These categories are not arbitrary. They have a deep description – I'm not saying the trees have mathematical minds, but they certainly express efficiency, elegance and coherence. Now those are the words I am going to come back to over and over again in relation to natural form: the "order of nature", as Christopher Alexander would call it.

So form and transformation live together in the biological realm, and there is always a life cycle. That is, whatever is brought into the world has a limited duration, and everything goes back to nature and is recycled. So here we have the series, from bud to chestnut, going through all its different forms. And there is deep mathematics and biology in there. But this is not yet complexity. This is the domain of non-linear dynamics out of which complexity was one of the components that arose.

I want to just say something briefly about the organic tradition that is manifest here (*new slide*). This of course is now architects creating, and in some sense combining, culture with nature. As you will see later, I am suggesting that the New Science does this; it can put culture and nature together in a new way. Here (*new slide*) are various expressions of form, which are

simultaneously beautiful, they're efficient in the sense that there is elegance with respect to purpose, and furthermore all of these forms can be recycled – there's nothing toxic in them. They will all be recycled.

I am looking at the roof of an Islamic temple, the jug, and the materials out of which things are made. And of course the Lascaux cave painting is something that is intrinsically part of nature. But here we begin to touch on meaning: what is the meaning of the form? This is the organic tradition.

Next we're going to cover modernity, the mechanical world-view and its artefacts. (*New slide*) Those are the artefacts that come out of a mechanical philosophy where what predominates is functionality. This in certain respects is very consistent with the Darwinian world view with respect to organisms as functional agents, but it fails to acknowledge the importance of life cycles, of recycling – there's a lot of toxic material here – and furthermore, I think you'd agree this is rather ugly. So something has been lost in the mechanical world-view. (I'm putting up caricatures obviously, because there are much more subtle expressions of this that can be beautiful)

I think we're used to the world of design not being terribly sensitive to the environment, and also not in some instances honouring our need for beauty.

So that then is the mechanical world-view of modernity. And for me what New Science does is bring together the organic tradition with what we've learnt from modernity. One of the most characteristic features of modernity is of course this wonderful elaboration of mathematics and mathematical description of natural process and form.

I very much valued my time at the Santa Fe Institute and the colleagues I worked with during the emergence of complexity theory into the full light of day.

One of the things that came out of the new mathematics were concepts like strange attractors. That is deterministic chaos, which is not represented here. It's what underlies the realisation that we will never be able to predict the weather accurately because of this phenomenon of sensitivity to initial conditions, and the need for mathematically precise knowledge of initial conditions for any system we're going to model. So as we know especially in this country, the climate is unpredictable and it always will be. This doesn't mean we can't put boundaries on what we expect the climate to do, because there are patterns in the meteorological systems as well as these unpredictable aspects to it – the butterfly effect and so on. But that's not represented here.

What I have here is the world of fractals and this was another extremely important emergence when Mandelbrot recognised that a lot of natural forms don't occupy integral dimensions in space; they're fractional dimensions. And of course there is the Mandelbrot Set with the gingerbread man popping up. You have self-similarity in these fractal structures. But it's a subtle kind of self-similarity, and different structures have different forms of self-similarity.

Now just below the Mandelbrot Set are artificial simulations of tree growth – fractal patterns in trees. Now to the upper right are these natural fractals, which are fractal only down to certain dimension. In other words the mathematics goes on forever, but in natural form the fractal concept has to be used with a certain degree of approximation. But it is very very suggestive nevertheless, and it is a great insight into aspects of the world of natural form.

Down at the bottom right you have the structure of trees, and in nature fractals are approximate. But the mathematics is an extremely good suggestor of what is going on. There is iteration and there is self-similarity: the part reflects the whole. And in the part you can see the whole. I'm going to come back to that in a moment, because that's very important in relation to health & wholeness, and coherence & elegance, which are all connected. You can see the whole in the part.

This happens over and over again in the case diagnosis of health. Your health can be diagnosed through your posture, your complexion, your eyeballs, and your tone of voice – these are parts of the organism that reflect the whole.

Let me now say a little bit about meaning. What I want to do is recognise that meaning is deeply embedded in the whole evolutionary process. This might sound a bit bizarre, but I'm just going to give a quotation from Peter Coors – he comes from a structuralist perspective. What he says is:

"Meaning has two aspects to it. One is signifying, which is distinguishing between different possibilities and the other is mattering. (Why does it matter?)

He says:

"Signifying is the defining property of signs and the fundamental mark of the intelligible. Mattering is the defining property of value and the fundamental mark of the purposive."

Now here's Coors reflecting on evolution and culture:

"The roots of mattering lie in the structure of biological needs. And it is in the intelligent satisfaction of those needs that meaning first comes into play. In the case of the matching of a structure of praxis with a structure of desire, the proportion of the purposive to the intelligible is very high. As the immediacy of need lessens, the balance of the two components changes, until at an advanced stage of culture or education a very complex structure of intelligibility may be evoked by almost casual purposes. One of the ways in which the meaningfulness of significant activity is maintained is through an intention to pursue the intelligible for its own sake. And in high civilisations this becomes in literature, music, art, and other forms of creative activity the dominant exercise of meaning."

Now you see what this does is put the whole of Evolution into this perspective of understanding meaning. Organisms go about their lives meaningfully. They have 'purposiveness', furthermore they do it with efficiency and they do it expressing themselves through their form and behaviour, which we perceive as beautiful. So again, we have efficiency, functionality as well (the structures and forms are functional – not arbitrary). But what I'm inserting there is evolution with meaning. So we have a continuity between the biological realm and the human realm of culture.

This is precisely, for me, what happens in the sciences of complexity because we live in a world that is complex and uncontrollable, except in very limited ways. Now let me say a bit about this uncontrollability with regard to understanding the behaviour of social insects.

Now social insects are absolutely fascinating. These are communities of beings; agents, that produce the most extraordinarily coherent and elegant forms of structure and behaviour. Now

think of a termite colony – architecturally an absolute miracle. It has air conditioning and when they extend the building they have these incredible chambers that are completely coherent with what has gone before. Yet when you look at the termites and you think 'these guys are chaotic'.

When these activity patterns are modeled the termites are achieving miracles of organisation, form that is elegant, functional, efficient, and beautiful. Maybe you don't think a termite mound is beautiful, but nevertheless…

George [Ferguson] said let's be systematic about this notion of beauty. Can we be systematic about it? This is where we get to the science of qualities. Is there such a thing as a science of qualities?

Modernity has been based upon quantities and their mathematic relationships, hence the laws of nature. Qualities have been put into the subjective domain, which is idiosyncratic and unreliable. That's the way it has been in our culture since the Renaissance and the separation of the arts and the sciences. The sciences are for people who want to understand the real world and have consensus about reliable knowledge and get on with control. That's given rise to the Industrial Age – which came to an end in 1970 we decided in our lectures at Schumacher just a couple of years ago. This is when Gaia, Chaos and Eros all remerged – the Orphic Trinity. Which of course then gave rise to the Christian Holy Trinity, but that's a very patriarchal form: Father, Son, and Holy Ghost.

So in this modern world, or the world of New Science, I see qualities re-emerging as dominant elements. We've already heard that from George. We need to assess the quality of the beauty of the environment because of its relationship to health. I've already talked about health, wholes, diagnosis, understanding the health of individuals, communities, and eco-systems. There are the systems upon which the quality of our lives depends.

So we need to pay attention to qualities. Now there is a methodology that is emerging called 'Consensus Methodology' with respect to the evaluation of qualities – and it works. It demonstrates the extent to which there is consensus between groups of people with respect to the quality expressed by whatever: pigs, a building, a landscape.

This is the work of Francois Wemelsfelder, who works up in Edinburgh in the Scottish Agricultural College. She's particularly concerned with the welfare of domestic animals on farms. And so a consensus methodology for evaluation of qualities is clearly very important, and it is taken very seriously by the Ministry of Agriculture because they recognise that good quality of life goes with good health and good quality of food. That's perfectly obvious.

So the New Science for me combines all the things we've learnt from modernity: mathematical forms, complexity, and the capacity to enter this non-linear realm and make sense of it. Nature remains intelligible even though it's unpredictable.

So we retain the intelligibility of the New Science but we go on to embrace qualities as well as quantities. We do so in a systematic way. We cultivate the capacity to know nature through her qualities and to know our artefacts, our buildings, and our spaces through their qualities.

Now very briefly, this is designing according to natural principles. This is the Zero Emissions Research Institute work – we can redesign all our natural production systems so they are sustainable and mimic natural forms and lifecycles.

There (referring to slide) there is organic culture expressing itself.

The last point is communities. Here is our community as Schumacher reading the land. That is individuals who get together to try and understand the qualities of the land, and ask the question that Christopher Alexander asks: what is the appropriate form of building for this place? And because qualities are what we work with all the time, a science of qualities is in a sense 'common sense', and this is where we connect with communities, with people, with civil society, and the natural involvement of people in the evaluation of the quality of life that they aspire after.

This is not esoteric. There are esoteric aspects of the New Science, but I think it comes full circle back to involving people; cultivating their capacity to recognise quality. This is the capacity of direct knowing, of intuition, which is often looked on with great suspicion, but it can be handled systematically. Generalized Procrustes Analysis (GPA) and Free Choice Profiling are the technical terms used for consensus methodology.

So (*referring to slide*) that's us trying to figure out what the appropriate buildings are if we extend Schumacher College. And I think this extends to any community in any place and this is the most radical message of complexity theory: radical devolution to communities, to place, to bioregions, at the same time as connecting with global culture. It's a big job, but I understand this is what the built environment is about: it's about achieving this perspective of something healthy, coherent and beautiful, and fitting into the local situation as well as interacting with the global.

Thank you very much.

Order, Emergence and the Self-made Tapestry

Philip Ball

There have been a lot of discussions leading up to this conference, and I've had the distinct impression that my role in them has become something of the sceptic, or at least the voice of caution, which argues that extending the science of complex systems into the sphere into of human behaviour should be done gradually, critically, and very selectively.

I must say it feels a little bit odd to be adopting that role, since the basic question I have asked in my book 'Critical Mass', is one that is at risk, I'm aware, of appearing hubristic if not indeed representing a case of Scientism gone mad. At root the question is the following one: are there natural laws of society in the same sense as there are natural laws of physics (the physical world)?

That's to say, do we spontaneously organise ourselves into natural modes of behaviour that challenge our ability to model our societies and our institutions and law into arbitrary forms? Because if we do I think it's immediately clear that there will be implications not just within planning and the structure of the built environment, but for political theory, our interpretation of history, and even our perception of what we mean by Free Will.

I found that the popular media are particularly keen to frame this question in a predictive form. One might ask whether a set of tools that enables us to understand collective human behaviour, would allow us to answer predictive questions like these:

- What political policies will guarantee electoral victory?
- How will companies align themselves in conglomerates?
- What international policies encourage democracy and discourage conflict?
- What will the stock market do tomorrow?
- How will congestion charging affect London's traffic 6 years hence?
- How will harsher sentencing affect crime?
- What is the most efficient way to lay a road network?
- What is the likely lifetime of a new small business?

These are the sorts of things to which answers would be very valuable. But in what cases is it really possible to get answers to these questions from some kind of scientific approach?

It's my contention that we can at least speak to that general issue using models of human group behaviour that draw on ideas and principles from physics. Of course, the danger of such an approach is that it could become prescriptive as George [Ferguson] said, or even oppressive. And that's one of the primary reasons for my caution.

When Thomas Hobbes tried to use Galileo's physics to develop a theory of government, his recommendation was that a country could guarantee stability and internal conflict only by imposing what amounted to monarchical tyranny. I'm equally concerned that today's complexity science should not be used to make the self-organised tendencies a justification for the laissez faire attitude that opposes all regulation of free markets. Indeed I think this kind of modelling has the potential to challenge such ideologies, whether they come from the right or the left of the political spectrum.

Properly applied, it doesn't ask how we should govern or construct our institutions. But rather if we set things up according to this or that particular set of rules, can we predict what the outcome will be?

So the science is not being used to tell us what is the right or wrong way to do things, but to try to understand which choices lead to which consequences. As I've implied, the notion that physical science can speak to social science has long historical routes. But one of the key observations that appeared to lend credence to this idea in the 18th & 19th centuries was there was a kind of regularity in the statistics of social phenomena.

So scientists like the French mathematician and astronomer, Pierre Simon Laplace, discovered that a whole variety of social statistical data could be fitted onto a single mathematical curve like this (*slide*).

This is, of course, the well-known Bell Curve, known to physicists and mathematicians as the Gaussian and to statisticians as the Normal Distribution. You can see this curve either as a summary of empirical data or as a predictive function. If you were to measure the height of every adult in London you would plot a graph like this. But you can then use that curve predictively to say what the chances are that any randomly selected individual will have a particular height. The most probable height is the average one, and the probability falls off quite sharply for either extremes of tallness or shortness. In other words gathering social statistics has a predictive as well as purely descriptive value.

To their surprise, early social statisticians like Laplace discovered that bell-shaped curves described not only the statistics of parameters over which the individual had little control (such as births and deaths), but also those of volitional acts such as crimes and marriages. In other words people's apparent freedom to choose didn't undermine the emergence of this mathematical law. The key consideration is then that if there is a physics of society it will be essentially a mathematical one.

Mathematical regularities appear only when we look at populations or large datasets. Conversely, what this means is, in general, specific predictions must be probabilistic. We can't say what will happen to any of the individual components or agents in the system. But only what the probabilities of various outcomes are.

This is where the connection with physics comes in. There's a branch of science called statistical physics, which is used to understand just about all the properties of everyday matter: from liquids, to polymers, to metals. It sets out to relate these properties to the statistical behaviour of the atoms and molecules and other particles that make up the material. It's out of this discipline that the new social physics has emerged.

Physicists have asked whether we might see in society some of the same phenomena that we find in collections of interacting particles. So if we substitute atoms of molecules, by people, or cars, or market traders, or businesses, can we use statistical physics to understand some of the phenomena that arise in the real world?

In many ways what is now called complexity theory or the science of complex systems is really just an extension of this older and well-established discipline of statistical physics.

Now there is an obvious objection to this idea of a science of society, and the economist Robert Heilbroner put it this way:

"There's an unbridgeable gap between the behaviour of particles and those of the human beings who constitute the objects of study of social science. Aside from purely physical reflexes, human behaviour cannot be understood without the concept of volition: the unpredictable capacity to change our minds up to the last moment. By way of contrast, the elements of nature behave as they do for reasons of which we know only one thing: the particles of physics do not choose behaviour; do not choose to behave as they do."

Now that's a valid concern, but it risks overestimating both the power and scope of Free Will. In many social situations it's unrealistic or even meaningless to assume we can do whatever we want. We often have only a very tightly constrained range of choices. If we're driving a car we can in principle steer it anywhere we like, at any speed the vehicle is capable of. But of course we don't do that. Left to our own devices we will all tend to drive in a line along the road on the left hand side, at a speed that is somewhere close to the speed limit.

When we vote, we choose a candidate from a short list. Our actions, which are nominally completely free are constrained by a wide variety of factors: social norms and conventions, economic necessities, restricted range of choice. We're far more predictable than we like to believe.

Even so, we might imagine that from the palette of available options we choose freely. But it becomes clear once we look more closely that we don't, in particular because we're affected by one another. When we make choices we're influenced by what our peers do. An interdependence of a system's discrete components often shows up in the statistical distributions of their behaviour. If they behave independently the statistics have that Gaussian bell-curve form. If the statistics show deviations from that it's generally a sign that the agents in the systems are not behaving independently but are feeling the effect of mutual interactions. And that's a simple diagnostic tool that can be taken from statistical physics.

Here are some examples of social statistics that are non-Gaussian, and which tell us that interactions between people or group entities play an important role. (*graph*) This is the distribution of American firms in 1997 according to the size; (*new graph*) this the probability distribution of towns around London according to their area; (*new graph*) this is the distribution of wealth around the UK taken from tax returns; (*new graph*) this is the statistics of fatal conflicts and wars according to the number of casualties; (*new graph*) this is the voting statistics in Brazilian elections in 1998.

Now you'll see that all of these statistical distributions look like straight lines when they are plotted on a logarithmic axes, and that's a distribution called a Power Law, and it represents a very common kind of statistical distribution for systems in which interactions between the components are important. (*next slide*) I'm just showing you here how that is different from the Gaussian distribution.

Another sign of interactions is the group behaviour of all the particles can shift abruptly and simultaneously in so called 'Phase Transitions'. For example when ice melts all the water molecules change abruptly from a state in which they are all arrayed in a regular, orderly, more or less immobile array, to one in which they move about randomly, jostling each other. And the phase transition of melting is an example of a so-called 'symmetry breaking process'.

The symmetry properties of the solid and the liquid states of water are different. When water freezes some of the symmetry of the system is lost – symmetry is broken. The key point is: far away from a phase transition, perturbing a system has little effect. Water at room temperature looks much like water at 60 deg C. But when a system is close to one of these phase transitions, small changes can have major effects. For example, water at one deg C is very different from water (that is ice) at minus one deg C. Physicists say in that case the behaviour is non-linear, which means you don't have a simple proportionate relationship between cause and effect.

I just want to mention a few examples of the physical modelling of human behaviour that might be particularly pertinent to today's discussion.

The first is especially relevant to Bill Hillier's work because it considers how people move around in space. There is a German physicist at the Technical University of Dresden called Dirk Helbing who has devised a model of pedestrian motion that represents people as particles that interact through forces of attraction and repulsion.

If you want to see the force of repulsion at work, you just need to take a look at a crowded beach where people space themselves a more or less even distance apart – which is precisely what particles do when they repel each other. People aim to avoid invading one another's personal space unless of course they're in a group of family or friends, in which case it's as if there is an attractive force that binds them together.

Now of course, there aren't actual forces that you can measure in the sense you can measure a force of magnetism, but the key point is people seem to act as though such forces exist. And it's the same when people move about in crowds – they avoid bumping into one another as though some invisible force is keeping them apart.

Well, Dirk Helbing has carried out simulations of the motions of these 'particle people' on a computer in various different situations. For instance, moving down a corridor: some people are programmed to move in one direction, and the others in the opposite direction. And Helbing assumes that each person will, if they can, reach a preferred walking speed, but they'll slow down if necessary to avoid colliding with someone else. And with no more ingredients than this these particle people showed some very interesting behaviour.

Here's a snapshot of the simulations and you'll see they've organised themselves into counter-flowing streams: blue going in one direction, red the other. Now, there's nothing in the rules of

the model that specifies that these streams must form. They just appear as they do in real life. This is an example of what is talked about in complexity science as an emergent phenomenon. Now it makes sense for the crowd to organise itself in this way, because it means that chances of collision are much smaller. But of course these particle people don't know that; they're just automata with no real intelligence at all. Yet, they show seemingly intelligent anticipatory behaviour.

Another kind of seemingly intelligent behaviour emerges when people pass through a door from both directions: first one stream captures the doorway and streams through, and then the other group captures it. As the people step through, people on the other side step back, and it looks like polite behaviour. But it's caused by nothing more than this repulsive force that's put into the model.

If people are programmed in these models to exit much more quickly then something different happens. Their desire to move fast can overwhelm this repulsive force that keeps them apart and they start to come into contact. And if they're slightly rough sandpaper like particles (so there's a force of friction when they touch) they can become jammed in the doorway preventing people from getting out. And this what Helbing and his colleagues think happens when a crowd panics. The jamming effect means that although people are trying to move faster, the room actually empties more slowly. And effects like these can undermine calculations for how many emergency exits a building needs.

Michael Batty and his colleagues at UCL have used simulations like this to help design crowd control measures and safety measures for the Notting Hill Carnival. You can see here (*slide*) an aerial shot that underlines this particle way in which people are moving.

Batty and his colleagues have simulated differing crowd densities along the route, and that's helped them identify (on the right) potential flashpoints where overcrowding could pose safety problems.

Pedestrian simulations like this can be used to work out how people wear down trails over open grassy spaces. Here is a trail system that has been trodden down at the University of Stuttgart. No one planned these trails; they're just the product of many feet going about their own business. The striking thing about these trails is none of them represents the most direct route between any of the common points of entry or exit. They arise from a compromise between people's directness and their tendency to walk where other people have walked already.

Helbing and his colleagues have modelled the evolution of trail systems like this and find that they evolve (slide of two pictures). On the left is what they look like initially: they tend to follow these direct routes between the entry and exit points at the four corners. But as the simulation goes on these evolve into these gently curved routes, very like the ones we saw in reality.

When park planners institute linear geometric paths they find that sometimes those paths are subverted by trails that people wear down spontaneously. How much better it would be if they could predict where people will want to walk and build the paths accordingly.

(*new slide*) In modern urban housing development, when there's no opportunity to establish such organised routes, studies show that pedestrians traverse these spaces more or less randomly at the statistic level. Any natural patterns are inhibited.

And this kind of particle-based modelling lends itself also to the flow of traffic around a road system. Now I know that the modelling of pedestrians and traffic is nothing new. Although in fact traffic modelling was really begun in the fifties by physicists. But what I want to show is that there is an explicit connection to the kinds of statistical physical ideas that arise in complexity.

So in traffic modelling the particles are now vehicles that will accelerate until they reach a desired speed, but will slow down to avoid colliding with the vehicle ahead. And implementing those rules in a computer model produces a kind of traffic fluid with properties that are somewhat reminiscent of the states of matter. That's to say when the traffic is light all the vehicles move freely according to their preferences – they barely interact. If the traffic gets denser then the vehicles adjust their speed until they're moving more or less synchronously at the same speed with a more or less equal spacing between the vehicles. And if the traffic is denser still, it forms a more or less stationary jam.

So these are kind of reminiscent of the gas, liquid and solid states of matter. And they change from one to the other quite abruptly in what is essentially a traffic phase transition. And the sort of modelling that has been done gives rise to things like this (*new slide*).

This is a plot where each of the lines going up represents one vehicle going at constant speed along the highway. What's happened is at one point in the top left a vehicle was programmed to brake quite suddenly and then to carry on. So it was just a little perturbation. When vehicles have to slow down, these straight lines bend – time passes but they're not getting very far.

These kinked lines here show there was a traffic jam, and this institutes an event that grows as time goes on. In fact it splits into several traffic jams that are moving steadily upstream. Of course we all know this 'phantom traffic jam' effect. By the time a vehicle comes out the other end there's nothing to show what caused all of this mess, because it lies right back here in the past.

So these models can be used to test out the effects of different driving regulations, or road designs. For examples they can show whether imposing speed limits on certain stretches of road might actually ease the flow of traffic by making jams less likely to be triggered. Or they could help in positioning the entries and exits on motorways. They can help to identify driver control measures that will reduce the chance of crashes.

The key question is how far this sort of modelling can be extended to more complex systems. It's straightforward to make the interaction rules between the particles in these models more complex, and even to include such effects as beliefs about the future or learning from the past. And many such models continue to show some of the phenomena that I've mentioned already: spontaneous self organised patterns, phase transitions, non-Gaussian statistical distributions. The harder question is whether these models bear any relation to reality. It can be difficult to identify ways of testing the model predictions against robust social statistical data. And I hope the limitations of this kind of approach will be one of the things we'll be able to discuss today. But with that I'll stop. Thanks.

First Panel Discussion

Brian Hanson: Some of you may know that Phil, Brian, myself and Ian Stuart (a mathematician) have already had a more extended discussion on the application of complexity science to architecture – which appears in the new Katarxis 3. I recommend reading that if you want some more on this.

This discussion is really between us three. There will be questions from the floor later. I think my role here is to bring closer to our concerns here as architects, urbanists. I plan to draw these two a little bit out of their comfort zone to address the issues we are concerned with from day to day.

Due to the marvels of modern communication I've been having a two-year conversation with Phil about these issues and this is the first time we've met.

Thank you for your well signposted presentations.

Let's start with something very basic. Anyone approaching the scientific literature about complexity science is going to encounter words like: non-equilibrium states, chaos, phase jumps, symmetry breaking, fractals. Yet the more you read the sense is that this science is about order and harmony and simplicity and wholeness. Do you agree there is a kind of paradox in the language and the concerns of science itself?

Philip Ball: Any scientific discipline is going to have its technical terms and I think some of those can be potentially off-putting. Particularly I guess the ones from the sciences I've talked about: the traditional approach of statistical physics. I think in a way the terms we talk about in complexity theory almost speak for themselves. This idea of 'emergence' is something that is quite intuitive to us – I don't think that takes a lot of unpacking to get some handle on.

I guess it is about order and symmetry. These have been central concerns of this whole area of science all along. Of course 'order' means very different things to very different people. To some people 'order' can sound oppressive or conformist. To some it conveys an idea of symmetry. To some people there is more beauty in systems that aren't regular.

So, yes I guess this idea of order is a subtle one. And sometimes the way it is manifested in these systems is quite subtle – how you quantify it. So I think one of the difficulties is the terms used sometimes have different implications from the ones we're familiar with in every day terminology.

BH: Do you agree, Brian, that post-modern sensibilities might get the wrong end of the stick if we just look at the language of the science and don't dig deeper?

BG: Yes, I think Philip and I agree that the domain of complexity as it has emerged has remained within science. It is about looking at something and trying to understand it – the domain of intelligibility. But how is it that this emergent property arises?

Through looking at the power laws; phase transitions; the behaviour in social insects, we can begin to make sense. But that is science in the conventional sense of looking at something and trying to make sense of what you see.

I might be anticipating a question, but I want to distinguish that from the message of the Sciences of Complexity with respect to our behaviour in relation to the world. When I say 'world' I mean the world of complex systems. Most natural systems are complex in the sense they are unpredictable, and uncontrollable, but not intelligible.

Now this has enormous implications with respect to how we behave in relation to these complex systems. Because we depend upon them. So there is a distinction that I am making between science in the observer mode. Philip and I entirely agree with respect to what has been revealed in the sciences of complexity, but when we look at the implications of that with respect to our behaviour, the fact is we are inside all these systems. We cannot be detached observers.

BH: That brings me to a point Phil raised. He mentioned the science is about order, and then talked about the repressive aspects of order. Here is a man who has mentioned "monarchical tyranny" in this place, of all places. But you have a different sense of this order, don't you, of not being repressive in the least? You believe the New Science points a way to the emergence of some kind of order that is much more 'bottom-up' than 'top-down'.

BG: For me complexity theory emphasises the continuous ongoing creativity of the natural world. By the natural world I mean nature and culture – us involved in this whole process. And the question is what's the appropriate way to behave and to interact with these complex systems so that we achieve what we want to achieve. Now that's the big question: what do we want to achieve? I think the questions I'm raising are what are the ways to right actions so that we improve the quality and health of the environment. And those are questions that involve qualities. The cultivation of this sense of recognising what are the emergent qualities: are they better or worse than the ones that we had before?

BH: I think that brings me on to a related point. Again I heard some phrases that would strike fear into the hearts of designers – the lack of predictability of complex systems; the difficulty of tracing consequences to their causes in complex systems. 'Uncontrollable' was a word you used.

If you read Stephen Wolfram, whose book is around here somewhere; he makes more or less the same point – that there is a limit to how much we can reduce the world in order to understand it.

Now how do we as designers operate with this complexity science if it is essentially out of our control, and opaque to conventional methods of understanding and applying science?

PB: I'm not sure that it is completely out of our control. One of the messages that comes across is that to understand some of the systems that Brian showed earlier on, you have to know where to look, I suppose. But there is an order there; there is an order in patterns of philotaxa and leaves on stems. But it's not an obvious one – we understand it intuitively.

I think you can see the same in city growth. From one perspective it rather looks as though attempts at planning and constraining the growth have had no effect whatsoever. But there is an order to it. If you look at the graph I showed of the statistical distribution of towns there is a pattern to it: towns are not just growing completely randomly.

No matter how sprawling cities are, it's not random. There are quantifiable aspects to the pattern you can pull out. And so I guess that's what we need to identify and work with. It requires relinquishing the idea that you can control some things that you can't. But at the same time you need to notice that there is this self-organising tendency that gives rise to certain patterns.

I guess the way I look at it is these sciences are tools to help us understand what we can control and what we can't. I gave the examples of paths across open spaces, not just because that was a concrete example, but also because I quite like that as a metaphor for the approach to this whole system.

There is a self-organising pattern that comes out of it. And if you ran that simulation again, you wouldn't find exactly the same kind pattern. You would find one that looked more or less the same. It would have more or less the same qualitative characteristics, but the path would be in slightly different places. So we need to be looking at that level to understand the sorts of patterns.

BH: So one of the messages there, quite clearly, is if we take complexity science seriously it might encourage us to become less uptight as designers, realising that there are certain things we might not be able to control, but at least we may be able to shape. Isn't this where your 'consensus methodology' comes in?

BG: Absolutely. Consensus methodology is a quasi-quantative method of evaluating consensus in a group with respect to questions that would normally remain outside of science because they have to do with qualities. Now there is a phrase that just popped in to my mind – no doubt because Mae-Wan Ho is sitting here – she has a way of describing the relationship between the individual components of these complex systems you've described in terms of statistics. And this description applies equally to physics and to human organisations.

The paradox is that these distributions, phase transitions, and the whole property of quantum mechanical coherence reflects this relationship: that it's maximum freedom to the individual components; maximum coherence to the whole. Now you notice freedom and order are now put together. They are not incompatible; they actually lead one to the other.

Now this kind of paradox comes up again and again, and this speaks to me very deeply with respect to the whole pattern of civil society and interaction, and the whole process of achieving consensus in groups. Because if you give people freedom in their interactions and use consensus methodology to find what's going on, you'll get coherence with respect to an appraisal of the whole.

Now this is just something we work with at Schumacher. It's not widely known as a methodology. But I'm just saying that this for me goes from one level of scientific analysis to the other level of human engagement.

BH: I think some people will be wondering what is the distinction between what you described and the straightforward community architecture as it has been practised for 40 years?

BG: That I would not know. I'm not a community architect. I know Christopher Day and Christopher Alexander's work, and I assume they have described something very similar to this. I think what I'm saying is the evidence, as I see it, coming out of complexity theory, is that those ideas are the way to go.

BH: I suppose you're talking about a much deeper level of agreement than has been possible in community architecture. I must say in another point in your talk I thought you were trying to lure us back to organic architecture in the early 20th Century sense: buildings copying plants and so on. That's not what you're talking about.

BG: No, no. That's the organic tradition, and that's in the past. But we need to put that together with the new sciences we have, and the emerging understanding of patterns of community relationship, put them all together and achieve something new. I'm sure there are examples of those around that we can take as paradigm cases. I leave that to those people who are closer to this to talk about.

BH: Phil, you made an interesting distinction in something you said to me at an earlier stage. You said what we should take from this new view of nature was not the forms of nature, but ask ourselves why can't we solve problems as natures does. In other words, trust to the inherent dynamics of the situation. I think you were touching on this in the description you finished with about trails. Is that more widely applicable, do you think?

PB: I guess I have the slightly uneasy feeling, in the discussion so far, about this question of leaving it to the individuals to do their own thing and it will work out in the end. In the case of the trail formation that does seem to work, I suppose. But in the end we have to say: 'is this what we want?' If you leave markets to do what they like there will be certain consequences that we might not want.

I showed the wealth distribution of Britain - and it's about the same in just about every capitalist society - where you have a very small number of very wealthy people. That's what comes out of that system. It would be tempting to say: 'that's natural form; we can't do anything about it'. I think we then need to say: 'if we collectively agree that a smoother distribution of wealth throughout society is a good thing, what can we do to the rules of the system to flatten that distribution and allow a greater equality of wealth? First of all, what are the knobs we can tweak to alter that, and secondly what are the constraints – how can we alter that?'

I suspect that some kind of inequality is inevitable when you have a capitalist system.

BH: I think we have to say right now, that the message coming out of this is *not* one that the designer is unnecessary and a society left to itself will shape its own environment.

It's very interesting. We're going to be talking about Christopher Alexander's work later, and for those of you who know *A New Theory of Urban Design*, it was on one level a rabid anti-planning tract. Nowadays Christopher Alexander has a much broader view of the role of the planner.

He now acknowledges that A *New Theory* was a bit naïve in thinking a collection of individual actions constrained by simple rules could achieve a high degree of order, and there was no need for a planner.

In fact Brian, I have a quote from you in Katarxis about what the planner of the future may or should be like:

"I think for planning to be effective there has to be a kind of facilitation that is prepared to engage with and hold the process of confusion and chaos long enough for something new and relevant to emerge from what has passed as history. The new order cannot be predicted or planned in advance if it is to be genuinely relevant to context; as it emerges it can be experienced so that some judgement is exercised through feelings, intuition and observation as the process develops."

That seems to me not to rule out the role of the planner/designer in the future, but to radically redefine the role such a person might take.

BG: I think that's absolutely right. We do need facilitation at many different levels. But facilitation is a very different process from imposing your will on whoever it is who is receiving the project or the building. And it's that process of working with groups, cultivating this property of direct knowing intuition – the sense of qualities – feeling it as you go along. You should ask yourself, is this a healthy process, or is it showing signs of some sort of disturbance or disease?

That needs to be monitored all the time, because you have a sense of direction, but you never really know exactly what's coming out of it. That's the beauty of the New Sciences: it reinforces that.

This is the way evolution happened. This idea of living on the edge of chaos – you need a component of chaos in there to keep you on your toes, in the sense of being sensitive to possibilities. I'm obviously opposing an ideological stance that imposes on the community.

BH: Your feeling is in the past there may have been designers who were too eager to close down the process, and make decisions too soon before that complexity could be carried over and nurtured…

BG: I think there are immense pressures put on designers to do that. In other words, to get the job done. To have a timescale to put in a plan and achieve the outcome. Whereas if you say I need to work with the people and I need to monitor it that can be a long-term process. And I think we just need to accept that there is a different timescale that needs to be put in place for processes that are going to lead to these structures that have these qualities of efficiency, functionality, and beauty and are appropriate to place.

BH: Behind all this is a bigger question than what kind of architecture or urbanism does complexity science suggest, or what kind of role for the planner/designer does complexity science suggest. Because the architecture, and designers, could begin to change, but we all operate within a much broader power structure. And I would be interested in your view in how far you think complexity thinking can change those institutions, economic, political and otherwise, that ultimately determine the way we might put these ideas into practice. I suspect there is a difference between the two of you. I suspect you, Philip, are a little bit more pessimistic.

PB: I think possibly pessimistic. My take on this is that these new scientific tools coming about are literally that, and at this stage the aim should be quite modest.

I don't ever see how you are going to be able to formulate a set of scientific tools that is going to tell you how to design a particular building. All you're going to be able to do is use those tools to avoid bad designs.

For example, Mike Batty has now simulated Tate Britain to see how the structure of the building was determining the experience people had, and which galleries they visited. It was nothing to do with their preferences for particular works of art; it was just the layout of the building that was guiding them towards some galleries and not others. It was a very modest thing: pointing out unintended consequences of particular designs.

But I don't ever see how you can turn that into something that prescribes a certain type of form for a particular building. I think there is always going to be a strong element of individual artistry involved in that, which will be out of reach of these kinds of scientific approaches. I think the same is true at the other institutional and social levels that you are talking about. I think that's why I advocate being quite modest initially in the lessons we draw from this.

I think looking at this sort of modelling in an economic context is again an interesting analogy, because it can challenge some of the assumptions that have become engrained truths within the way economics works.

BH: Interesting. You said something interesting about Jane Jacobs in the final chapter of *The Death and the Life of Great American Cities*; she talks about the city being an exercise in organised complexity. And you said that was so straightforward and commonsensical to you that you were surprised it took so long for the world to catch up. That was a fairly immodest statement on her

behalf, but what we've seen over 40 years is institutions have started to embrace that idea and implement those ideas.

I'm just wondering if you can foresee similar institutional structural changes that might make it easier for us if we take the lessons of complexity science seriously to put these things into practice.

PB: I guess I do take heart from the fact there are people working on those things. There are for example people working at LSE who are looking at how some of these ideas can be applied in a business context: to help businesses have a more efficient way of structuring themselves. So, yes, I guess there are useful lessons to be learned from that. I guess I don't have a feeling yet of how effective that is going to be.

But again, I'm a naïve scientist, it seems obvious to me that this would be a worthwhile way of doing things. Beyond that I don't want to predict.

BH: Brian, you seem to have unbounded optimism in the ability of institutions to change and to take this message onboard.

BG: I think I'm extremely sanguine. Not because I have good evidence, but simply because I believe in this capacity of human beings to transform in various ways.

I mentioned at the end of my talk that radical devolution is one of the consequences I see of complexity. We need to get back to diversity. Diversity goes with locality. Now there are two different ways of achieving diversity. You can do it at the global level through the sorts of beautiful, innovative, interesting, transformative architecture patterns that Charles Jencks has talked about – and that's absolutely legitimate. But that's not the local type of empowerment that I'm talking about. That's within the more or less conventional procurement of the economic system, and I understand the constraints that give rise to that. But that can go in parallel with local empowerment and bioregionalism, which is encouraging local diversity in a very natural form where people want to express themselves.

So I feel this is what people want. I just feel the move towards control and centralisation has run its course and now we're moving in the opposite direction. Now exactly where it goes, and how it expresses itself, I don't know. That's one of the unpredictables about the social future. New patterns of governance are on the cards, and this is one of the major transitions we're going through, and we should just keep our eyes open to see how this is evolving.

BH: Indeed if this trend intensifies and continues the kinds of things we're talking about today will become increasingly relevant, I think. If they don't I suppose we're left with a fairly formalistic application of complex ideas to buildings with not very much happening underneath.

BG: That's right. And that would be a continuation of modernity for me. It's a valuable paradigm, but I'm hoping for a transformation, because I feel it's needed.

BH: Thank you both. I hope Brian feels our positions are crystal clear now, and I hope that we have a sort of proximity between their concerns and ours. Thank you very much.

The Art of Urban Design: Growth From the Science of Space

Bill Hillier

Let me immediately follow Philip Ball and say it's not about a science that tells you what to do, it's a science that tries to tell you what you're doing.

If you're aware of space syntax you probably think of it as a way of analysing street networks and trying to understand how people move and trying to forecast new developments, as we did at Brindley Place or the Millennium Bridge. Or a way of analysing visual fields, because that plays such a vital part in how open spaces work, as in Trafalgar Square.

But it's more than this. It's a way of researching cities and trying to understand how people shape space in cities, and how social and economic factors affect how they shape it. So it's a way of trying to research the cities as a self-organising system if you like.

What I'm going to give you today is a thumbnail sketch of a city as a self-organising system. And I'm going to try and end by showing how it relates to the human individual, which drives this. In spite of the fact that there are also autonomous laws at work in this. I've got a large scope, so forgive me if the presentation is quite sketchy.

So why is the theory about space and spatial design so much more important than we ever thought? There are two reasons for this. The first thing is space is not just a background to human activity as is often thought. It's an intrinsic component of it. Movement is essentially linear. Interaction, as here, needs a convex space. As we move in cities we see variable shapes we call iso-disks (?), and somehow the successive pictures that these give us offer an understanding of the city as a whole. Because what people do is spatial in itself, we externalise this and therefore the space of the city becomes humanised. It's a record of what human beings are like.

The second thing is it's not just how this space or that space is shaped – although this matters. It's how we link spaces into an overall network that really matters. A network is very important, because more than anything that shapes how people move about in space. I can almost hear you saying: 'surely it's where the shops are?" In fact it's the other way round. Let me try and convince you that how the pattern of space in the city shapes movement is common sense.

What I've done here is create a simple notional grid: main street, sides streets, and back streets if you like. Imagine that all the streets are lined with dwellings and people are moving by sensible routes from everywhere to everywhere else. Just looking at this we can see that more people will pass through the main street than any of the side streets or backstreets. We can see that more people will pass through the central bits of the main street than the peripheral bits. And we can see the high street is easy to get to from all of the houses.

So we would expect the position of each street on the overall grid to have a strong influence on the flows in the different streets. It will affect 'to' movement through accessibility and 'through' movement (people passing by). It's not a matter of psychology, it's to do with the way the group is put together. But it has consequences, because if you wanted to open a shop in this simplified system you'd put it where people are going to be. You wouldn't do what planners have sometimes done, and put the shop there in the hope it would attract people – it's best to put it where people are going to be and where the grid is going to put them.

Now the key thing is this is true of all networks of space however large and complicated they become. We still find the street network is the main influence of how people move. Of course it's much harder to see it when the network is as large and complex as it is in a normal city. But we can show this because there are simple ways of measuring the accessibility of space and the 'through' movement potential of spaces. With the help of computers we can ask exactly what properties of the network seem to affect flows along the streets.

At the simplest level it turns out that by simply extending street-lines as far as they can go without a change in direction, and treating these lines as a network, and measuring the accessibility and 'through' movement potential of each line, we can find out a lot about the structure of the city. This is even before we think about distance and how big the buildings are.

What we do of course in Space Syntax is translate the mathematical values into colours, so you can actually see a pattern. This is the town of Conia (?) in Turkey.
The red is the most spatially accessible to all other spaces, through to the blue, which are the least. We can see that the red, orange and yellow lines make a pattern, which we call the integration core. It links the centre to the edge essentially, and the blue and green zones are the more residential zones in between.

In fact wherever we look in the world we find this shape of integration. We call it a 'deformed wheel' pattern. It means there is a hub of red spaces in the centre. There are strong spokes linking towards the edges, and sometimes a rim of red space on the edges, which becomes the start of the edge city creation.

Now, we think this is a deep structure of cities, and in the interstices formed by these wheel structures you find the more residential zones. And within each of them you find little sub-centres. There is a certain kind of self similarity in how they are organised.

Now it's amazing how frequently you find this deformed wheel structure. You find it in Venice for example, although it's much more irregular than normal. You find it in a much more complex form in Tokyo – quite remarkable – a deformed wheel with multiple rims, which relate to the very powerful growth of sub-cities in Tokyo.

London also has this kind of structure. And one of the remarkable things about London is we find this pattern at the local level as well as the global. What we call London's urban villages are local centres of deformed wheels, and the hub of the wheel is the bit with shops.

Now the reason for this structure is quite simple. It's a natural way to overcome the tendency for centres to become segregated as the city grows around them. It's a way of linking centre to edge, and so accessing strangers to the heart of the system and accessing inhabitants to the edge. It's a fundamental reason why cities make sense if they tend to be built in this structure.

Now what does this structure do?

Well I think it's the first organiser of the city. And it does shape movement; in particular in the way in which I've analysed it here. But you have to understand again this happens at different

levels. You have to think in terms of large-scale movement, which relates to the large-scale pattern. But we also have to look at the more localised pattern, which reflects local movement.

It's common sense. If you're going from Elephant & Castle to M1, you think Blackfriars Bridge, Yorkway, Archway, which is all part of the large scale structure of London. But if you're going from the Tate Modern to Barbican you think Millennium Bridge, New Change, and Foster Lane, which are important local things. But the mathematics can pick up the local and global differences and relate them to different scales of movement.

Now, we can test the theory in a very simple way. Here I take five very different areas of London with 468 gates of observation. (So we follow George Ferguson's advice of observing.) And we simply correlate the numbers representing spatial values with the numbers representing movement values. It's quite remarkable that taking five separate areas of London and one simple measure you can account for something like 60-70% of the differences in movement rates in the street, both vehicular and pedestrian.

This scattergram rising from bottom left to top right just means those are the streets, this means more integration, and more movement as you move up the x and y-axes. Now it's not a perfect relation, but it is a pervasive relation, and the foundation of urban movement. In the first instance it is the grid that shapes the movement and that shapes what happens after that.

Now I think the most important thing about the structure of the street network is that first of all it does something: that there is some outcome from the architecture of the system; that there is a consequence. The most important thing is because it shapes movement it also shapes co-presence in the cities. It creates, if you like, the sense that you're co-present with other people, especially strangers. And how the grid does this – making some bits busy and some bits quiet – is the primary source of why cities feel safe and civilised.

I think we found out to our cost in many 20th century developments that poorly used space is not the same as well used space. And since most space use is movement, it's only by knowing how to engineer movement through design that we can create the sense of effortless awareness of others that is the prime source of urbanity.

Now most of what cities are is seamless networks of busy and quiet spaces, often in close proximity to each other. I think this follows from this basic link between space, movement and co-presence. I think by understanding this we can begin to understand how land-use patterns develop, densities, and even what we call the 'urban buzz'. This is because by shaping movement the structure of the network sets in motion what I call a 'city-creating processes' by which collections of building become living cities.

First, if the grid does put more movement in some locations than others then land-uses and activities that benefit from movement like shops and workshops will tend to seek out movement-rich locations. Other land users (like residents) may prefer to avoid movement and seek out low movement locations. So a land-use pattern begins to take shape that reflects the degree to which activities and movement are related.

As the new land uses arrive in the movement rich locations they of course attract more movement and great multiplier effects, which then attracts more and more diverse land-use.

This is North Camden – this is all the shops and catering outlets – we see local patches of mixed denser activity development, which stand out against the residential background as local centres and sub-centres – sometimes just a few shops and a café, and sometimes something much more substantial. When this process becomes more intense it feeds back on the structure of space and creates what I call grid intensification, which I'll show you in a minute.

So if we take a pattern like this, we can show that the fundamental factors affecting this are actually to do with the structure of the street network itself. It's the same device of comparing two patterns of numbers. But there's something more complicated here that we have to understand. There's a range of network factors responsible for developing this kind of network of centres, which is really the defining mark of a good city. It's all about being close to movement, but also to the generators of movement – where people live.

Close to movement is obvious. By and large, street intersections will have more movement than a street, hence the ubiquitous corner shop. But it can be much subtler than this. This Barnesbury in London, and that redline in the centre is what we call the village line. We can see it's the centre of a deformed wheel linking centre to edge.

We also find large-scale integrators attract shops. This is Marylebone High Street where find the same thing. The position of Marylebone High Street in the local grid belies its more sinuous nature than the more regular grid adjacent to it.

Of course, you also find this developing on major integrators like Oxford Street for example. Oxford Street is the most integrated street in London. If you ask people why they're there they'll say it's for the shops. Again it's not the whole story. If we look again at the Camden network we find that some bits of the red lines have got the development, and some don't.

So, again here's a bit of theory. This is a thing I call 'grid intensification'. Here's a simple experiment where I've taken four grids. There's a regular grid top left, then I've broken up alignments, then I've made the blocks bigger, then I've made the central blocks smaller. And the redness to blueness is a measure of the distance you have to travel to go from there to everywhere else – it's a metric measure if you like.

The interesting thing is you would think the regular grid might be most efficient way of accessing people to each other, but it's the small grids at the centre that are. This is for simple mathematical reasons that I'll touch on later.

This is the Edgware Road. If we look at the Edgware Road it has partly got three high streets on it: Cricklewood, Kilburn and the Harrow Road Area. The bits in between are where you have a sparse grid. The bits where more is happening are where you have the intensified grid. In Maida Vale for example you don't have this kind of development, but you do below the Harrow Road flyover. So you can begin to see the logic of how cities develop.

This is Lamb's Conduit Street. Did you ever wonder why Lamb's Conduit Street became a shopping street? Well, the same kind of grid intensification can become the spark as well as its location in the larger scale of things.

We can also use this to begin to understand mixing land-uses. At the moment we've gone from zoning to jumbling them all up. But in fact traditional cities have a logic to the way in which different land-uses are related. I'm using the Booth Map here to demonstrate this, because you can actually see the gold of the rich, through to the black of the poorest people in 1900. You can actually see the relationship between integration and segregation. Interestingly when you go along the lines the colours stay the same, when you turn the corner they change. This is because the line is the main organiser of the city, and as you go along lines the pattern of land use stays consistent.

Now this is how cities like London manage these wonderful rapid transitions from being in one kind of place to being in a completely different kind of place. Now we call this marginal separation by linear integration – it's the way in which cities organise land uses on different faces of the blocks, so it makes sense when you're moving around them, but nevertheless things are juxtaposed close to each other.

So this is the city-creating process I'm talking about. This is the way the grid generates movement, movement generates land use pattern, these produce multiplier effects and densify. And this is how cities self organise. The city becomes a network of places with different qualities, full of unexpected juxtapositions, but still with this underlying structural tendency to be a thing like this.

Now I think this should inform how we think as designers. Some of you might have come across the application of space syntax on a large number of projects as a tool for evidence based design: we study the situation and we study the part of the city where the development is taking place. And we work with the designers in trying to evolve the optimal solution. But here I want to suggest some more philosophical things I think we have to be aware of.

The first thing is we shouldn't see the urban grid as an inert background to human activity. We should see it as a historical record of a city-creating process – this is being created by people. It's not what we once thought: it's of no interest to the artist because you can't see it all at once. It is of interest to the urban artist because it is this that is the source of life in the cities.

The second thing we have to know is the process that creates the city is a dual process. It's what I call a public space process, in which we maximise local and global integration to maximise movement and co-presence.

These are if you like the spaces of transaction, the spaces of most public activity. And a residential space process, which is different in different cultures, is driven by much more restrained factors. We use the way in which the law relates the structure of the grid to movement in order to create something that is more restrained and somehow mirrors the culture.

So we find that cities tend to be similar to each other to the extent that micro-economic activity, trade, and transactions create the large-scale structure of the city. But cities are very different in terms of their residential background structure where the residential culture has had a much greater use.

This tells us that we can use space in two ways. We can use it to generate life, and also to structure it. We can make space sensitive to the different phases of our lives and the different

times our day. It's not just a matter of creating integration, but creating the gradation between them.

The final thing we have to know is the relationship between human activity and space is not direct. It passes through the demands the different activities make on movement and co-presence.

So urban space is not structured to reflect the relation between this activity and that activity but the generic relationship between kinds of activity. Now because a society evolves there's always a new range of activities some of which need movement and co-presence, others which move away from it. This is why old cities accommodate new patterns of use so well. Things like the City of London, where what used to be a network of trading complexes has now become something that is recreational and leisurely. But space is still working the same way to make it exciting.

In this way we can approach the city in a different way. We'll have more respect for what it is, and more respect for how it comes to be as a place.

Now the final thing I want to do is talk about two foundational questions. This is because what I've said is starched from the idea of an urban grid. But what creates that in the first place? And why is it as it is? How do people understand spatial complexity and why do they create spatial complexity in the way they do?

I want to just show you two recent things that I'm doing.

There's a great deal of interest in space, especially in cognitive neuroscience. I'm sure you've seen the articles about the brain development of taxi drivers in London.

But there's a very great puzzle about how people learn and represent space to each other, and how they navigate. How do we understand this complex system here? Especially as I've shown you that the structure of the network itself will also determine quite a bit of the flow. Is there something human about this, about why we've made space in one way or the other?

Now we're very excited because we think we've found a very nice way of resolving this experimentally. We've taken the four London areas that I looked at originally, these are areas where we've got very dense data on movement, and we developed a new way of modelling space, which instead of starting with a line, starts with a segment of the line between junctions – so it's a much finer scale analysis. Then we can allow all kinds of factors to be involved in the analysis according to how the segments are connected. For example, the length of the segment matters; the angle of connection to another one matters; the fact of connection.

The debate in cognitive science tends to be: when people are navigating do they judge shortest distance, or are they affected by topology (the way the system is connected together)? Or is it something to do with the angular structure, where we are trying to approximate a line in going in different directions? (Traffic engineers use the metric assumption by the way.)

But with this new model we give different mathematical interpretations of the same grid. This is the same part of London – you can see this is one kind of analysis and that is another. So if we

then correlate movement patterns with these different kinds of analysis and they perform differently we can be fairly sure if one mathematical interpretation is better it can't be the network (because they're the same). It must be that people are interpreting the network in this way rather than the other.

The results of this study are completely unambiguous. People navigate by what we call 'least angle paths' – they navigate geometrically rather than in terms of calculations of distance. They also navigate topologically to some extent in that they are interested in the fact of connection. But the fact is if we analyse the system of the space in terms of its angular geometry then we get a far more powerful account of both vehicular and pedestrian movement, and also we get astonishingly good correlations between the structure of the grid.

It doesn't mean that metric distance isn't important in cities, what our research shows is metric factors work locally in a very powerful way as in reintensification. But as we move to the larger scale the picture that we develop is much more geometric and topological, and this should affect how we model cities. So this is trying to get to the foundations of how people read space and understand space.

We're trying to work on another foundation, which has much more to do with the idea that space has autonomous laws, which it does. One of the most important things is where the pattern of space in cities results from the aggregation and placement of buildings, and how we place the buildings relates lawfully to the kind of configuration we get through some very simple mathematical ideas.

I'm illustrating one of them here. If you take a simple object and move it from the corner this shows what we call visual integration, which is a kind of measure of the lack of visual complexity. So the redder it is the less visual complexity there is in the system as a whole. As we move the object from corner to centre edge and then towards the centre we find that in effect placing an object in the centre of the space interferes with visibility from all parts to all others much more than if you place it at the edge. It's to do with unequal spaces. Large spaces and small spaces, or long lines and short lines are much more efficient. It also applies to movement.

The same applies to the shaping of objects. If you change the shape of the object from a square to a rectangle you find the elongated form blocks movement and indivisibility much more than anything else.

Now I believe that human being knows these laws of space. We sense them in the same way we internalise enough physics to throw a ball of paper so its parabola leads it to land in wastepaper basket. I think you learn space by manipulating space, and I have some very good stories about how children's behaviour reflects this knowledge of the basic laws of space. But in doing this we can begin to look at the effects of how we aggregate buildings together.

What I've shown here is two systems. They're the same block. The only difference is the one on the right I've moved the blocks slightly to break linear relations between the spaces. We can see if I look at the visual complexity analysis that the one on the left has a structure to it.

There are also statistical processes. In the one on the right you can't get much idea from where you are, about where you might go. It's very constrained. Whereas on the left we get information, not just of where we are, but it also gives us a good idea of where we might go to.

(*new slide*)

We can use another one of these statistical devices. This asks what is the relationship between what we can see and where we are, and how it fits into the system as a whole. You can the one on the left focuses into a very sharp strong relationship with a 70% correlation. Whereas the one on the right is disorganised. We don't get any clues about the large-scale structure from the small-scale structure.

We've been doing two experiments with this. What I've done here is I've simply moved 10,000 computer agents around and left their traces. Red mean lots of agents passed through, blue means not many. So just by changing the configuration of the space the agents behave in an entirely different way, and in fact prioritise different places. It's the same number of agents in both places, and we can reproduce the same thing.

This is an experiment done in a three dimensional world where again we take an urban like space and move the blocks slightly to make it feel less urban. Then we ask people to navigate from centre edge to the centre and out again. We find that where the system has this property of local to global intelligibility they can do it. When the system doesn't, they can't do it.

This is why cities grow in the way that they do. What we're now simulating is the way in which the growth processes, by implementing these spatial laws and looking at the rate of growth, can begin to evolve cities that have the two key invariant properties of cities.

One of these properties is the fractal distribution of line lengths; it means there is a dominant structure. But also in generating the fallen wheel structure.

So this is the argument that we end up with something that seems to be lawful. Cities have lawful tendencies. Somehow through the aggregation of innumerable behaviours over a long period for different reasons we can begin to see how cities become similar as well as different. This is because physical and psychological laws intervene, and economic and social activity have different requirements of space.

This means Cities are similar in their global structures, but they're very different in their background fabric. This is how cities organise not just to be things that have universal structures to them, but also have this extraordinary characteristic of individuality. No city is the same as another, and I think this is why we value them in the same way we value individuality in human beings.

So I'm trying to make the science lead in the direction of our humanity. We're trying to understand that there are objective spatial laws that are internalised by human beings into their behaviour, and then become the ways in which to shape the city in the light of the different kinds of things that we want to do in the city. This is why I'm saying I think we have to internalise this knowledge as designers and try to, if you like, utilise the inevitable self organisation potential of cities.

One of my favourite subjects is Brasilia as a self-organising system – it's organising itself all the time. The planners are battling against it, but it's still doing it. This is why the art of urban design, as I firmly believe it to be, does rest on the foundation of the science of space. Thank you.

Second Panel Discussion

Brian Hanson: Before I open this up to the audience, I just want to ask a couple of questions of Bill Hillier. I think the first time I met you, Bill was 15 years ago, and the first thing you said to me was: "Tell your friend Leon Krier that it's not about blocks, it's about streets". And you're still saying the same thing. Are you therefore critical of this new urbanist thinking that seems to be taking over?

Bill Hillier: I'm not critical of the idea – my work is based on the idea that we need to understand how cities acquire the form they do, and how they work in order to be good designers. So I'm extremely sympathetic to that idea. I think there are certain aspects of New Urbanism which worry me. But this is part of the interaction one has with designers all the time. I believe that there are marvellous things about large cities, for example, that we're beginning to get to grips with. New Urbanism tends to be a rather small-scale thing.

One of the wonderful things about a city like London is how it manages to feel like a local place wherever you are, and very different from other bits, whilst at the same time you have the sense of being in a large city. I think that I am in favour of the direction that New Urbanism is going, but I would like to try and raise its ambitions a bit to understand more things about the city, and how different aspects of configuration work together.

B Hanson: Dare I ask what you think about Poundbury?

B Hillier: That's not a fair question.

B Hanson: So I daren't ask?

B Hillier: You asked me, so I'll say. I haven't been to Poundbury for a year and a half. I walked around Poundbury for 90 minutes one Saturday morning and didn't meet anybody.

There are things about Poundbury that delightfully record very nice things about cities. My worry is about the design as a whole, which doesn't have the intelligibility property that I talked about. It doesn't have this way in which where you are locally gives you a reliable guide as to where you might go next. It's quite difficult to understand. I also think it's over complicated.

One of the things I specialise in is crime and space, and although Poundbury is relatively crime-free at the moment, you shouldn't provide too much back access to roads. Alleys are wonderful things, but in modern times they are not the optimum.

The street plays a very important role. A recent study asked 'Can Streets be Made Safe?' and argued very powerfully that they can. The one thing you have to do with streets is to structure them so they're not just localised things, but related to the larger scale. So with Poundbury I

think the idea is marvellous, but I'm worried about certain aspects of the overall scheme, and some aspects of the local detail.

B Hanson: Well, just to move from Krier and New Urbanism for a moment; a lot of what you just presented has a lot of resonance for someone who's read Christopher Alexander's books. Has he been an influence on you, or is this a parallel development?

B Hillier: It's a parallel development, I think. Obviously Chris was the first person in the field. Had he not claimed the term 'Pattern Language', I would have had it. (*Audience laughs*) But he was in first. I didn't publish 'The Social Logic of Space' until 1984, and I think 'Pattern Language' was 1977. So, I'm deeply envious of his 'logo' if you like.

In a sense we're trying to do the same thing. Chris is trying to 'mine' reality for structures. I'm trying to do that in a different way, and I think also I'm trying to do that at a larger scale. I think the essence in my work is to try and understand the relationship between scales of the city. I think the most marvellous thing about cities is being aware of here, and the larger scale, at the same time. Almost wherever you are, this is how space is articulated.

So I'm doing something that is complimentary. But I do think that one of the most fundamental things is that configuration is very sensitive—if you change one bit, you tend to change the whole pattern. When you join two things together you tend to change both of them. One of the things that worried me about the pattern language, which I think he has handled in the new book, is that when you juxtapose patterns it's makes a third thing, which changes the original pattern. So I think we need to understand more about a larger scale of organisation, rather than simply a particular pattern of how we put them together.

B Hanson: Any questions from the audience?

Charles Jencks: It's a question for Brian Goodwin, and it's to do with consensus methodology. There was a study by Wilson where they wanted to determine who was the most beautiful woman in the world, and they found that if they took the average of all women, that produced the highest results. I'm worried about consensus methodology because people have taken it to be the lowest common denominator. So the average is preferred. And then they argue that if you treat the average in certain ways – you make the lips fuller, the cheeks thinner, as Vogue and Glamour magazines do, you get a prettier and prettier face. So the prettiest face is based on the mean. This seems to me like a structural opinion of beauty...it's true that we all share a deep structural feeling. What I deny is that this beauty and prettiness in structures that are sophisticated, measurable, really work across time. Because from that kind of consensus you can get a sense of beauty in cities which look very like suburban America -- because we all want to live above a green lawn, and have a pool in the distance. So what I'm asking is what is the consensus methodology, how do you keep it from a regression into the average suburbanite view.

Brian Goodwin: Thank you Charles. I think what I would have to do first is say what you've described in the work of Wilson and others is precisely a kind of averaging method, and consensus methodology has nothing to do with that. It actually respects outliers – in other words, people who disagree with the consensus, but it shows you precisely where they fall in relation to the consensus.

Now what this methodology does is provide a tool for asking a whole lot of questions about the issues we've just raised. It's a new tool; it's a new way of looking at things. It doesn't use anything to do with evolutionary psychology, determinism, and Darwinian fitness—it breaks loose of all that. It's primarily phenomenological. It actually looks at how people respond with qualitative evaluators to whatever it is they are asked to evaluate. It can be a landscape. At Schumacher we look at landscapes, we evaluated with consensus methodology, and we looked at that in relation to the ecology, the diversity of species and so forth. In other words you can do correlations between quantitative and qualitative, but one doesn't reduce to the other.

Now, I think we're just at the beginning of this science of qualities. We have a method of bringing back qualities into the scientific arena, and demonstrating that they are a source of reliable knowledge. Now, the extent to which these evaluators are influenced by cultural ideologies, experience and history all needs to be explored. It's crucial for the whole issue of globalisation. Now that the meta-narrative structure of modernity is more or less gone, and we have local narratives that hold (even in science), this reinforces that whole process of going local and empowering people.

Let me just say that this in relation to Bill's presentation, I thought it was wonderful the way he demonstrated that it is maximum freedom to the individual that gives maximum quality of appearance to the whole. In other words you actually have faith in human beings to design these things, because they do have intrinsic qualities of space and order, and some form intelligibility. Let people at it, and what emerges is something that is functional and beautiful. And it does the job.

B Hanson: Brian, someone asked me in the break, and Charles broached it, what does happen to those who don't share the consensus?

BG: If Einstein hadn't disagreed with everybody else we'd have no creativity. So it's recognised that the outliers are a potential source of creative advance. But we don't know which ones they are, and those outliers have to convince the others that they've seen something that is important. Therefore it's a dialogue that is extremely important and that's why it's not a fast process, but you can nevertheless recognise a consensus, and say: "Sorry guys, you're so far off the grid, we're going to proceed in this particular way".

B Hanson: People might want to come back to that, but we'll have a question from the back.

Nicholas Woolley: I find this whole discussion about consensus absolutely fascinating, because, perhaps we're now at a very exciting time for this whole form of thinking to be going forward –

what is coming out of the ODPM at the present time with stakeholder consultations and so forth. Because that, I believe, can be moved in to creating what Brian was talking about earlier: a greater consensus from the stakeholders who are going to be affected in their various ways. Some of who may be outliers, they may be extreme outliers.

Certainly, I've been involved, as Michael is aware, in taking forward major research projects into seeing how we can actually understand and measure the priorities of stakeholders. And through the dialogue that Brian Goodwin has mentioned those outliers are able to discuss with others why they are thinking a particular thing. At the end of that discussion you are able to achieve a prioritisation from all the stakeholders' viewpoints. And then through statistical analysis, understand where different stakeholder groups are coming from, and see how they prioritise similar things in radically different ways, but also see them in the context of the whole.

Questioner: I'm very interested in this concept of how statistics are necessary in this field of research. You have to address these problems, as Phil made very clear, in a statistical manner, yet as designers we're always concerned with the particular. And all the questions so far have gone to this point.

There was a very interesting point that came out of Bill Hillier's analysis, which I think underlines why people are very nervous about this. This is when he changed the grain of analysis the answers changed. And what that raises is something that has happened in many fields of science: namely that if you change the grain of analysis you find out you're dealing with something different. So the answers are an emergent property of the analysis and not of the real situation and that's something I would be very interested to hear all the panellists' views on. Obviously we have to do the analysis—the statistics are there—but statistics never apply to individuals, they apply to populations, and that sensitivity to that situation is crucial to not getting this whole thing wrong.

B Hanson: So there's no such thing is as absolute truth in these matters, it's the question really.

B Hillier: I think the point you've made is very cute. But I think the form is different. The finer form is not separable from the larger form, but also the simple topological connections are in some instances more powerful, and we need to do more work to try and discriminate those. What is quite clear is our ability to judge distance is very much subordinate to our ability to judge the geometric and topological picture of a large-scale system.

B Hanson: So Phil, I think the question was trying to get at the cultural determinants of this. That the answers we take are as much culturally determined as scientific, and it's not therefore pure science in that sense. Do you agree with that?

Philip Ball: I think it's a methodological question really. How do you make sure the outward model is faithful. To some extent it clearly will be. To some extent is just a methodological question of running the models under different conditions on grids of different sizes. That's the

standard thing that people will do for example in weather modelling where this really is a problem.

There are also techniques one can use for integrating grids of different sizes. Again, in weather modelling you sometimes want to be looking at weather patterns on a quite a local scale, but you somehow have to take into account what's going on at the bigger scale, which you can't model at the same resolution. So there are ways of interpolating between the two. So it is a concern, but it is one that is recognised, and there are tools for dealing with it.

I guess there are also situations where sometimes the grid size/ pixel size is pretty much determined by the system. In traffic modelling you're looking at individual vehicles, and it doesn't make any sense to go any smaller than that. In those models also you can sometimes find a sort of coherence between those sort of individual modelling of single particles and modelling the traffic as a continuous field.

Michael Mehaffy: Can I ask a question of Brian Goodwin. I think that's an incredibly important point, because isn't it true that whenever you ask any question that uses language you're going to have an effect on the result, simply by virtue of the abstraction that you use. And therefore the kind of abstractions that you use, the kind of scientific language is incredibly important, is it not, in such things as for example Chris Alexander's patterns. The whole concept of that was to come up with a language that would better model the reality, so you reduce the problem that the science has unintended or unhappy consequences.

BG: My response to that is there is no privileged position from which we can view reality in any absolute sense. We're inside it. We're always part of it. We always have to examine what our assumptions are, and they become part of the analysis itself as you pointed out. So this stance that there is some sort of objective position that we can adopt and then talk about a reality that is independent of us; that's the major fiction of modernity that I think has broken down. So I think your point is very well made.

B Hanson: We'll move on in terms of the subject of the question.

Mae-Wan: This whole business of objectivity. Well I don't think there is such a thing because we are within nature, so it's always a negotiated partnership with nature. And if you take quantum physics seriously it does entail that how you deal with the world determines what sort of world it is. I think that's very fundamental. In precisely the same way, when you are in Brian's case applying this consensus method… maybe it's not the word I would use. The word I would use is something like a partnership in co-creation. You allow for surprises. It's not a matter of putting up with outliers; it's your willingness to let outliers take you to places that you wouldn't go yourself.

So, my term for such a process is 'quantum jazz'. In Appropriate jazz music where each individual, however small, is improvising and creating something and yet keeping in tune and in-step with the whole. So I don't think we've reached that kind of really organic way of working.

B Hanson: You're speaking as a biologist?

Mae-Wan: Actually I edit this wonderful magazine called 'Science and Society' -- and you can see copies of it outside!

B Hanson: Alan, you had a question.

Alan Simpson: I always enjoy Bill's presentations and I have for many years. They do produce wonderful drawings. If I may take a historic perspective here, going back at least to the beginning of the 20th century, from Seeks, through Appleyard, Lynch, we've had an addressing of this set of issues about cities: about their character; their form; how we use them; understand them; interact in them.

What's notable about all those pure figures is they dealt with the third dimension, which is notably missing from space syntax. I offer this only as a suggestion and not a criticism – how do we move into the third dimension with that form of analysis?

There's a lot of talk about consensus and working with communities which I do a great deal of through my renaissance work in Yorkshire. We start with the community in all our city plan making. It's interesting how from children through to adults, most people articulate cities in three dimensions – even if they are often crude drawings. So this concept of space syntax seems to be missing that critical third dimension, or am I wrong?

B Hillier: No, you're right. The reason we do things in two dimensions is human beings don't fly. We're trying to understand if you like the logic of moving along lines, and how the city organises that. Now it's not a difficult thing to add the third dimension, and in a sense it's implicit in what I was saying. When I tried to identify the process whereby patches of more intense development take place, well that is also a three dimensional development, and the density of development reflects that. Buildings are three-dimensional objects, but they have all sorts of devices to make them work in two dimensions like stairs and lifts. So the theoretical argument has to be made in two dimensions in order to understand how it shapes the third dimension…

Alan Simpson: The third dimension offers an indicator about orientation—about routing through the city. It provides all the elements of beauty through the city—I often take a route through a town because I know I'm going to get a beautiful experience rather than the efficiency of getting from A to B. I just think this is such an important thing.

B Hillier: I agree. I walk to work, and always take a different route for reasons that are similar to yours. I am talking about aggregate effects here, and I'm talking about those because they're the things that shape the way city grows… it's the effect of the structure of the network on aggregate

behaviour that does determine growth. I wouldn't like you to think because I'm not talking about it that I don't feel about cities the same way you do. It's just that I'm trying to explain something about them, which is essentially about the human capacity to move and become co-present, and understand scale.

B Hanson: I must say, Alan, that I thought your question was going to be: as we've been talking about how to design good cities from the early 20th century, how come so many of them are crap?

PB: That was basically what I wanted to ask. If we have this innate capacity to interpret space, and that gets expressed in the structures of cities, what does go wrong? Is it simply bad planning? What gives rise to the Elephant & Castle as it now stands?

B Hillier: It's land use rights. Urban space is essentially nonexistent.

Questioner: My name is Alistair Mellon, I'm a practitioner, and I run a property development company. I've worked with Bill Hillier a number of times, including my current project. My question is going to address a dilemma of two different things I believe, all of which have been touched on.

There seems to be a background of increasing complexity of life, and with that comes an increasing specialisation within that. Everything is abstracted into ever tighter defined specialisations and the opportunity for understanding across one's own disciplines seems to be limited. I think that is particularly true in the built environment and the narrowness of particular curricula – I'm a civil engineer myself by background – the complete lack of integration with any architectural or wider social science background is indicative of this. But together with that specialisation comes another issue, which is asymmetry of skills and information as well. It seems to be true that practitioners have lots of information and lots of specialised skills.

And against that – I read a book called 'the Wisdom of Crowds'. This book revealed that the audience of 'Who Wants to be a Millionaire' would win the prize collectively almost every week. Something like 92% of collective answers were right against the best individual of 65%. Also they gave an example of when crowds at a country fair were asked the weight of a bull, and the average of the crowd's answers was always the exact weight of the bull.

So I have this dilemma. I believe in clear skill sets, clear symmetry, and I've tried in my own development to reach out to wider community, but I always have that nagging doubt at the back of my mind that maybe I do know better because my team and I have been trained.

At what point should I listen to my skilled advisors, and at what point should I listen to the crowd? Maybe you can help me?

B Hanson: Oh, that's a good question.

B Hillier: I think we mustn't rush to judgements. Having been involved in quite a lot of urban projects I really do admire the project man / developer who manages to keep all these diverse groups in the building professions working together. It's something that people like Stuart have pioneered. They do these things in a confrontational round table, often around a model or something like that. And really address the issues.

I think in a sense my life is easy because I'm only doing one thing; reality is much more complex. When you're developing and designing things you take into consideration a much greater range of factors. So I think eventually the decision emerges. Having said that, we do make mistakes.

The public often get some of what they want, and not all of it. And sometimes the not all is quite a crucial thing.

B Hanson: So Phil, do we phone a friend, or ask the audience, for the best result?

PB: Well, actually part of what was asked touched on what Bill was saying about this problem you have between dealing with something statistically and dealing with particular solutions. When do you trust in the wisdom of crowds and when do you ask the expert?

I guess I feel that Bill's talk bore that out in the sense that sometimes the value the crowd (and the statistical analysis) bring to this is it helps you to understand what the rules are.

By looking at it statistically you can start to see for example how people do youth space – there are particular rules that work. You can then apply those in specific instances, as Bill knows, to a particular problem you encounter, but you know what the important factors are from the statistical analysis. So I think you can use both.

BG: I'm going to respond to you by talking about an experience we had last year with Christopher Alexander facilitating the process. We were asking the question: if we were to refurbish Schumacher College, on the Dartington Hall Estate, how would we go about understanding the nature and quality of land on which the current building was sitting? And in what ways could new buildings enhance the expressions, the gestures, of the land that was already there. So we built the usual sort of process you're very familiar with. We built the topological model. We constructed models of the existing buildings, and we collectively explored this issue by walking the land, looking at it, and sharing our feelings. And for me what was a revelation, was the ideas that came out of that, that contributed to the plan. Christopher was instrumental, because he knew how to implement these ideas. But it was the co-operative activity of the group involved—we had intimate knowledge of that land. We knew where we wanted communal spaces—we didn't want a dormitory.

Let me just say to you that there is already a design that has been commissioned for this refurbishment process. And I was very uneasy with this design, because it was done without the collective community participation. So the experience with Christopher last year showed me the

power and the value of community involvement, and the emergence of consensus insights. So that's my experience of that process.

Bill Hillier: We try to make our work transparent so we can see what's going on. One of the reasons we do this is when it's a question of redesigning disastrous housing estates we've actually gone down there and met tenant groups, and explained how our models work and use it to model their estates.

They very quickly get the idea, and there is some discussion about how we should do it, and what we should try and make happen. So we think one of the uses of our modelling—and it has not been used enough—is to democratise the discussion about how we should design things.

Questioner: If you do this process does it give you a bit more flexibility in the planning?

B Hanson: This goes back to a question we talked about earlier: how much this complexity science can affect the attitudes of organisations.

Questioner: I'm now a retired professor of architecture. I have a question for Bill. In the Seventies, when you were conducting seminars at the Bartlett, you were using the simplest possible unit of shell/brick. You played with it like Lego, and how more than two units made a street. Would you have anticipated that from these beginnings you be able to use this to analyse big cities? This is just a personal question.

B Hillier: I think it comes down to the idea of trying to get down to physics. I was in the South of France, where one has time to think, and a friend said: 'I'm going to take you to see some urban hamlets; can you explain them to me.'

We found these little bits of building, little ring street structures, delightful little patterns of space, very small and freestanding in the countryside. Now I couldn't explain them. But those experiments we talked about were an attempt to do what we now do on a computer. If anything led to Space Syntax becoming what it is, it was finding out how to solve that form.

Questioner: [*inaudible*]

B Hanson: We kind of addressed this earlier. It's a tough question. We can take as much as we want from complexity science, but it will be a pipe dream if we find we are then out of kilter with every other organisation and structure we're working within and alongside.

BG: Perhaps I could comment that this is a general problem. This isn't just town planning—it's the whole range of areas where science is being use to advise government to policy. Often it is science that is rather detached from principles we would tend to adhere too (proportionary

principles). Mae-Wan and I have both been involved in Royal Society policy with respect to genetically modified organisms in agriculture, and this is something where there are institutional norms and patterns that we see as somewhat irresponsible forms of science because they say: 'here's our understanding of these things and we allow the government to make up its mind'.

Now what we'd like to see is much more responsibility taken by scientists themselves in talking about the dangers of proceeding in particular ways. You may have noticed that the Royal Society has now adopted this precautionary attitude with respect to nano-technology. Now we need to do it with respect to the whole of the built environment and with respect to design. And this push for sustainability both in the ecologic and economic sense is a big challenge and we're all in it together. So, I think it's absolutely major.

As I say the shift to centralisation of power has gone too far. We need to go the other way now with evolution and local decision-making.

B Hanson: Let me ask you, Brian and Phil: last week the Prime Minister gave his speech on the environment—very radical in some respects—but do you think he at all envisages the amount of institutional change required to bring about the ends he is discussing? Or does he see it happening entirely within the structures that exist?

BG: Well our leader is a lawyer, and he knows rhetoric. And that is primarily rhetoric and no action. I'd like to see some action.

PB: As far as I could see it didn't even lay out a plan for how we were going to get from here to 60% less CO2 by 2050. So I don't know what he meant.

B Hanson: It does take a crisis to bring about the far-reaching institutional changes that some of our audience have been suggesting. And I suppose the nearest we have to an ongoing crisis is the environment. And it's interesting that if that's not forcing institutions to change, then how can our petty little concerns about buildings make any difference.

PB: I think the common response to the problems with the environment is to hope and imagine that technological change is going to provide the answer. That someone is going to come along and give us fuel cells. And I don't necessarily think that is always nonsense. I think there are technical advances that will perhaps mediate the problem. I guess I don't have a clear vision of the institutional changes that would help to achieve the ends.

B Hillier: I think there are institutional structures that will have to change. One of the things we've done is studied how cities grow and change and become as homologous as they are. One thing is clear: the process isn't just organise; it's a process that at every stage people reflect rationally on what they've got so far, and how they can take the next step. I think we've got to develop a planning system that is much more like this. I think we're getting away from the

appalling idea of planning as matt colouring and we're developing a much more informed, localised, organic process. A process that is informed by a principle of knowledge—where if you do that, it creates that effect. I think we're beginning to get the self-organisation, but it does mean breaking the power of planning and the idea that there must be a certain set of rules from the top. Every rule that has come from the top has been wrong.

B Hanson: I'm glad we can finish on a more or less optimistic note. Apparently it helps the digestion.

The New Paradigm and The New Iconography

Charles Jencks

Thank you for inviting me. I'm excited to be here with the other speakers because we are interested in similar things. There is a kind of Jane Jacobite consensus emerging. I'm also happy to be in this room with its sub-optimal design: sub-optimal as a 19th century furrier, sub-optimal as a restaurant; sub-optimal as a lecture theatre – but rather good for all that. It has mixed uses, mixed ages, relates to its context – everything Jane Jacobs likes. So, I'm glad to be among Jacobites in a building she might value as an instance of the new sciences of complexity.

I'm assuming we have some agreement on this 'New Paradigm' and, because of that, I'm going to rush through four lectures in one tying together threads. If you can follow me it will be because of pattern recognition, the pattern that connects complexity with cultural and political pluralism and our new view of the universe story. The great thing about a slide lecture is that, if a picture is worth a 1000 words, then 30 slides is worth a small book: the gearing is great, you can imply, entail and suggest 1000 more things than you have time to say.

Outline

In the first part I'm going to stress opening up the discussion of community to politics and participation. No one has yet focussed on these two aspects, extremely important, especially when you're considering bottom-up design.

Secondly, I will show how this leads not to real, or radical, complexity in architecture, but to the hybrid *quasi-complexity*. I'll put forward the quasi-complex idea of the heterarchy, and the heteropolis, a mixture that we can achieve in a global culture. That is a consensus—not of the majority, or The People, or the General Will – but of what I will call "the 5%." Briefly put, I don't think that today any interest group, or taste-culture, or identifiable community gets much more than 5% of the whole consensus. Such a radical pluralism would mean that 95% of the culture is marching on its own, its fragmented way in a global culture, something that presents great problems that might be confronted.

This would take us into multiculturalism and post-modern liberalism, subjects beyond this seminar, the rights of proportional representation in architecture.

I will then discuss very briefly *The New Paradigm in Architecture*—the subject of my book, but just three of its six main traditions. To hint at the patterns here I'll show:

- Fractal architecture
- Organic-tech or eco-tech architecture—the incredibly compromised but interesting quasi-complex movement.
- Iconic architecture — the recent mutation in the new paradigm towards landmark buildings of an extraordinary kind.

And then in the fourth part of my talk I will end with my own work on the new cosmology and its implications for a new iconography. Not because it's the best work around, but it's the only work I know putting forward an iconography based on the universe story. My argument is that, with the decline of religion and a shared symbol system, architecture needs this new iconography, especially in the "age of the iconic building".

But, as I say, it's really four lectures and 30,000 words packed into one, so apologies for speeding over difficult terrain. And I do agree with Brian Goodwin that we should 'go slow', so I'm even contradicting his and my own injunction – in the interests of getting the common idea of complexity across.

Complexity versus reductivism

(*Referring to slide 1, 18th century orrery*) Look at this orrery, a symbol of the Newtonian, mechanistic worldview. You crank the shaft and the world goes round, just like a machine. This model of the solar system was a teaching instrument in the 18th and 19th century, one where the planets revolve according to deterministic paths that could be explained through the simple reductionist laws that Newton derived, the laws of motion and gravity etc.

(2 Newton as Pythagorean God) This is a watercolour by the Romantic poet William Blake, which is a satire on Newton, although many people don't realise it now. He's been put underground and divested of his clothes, as a critique. Newton wasn't at home with his own body. In the same light, Newton has been given a Herculean torso, and put amongst the kelp, squid, and goo, and all the things that are 'not rational' (or at least hard to figure out with Newtonian physics). And here he, is like an architect laying out the Pythagorean world. So this was a satire, which became retrospectively in the 20th century, with artists like Paolozzi, a great heroic view of Newton. This shows how the mechanical view is attacked, how tastes change, beauty changes; ideas are misunderstood, even though they're written down by Blake.

3,4 Jane Jacobs and Goodman) Some Sixties books, including *After the Planners'* by Goodman on the right. *'The Death and Life of Great American Cities'*, by Jane Jacobs —is the foundation of complexity theory in architecture. In this book of 1961, its final chapters talked of the city as "organised complexity", not of simplicity. And it relates to the *life*-sciences, which, she says, are showing how we should consider cities. Cities "die" as well as live, and even in their dying, Jacobs later showed, there is an opening up of room for new economic experiment—it allows things like this institution to work here in an old furrier shop. So the death of part of a city is important for its partial regeneration.

Anyway, she takes the living biological analogy throughout and emphasises, as Bill Hillier did, the fundamental importance of streets. Streets are cities, whereas she writes, Modernists destroyed streets. And she wants to get the diversity, mixed usage, and use of streets back into the equation.

(5 Portrait of God the Architect of the Universe) You can't discuss all these things without discussing a Judeo-Christian background: where we in the west come from; where we are going; and how we are getting there. And of course the Bible as an 'operating manual for spaceship earth' is connected to the idea of this slide: God as "the architect of the universe", or conversely "the architect as god of the universe"—you can read the slide both ways. This is why architects like the image. It's from a 13th century French moralized bible, showing God as a big architect stepping out of the frame and designing the universe—even a chaotic, nonlinear one with the firmament, clouds, and water. He's laying it out with an architectural instrument, because as Plato had said: 'God is the great architect of all things'.

With this metaphor, comes the idea of male control, masculine design, purpose, teleology, and intentionality. All of which Buckminster Fuller, Le Corbusier and the architectural profession

admire because it shows their prowess and control. It is fundamental to the Prince's idea, when he says he is a 'defender of the faith', even though he doesn't specify the Judeo-Christian religion. And this faith brings up the ideology of the architect, to which I'll return.

(6,liesegang rocks, Goethite) In my own work, I'm very interested in self-organising systems, and art based on them. I happen to live in Scotland near one of the three sources where these stones self-organise themselves. In Britain they are called "liesegang rocks", after a German, whereas in Germany, they are often called "Goethite", after Goethe – something Brian will like, since he has derived his 'science of qualities' from him. When I first looked at these rocks I thought they were pieces of living matter: that is, old fossils. They have wonderful red circles and spirals, some overlapping and merging into each other. I thought 'gosh, how beautiful, nature is producing its own sculpture'.

You *can* see them as ugly; some people think they're horrible, but fascinating. Anyway, they were not created by things that were living, but through self-organising processes, in a white desert 270 million years ago, where red filaments of iron pulsated in certain ways. Philip Ball discusses this in his wonderful book on Patterns. So I've put them here on anglepoise elements, and took bronze and broke its symmetry in completely mechanical way. In other words, I squeezed the bronze, bashed it, ruckled it, and broke its surface. Why? In order to reflect the way the rocks self-organise; to mirror nature's process, to produce a cosmogenic art. I wanted to take a flat, boring, and unprofitable sheet of bronze and break its symmetry, just as the desert's symmetry was broken 270 million years ago. And that's what the history of the universe is, on a certain level: it's the self-organising process of breaks in symmetry. So I wanted art and architecture to follow that process, and reveal it.

(7, *garden terrace*)This is the 'symmetry-break terrace'. The first break, the universe, starts 13.7 billion year ago as pure energy. Then suddenly it cools, and simpler symmetry breaks in to matter; then matter, along with energy, bends space and time. Nine billion years later, and another break, life pops out, and then there is another break, with consciousness, 200,000 years ago (if you think of Neanderthals as conscious).

So the universe is shown in just four symmetry breaks, evolving towards greater and greater complexity, life and sentience. But, we are told by Vitruvius and so many others, that architecture is about symmetry-*making*, not symmetry-breaking. Well, breaking and making are interesting dualities, which turn out to be not so dual, when you look at them in a deeper way. Each breaking is a new and more complex form of making symmetries than previous, simpler one, especially the supersymmetry with which the universe started.

8, *emergence diagram)* Brian has been talking about emergence and, if you read this diagram you can see how, in the 1920s, the first books on emergence theory came out. This other diagram, produced in 1992 in the Sante Fe Institute, shows where the loose interaction of variables at a low level jumps quickly into an emergent global structure. Then, through feedback and putting more energy, or anything, into the system, it helps make this emergent global structure self-organise on a new level. That mirrors the history of the universe, on a very crude and basic level, and it celebrates symmetry-breaking.

Political space and consensus

9 Athenian polis) Now to democratic politics. If you go back to the early polis of the Greek city-state you can see they were based on a very interesting interaction between the place – a locale, a community – and the 10,000 that Aristotle said was the largest number of people that should form a political institution. Larger than that and they couldn't know each other, and would cheat. With 20, 000, they couldn't interact and communicate, and if they couldn't communicate they couldn't form a community (as the common root word confirms). Now you can see in the polis of the Athenian Agora, there is a shopping area around which the major institutions of the Assembly, Judiciary and Executive are placed. Anybody who was an Athenian man, especially one with property (so as to be educated and independent, the ideology went) could appear in the polis. When you were ostracised you were thrown out of the agora and you became a private person again, like a woman or a slave.

10 *Roman senate assembly)* So the origin of the Greco-Roman ideas were born in this kind of culture and produced this kind of glorified architecture. And we know it is not completely wrong, even when idealised in the rather autocratic Roman Senate. Here you see Cicero berating Cataline, located on the right side of that typical democratic assembly space, the horse-shoe layout. This form is where the slogans came from: 'No enemies to the right, or the left' – as they said in the French Revolution. Well, in this mural, all the consensus-builders are on the left side, and Cataline is furious at being isolated in this democratic space of action, of speech. Here is a political event that reminds us of recent ones on a national stage, especially when communism collapsed in 1989. An event is an emergent, where no one is in control, particularly politicians as Hanna Arendt has written many times.

11 Landesgemeinde in Switzerland) Hannah Arendt, in her book *On Revolution,* wrote something like: " bottom-up democracies usually emerge, for a moment, in revolution, and are usually killed off. They did so in 1776, 1789, 1918, and the American townships survived as political institutions, but only for awhile ." The only participatory one, that I can illustrate, is this one in parts of Switzerland, it has endured for over 600 years. It was anachronistic, the men voted by raising their swords in the air; but it is still the local community, even if has evolved today.

In the west this localism dies several times. Once with the Roman Republic turning into the fascism of Rome. The agora becomes Caesar's Forum, when the city grows to one million people, and the authoritarian system takes over. However, then a form of urban, participatory democracy is reborn in the revolution of the medieval time. We have a physical memory of this in Sienna with the power centres of the church, the state, and the communal *piazza*. That is where the agora re-emerges, again a surprise, an emergence. You can find an echo od this today in Florence, and in many Mediterranean public spaces.

12 Washington D.C) However, in spite of Margaret Thatcher saying Britain is "the mother of all democracies", what the British and Americans did was something else, a bit of a trick. Their invention was striking, "democracy without the people" – at least as far as architecture and place were concerned.

You can see this in London and in Washington DC. The only place for the people was invented in the 1960s revolutionary era when the civil rights movement took over the Lincoln Monument; otherwise the great mall area was closed off to the people. In 1840, Andrew Jackson and others said: 'people cannot congregate in this open place. It's not for them.' Instead Anglo-Saxons have a 'balance of power' based on the division and circulation of elite institutions. It's better than

nothing, but still 'the people' don't really relate to it. They only communicate in the English sense that they can lobby in private, behind the closed doors of the Houses of Parliament. That is what Anglo-Saxon democracy is about. Pause, and think about it. In London, Trafalgar Square was taken over by the people—there was no place for the people around the Houses of Parliament, nor in Americas' centre.

13 Krier plan) So, I show you Leon Krier's radical 1985 design for the Mall in Washington. He supplies four villages, filling up all that empty space with a densification of low-lying pedestrian-linked small villages. And he redesigns what was a terribly large bureaucratic design by pulling the Capitol to pieces and rephrasing it in a way that is much more grammatical.

14 Krier drawing of human species—mongrel versus pure) The Washington D.C plan is one of the last radical works by Leon Krier in the tradition of urban intervention. Thereafter Leon, like the Prince for whom he becomes the mouthpiece, starts turning against pluralism and, as the alternative, he puts forward a kind of vernacular classicism and high art classicism. He says, quite rightly, this approach has been suppressed by the modernists and post-modernists. But, like other people, he has almost a racist view of the organic relation between coherence and style and how different people are put together. So what starts off as a very radical theory of urbanism becomes allied, on a stylistic level, with a kind of anti-pluralism.

15 aerial of the New Scottish Parliament) However, by and large, people haven't followed Leon Krier, or even the Modernists, in their rear-guard action. They have leaned more to the post-modernists, in their open-minded pluralism, and to make this point I show you the recently completed parliament building of Scotland. It is much more eclectic than either Classical or Modernist architecture, not worried about combining different styles of the vernacular with quotes from the past, mixing the leaf-shapes relating to the nearby hills with the curved lines of its outdoor assembly. Here finally is a space for 10,000 people, also its also carried out with leaf-forms, and literally covered in various kinds of growth. So it takes a Barcelona architect to give us what we lacked, the *res publica*, the present-day equivalent of the agora.

Amazing isn't it—that we Anglo-Saxons, who had previously invented 'democracy without the people', had to wait until the Scottish Parliament to provide a space for them to show their collective will and personality. And the reason we had to wait so long is our suspicion of the people as a group, and preference for individual representation. The single individual relating to an elected member of parliament, an atomised democracy. Frank Lloyd Wright wrote a book about his revered master Louis Sullivan and titled it "Genius and Mobocracy" – the message was that Sullivan was killed by the mob. We tend to distrust the people because they may turn into an unruly crowd.

Integrated styles and common languages of architecture

16 plan of the New Urbanist Seaside in Florida) There are other aesthetic reasons for these attitudes, a dislike of visual complexity and contradiction, a desire to go back to harmonious simple languages, a city designed as a whole. The paradox here is to think back to the New Urbanism of Jane Jacobs, 1961, and what she says. It is all about hybridisation: mixed-use planning, mixed ages of buildings, the pedestrianisation of the streets, and organized complexity. These qualities produce plurality, and visual discord. It takes until the mid-seventies for Leon Krier to turn that doctrine into another form of New Urbanism – a more visually integrated one. It is interesting that, in a critique of many architects, Richard Rogers puts forward a similar Jacobite theory in

1995, in *Towards an Urban Renaissance*. This is a point when Jacobite theory, if we can call it that, is like ecology, so important for all parties to acknowledge. In spite of being on opposite sides of the equation, socially and stylistically, both the Prince and Rogers share the essence of Jacobite, that is, post-modern, urbanism.

One can see this paradox in recent events. Two or three weeks ago, Richard Rogers wrote a letter to *Building Design,* after he had been accused of copying the Prince's urbanism. He writes: "Since my Reith Lectures in 1995, I've maintained that the only sustainable urban form is the compact multi-centred city which mixes living, work and play, and benefits from well connected, well designed public spaces and building…" Standard Jacobite doctrine, this. Then he goes on to say: "Instead of squabbling over style we should focus on the need to restructure our professional education." Fine sentiments. But, he ends by inadvertently falling into a symmetrical position with the Prince, that is, the preference for an integrated aesthetic: "this [method] works well in many other countries and would create a holistic approach to the design of the urban environment and give us a common language."

"Common language". So, he culminates with a plea for a shared aesthetic, just as the Prince does, just as do so many architects. Ponder the paradox. Up until then they both put forward a participatory design and a Jacobite theory. But, for stylistic reasons, when it comes to city design they don't follow their pluralism and democratic sentiments where they lead, because they point to a *hybrid* design, a mixed aesthetic. They have not read those chapters in Jane Jacobs, which point to the hard truth that "a city is not a work of art". It is something else, a social and economic institution, often a visual botch and bungle, something that architects with a vision have trouble accepting.

Democracy and dissensus at the top

You can find this disjunction between theory and practice when the Prince intervened in the debate on architecture, particularly when it centred around St Paul's Cathedral, in the Paternoster area. Behind the scenes, as one of the judges on the jury considering many schemes, I became involved with the struggle underway. Everyone was claiming to be democratic, and speak for the people. The Prince with his support of Community Architecture, Richard Rogers invoking the popularity of his Pompidou Center (more visitors, 3 million per year, than any building in France), and journalists, among many other spokesmen of the general will. After the first round of selected designs, followed by the Prince with his counter-proposals, I chaired a public meeting at the Victoria and Albert Museum. Its subject was Prince Charles' intervention in the architectural debate.

On the right wing, to use the Ciceronian metaphor of the semi-circular layout, were Leon Krier and Lucy Lampton; on the left, were Colin St John-Wilson and Martin Pawley. Sandy Wilson was the designer of the British Library, that most expensive public building that never seem to be finished. The Prince had said it would make a good police headquarters. Tempers rose above normal.

At the meeting we debated with the audience for more than an hour, hearing at length arguments pro and con. The audience was a diverse mixture of types and about 400 strong. At the end, we asked: 'do you think it was good the Prince intervened in the debate on architecture?' Eighty percent said 'yes'. 'Do you believe his stylistic preferences should hold sway?' Eighty percent

answered 'no'. 'Do you think the way he intervened was democratic?' Again eight percent answered negatively.

These weren't the exact questions, but the best I can remember now, and the answers show an interesting point, something Brian Goodwin was talking about this morning: the emergence of an *informed* consensus. When you get people in dialogue, give them information, allow them to discuss it, you can get a consensus that has some significance and subtlety. The 'people' can rise above the 'mobocracy'; in fact, according to some pollsters and theorists they can make more mature judgements than the experts. The lesson is the old truth of democracy: given enough time and information, the 'people' can be collectively quite smart (the quotation marks to signal the way everybody claims to have their pulse).

However, the downside of our culture was also quick to emerge. The way the meeting was reported the next day in the tabloid press, and in the headline, was less nuanced:

HITLER JIBE AT CHARLES

The vote, the arguments, all this was lost because one of the speakers on the left compared Prince Charles to Hitler.

Once again the tabloid press blew up a disagreement into hyperbole, and architectural street-fighting. Yet the Style Wars and class wars, never far away, could be seen from a different angle, as I discovered when, a few years later, I spoke on the subject in East Germany. This was in 1991, shortly after their reunification with the West, at a conference called *Architecture and Power*. I concluded about the lessons of democracy and said: 'one of the interesting things about power in politics is that, according to Hannah Arendt, unless there is dissensus of power among the elite, then the "balance of powers" won't work.' This was a hard idea for the East Germans to swallow, at that stage, because the systems of Prussian politics and culture had been so heavily paternalistic for so long. I underlined the point: 'Whatever the nation's constitution says, whatever the freedoms and guarantees in writing, unless people disagree, at the *top* of the establishment, there will not be a full democracy. The institutional balance of powers works, but is not very effective if those with the most power have the same taste, interest and theories.' Architects, politicians, media, royalty must on occasion dance to different tunes.

I showed another tabloid headline, now it was the architect Jim Stirling comparing Prince Charles to Hitler. During this conference on power, in Weimar Germany, mobs of disaffected youth were roaming the streets, a crypto-Nazism on the rise. In this charged atmosphere, I underlined my point to the Eastern Germans: 'A couple of weeks after this architect's extreme insult, the Queen knighted Stirling – "Arise, Sir James". The architectural profession had forced its values on another, larger part of the establishment; one hierarchy had its way over another, royal taste. That conflict is dissensus at the top, that friction is the guarantee of democracy, not just the formal systems, and rules. From these conflicts and tensions, freedoms emerge.'

Regrettably, not many Germans understood my point.

At all events, in a book on the Prince's intervention, *The Prince, the Architects and New Wave Monarchy*, I ended with the conundrum that still exercises us, the fact that all quarters speak for the 'people,' most all architects assume a moral position, that they know what the 'people' want

and what is best for them. By implication, and perhaps even government charter, the moral rightness of the architect is built into the profession.

But the paradox was clear. At that point in the debate, although the Prince and Rogers both claimed to believe in community architecture, neither of them actually tried to find out what the British public wanted. Naturally they came to opposite conclusions. Since many sophisticated polling methods existed – computerised sampling, the science of geo-demographics, market-research, TV polls, Mori and Gallup polls – it was a political embarrassment that architectural leaders spurned them. Later, Roger Graeff, the filmmaker, and I went to Mori, and we measured opinion on the Paternoster issue for a TV programme called *Let the People Choose*. Wouldn't that be radical, letting the 'people' choose? The filmmakers, with the aid of Mori, took samples at the local and national level. It could be done, and if you are speaking for the 'people' should be done. But it isn't, even today. As long as this continues to be the case, and all sides lack legitimacy, then the architectural scene will remain a battlefield.

Heteropolis: the reality of overlapping communities

17 *Cover of Marxism Today)* So, if it is contested territory, if all sides will claim consensus, yet none measure the fine gradations, then other mechanism of quasi-democracy will come into play. There is the marketplace, which distributes the choice and variety that are lacking in the situation I have described, although it does so inequitably. But there is also the circulation of powerful institutions, as this paper argues, one that I wrote for the now defunct magazine, *Marxism Today*. The cover shows the game 'Scissors, Paper, Stone', where each of the instruments can beat one of the others, but none can beat the other two. Scissors can cut paper, paper wrap stone, and stone break scissors. Formally this is A over B, B over C, C over A, or what is called an heterarchy. The brain, with its interacting and competing modules, is a good example; and also a mature democracy with its balance of elites and powers. The latter means that power never resides in one place, and keeps moving. It is dynamic, emergent, coming into being through action.

18, 19 *Heteropolis cover and sociological map of LA)* Also the pluralism of the global city provides a certain democratic choice, the heteropolis. This cover of a book I wrote on Los Angeles in 1983, with its hybrid Frank Gehry building, shows the kind of architecture that typifies the heteropolitan sensibility. And the geo-demographic map also shows a series of identity areas: there are seventy or so different places that have a discreet and identifiable elements. A lot of them are ethnic: "Little India, Little Pakistan, Koreatown" etc. But most are areas of voluntaristic community and taste, formed by millions of historical choices. The global city of LA is, in this case, like London, actually a collection of 132 villages pulled together as various communities.

The basis of a community, as the sociologist Melvin Webber said of this city, is communication. He asked: 'why do theorists hate LA? Because they only see chaos, and don't appreciate that it has these communities. How do the inhabitants communicate? By travelling through the car and bus, by telephone etc., and by constant movement to their place of work.' These places of identity are revealed not only as ethnic areas, but also, by geo-demographics, as communicative structures. They are voluntaristic communities of taste, consumption, belief and habits but, being urban, are not as tight as the place-communities of the past. Applying geo-demographics to the taste cultures of LA, you can find forty or so different clusterings, as this slide reveals.

The point should be emphasised. In the average-size city today, especially in the global one, communities are not necessarily local. They may have nothing to do with space or location. In

London, one may belong to several communities that are loose, fast-changing, based on work, taste, and, as always, communication. They can even be virtual communities of taste and belief, and it is these that constitute what I have called "the consensus of the 5 percent." When spokesmen speak for the 'people', it is these smaller groupings that they usually represent, and just as politics is beginning to appreciate proportional representation, I think architects and planners should follow suit. Instead of a winner-take-all system, where Bush with 52 percent of the vote gets all the USA power on offer, we ought to have a professional and planning system where architects speak with more authority to those with whom they share similar values. The largest issues – ecology, economy, transport – might have a winner-take-all decision, but cultural and taste issues need a finer grain, as it was in the past before superstars flew around and designed billion-dollar chunks of the environment in a single style (the cost of one Getty Center). Under late-capitalism such commissions are becoming the prestige projects and the engine of iconic architecture, a subject to which I will turn.

New Paradigm and the sciences of complexity

These urban and political points relate loosely to the New Paradigm in architecture. The idea that ties it all together, remembering Jane Jacobs and Robert Venturi, is complexity theory, more specifically the new sciences of complexity. They should be contrasted with the modern sciences of simplicity, such formulations as Laplacian determinism, but more importantly the central notions of Newton, Darwin, Freud and B.F. Skinner, all of whom emphasised a related worldview. This modern episteme fluctuated in various places within the boundaries of mechanism, determinism, reductivism and materialism.

20, sciences of complexity) Since the 19th century, and the growth of thermodynamics and a host of nonlinear sciences, since Quantum and Relativity Theories were formed in the early 20th century, since the life sciences have prospered during the 1950s, and the chaos and computer sciences ever since, there are more sciences of complexity than you can mention – probably over thirty. This diagram shows that, if you take away any five, there is still the matrix of interrelationships of another twenty-five at work. What was a trickle in the 19th century has become a river delta. And although theorists disagree over whether the common ground should be called complexity theory, chaos science, non-linear dynamics, or postmodern science, I think this matrix is the heart of the new paradigm. It probably has another twenty or thirty years of deepening before it is fully accepted as the reigning worldview, but already it has sublated the modern sciences of simplicity on which, of course, it has been built. Sublated—not contradicted. Newtonian gravity is a simpler reduction of the Einsteinian version, not at war with it.

I was led to this conclusion in 1995, with *The Architecture of the Jumping Universe*, a book with the subtitle, 'How Complexity Science is Changing Architecture and Culture'. Here is my answer to Michael's basic question behind this seminar, a treatise where I tried to outline shift in worldview. Following that with *The New Paradigm in Architectur*', 2002, I argued that the new movement, "Complexity II stemming from earlier post-modernism, has at least six different traditions. It's a compound, which *does* have some contradictions. Contradiction is an unholy state in science, but as Robert Venturi and psychologists have argued, it is perfectly acceptable in the environment. And as my theme of pluralism suggests, the new paradigm is *not* an integrated worldview, or holistic movement

Thus 'The New Paradigm' is a slippery concept, intentionally so, to emphasise that there is not a single set of doctrines or methods or pattern languages that this mega-tradition follows. In that it

differs Alexander and others' New Paradigm. As in a Venn diagram, or the Wittgenstinian language games, what makes it hang together are a set of overlapping preoccupations. I'm going to mention three: fractal architecture, biomorphic building, and the enigmatic signifier leading to iconic architecture.

Three traditions

Fractals have been on the agenda since Benoit Mandelbrot wrote *The Geometry of Nature* in 1977, and showed with the aid of the computer, and a new mathematics, that you can analyse these new, growing systems. Such varying forms were, of course, appreciated previously, for instance by Romantic painters William Blake and Caspar David Friedrich: existing fractals have been around forever. As Mandelbrot said— "we have intuitively known about them". But it only when they are subject to rational understanding, a type of science, can they become an accepted tool. Indeed, they have become so fashionable in architecture that the recent Venice Biennale, called METAMORPH, might have been better designated FRACTAL.

21 *Eisenman school)* Peter Eisenman is one of its protagonists, as one can see by his addition to a modernist school of architecture and art in Ohio. This 1960s building had a zigzag structure, to which he attached a vermiform, staccato structure with its tilts and different colours. Here you can see he has taken the zigzag form, and has oscillated it around a "strange attractor" , a chaotic attractor basin, and produced the poetic equivalent of an earthquake. The idea is that architecture is the representation of the earth, and that the tectonic plates always moving under our feet makes a dynamic structure. Also, using the computer to allow emergence to happen, he is typically of the new paradigm.

Quite different is Daniel Libeskind, who will only use a computer at the end of his design. Nevertheless, Libeskind produces another kind of a fractal, another self-similar architecture; but it has semiotic or meaningful components that drive it. In the Jewish Museum, they are the connecting lines of Berlin figures, and the Holocaust void down the middle of the zigzag pattern, the "drunken walk" of modern history. Incidentally, this last phrase is taken from 20th century chaos science. With these chaotic angles, self-similar but all slightly different, Libeskind is communicating the contemporary loss of direction: its disorientation.

This become poignant, and problematic, in subsequent work. He applies a similar grammar, in the New Denver Museum, to bring in the crystalline structure of the distant mountainscape. That is appropriate. But we will see, in a few years, whether it works on the largest shopping centre in Europe, the one Libeskind has designed outside of Bern.

Fractals come in infinite shapes and sizes. Roger Penrose quasi-periodic tiling pattern has been one inspiration for interesting work done in Melbourne by the group ARM, and another group there, LAB, has developed this urbanism in a large city centre project. In summary, fractal architecture starts off in the late Eighties, becomes a distinguishable movement by the Nineties, and with the Venice Biennale it becomes mainstream, today.

Organi-tech

Now look at another part of the new paradigm: sustainability and ecological architecture. This movement cuts across many approaches and has its advocates in those cities that boomed the most, and suffered the most pollution. Hence the modern city of Ankara, set up in the 1920s *de novo* by the self-styled modernist, Ataturk. It is located on a semi-arid plateau that, by the 1960s,

became a desolated landscape. So the students of Ankara, when they came to the Middle Eastern Technical University, were asked to plant ten trees a year, and look after them for four years. So now there are 32 million trees, 150 new kinds of fauna, and 250 kinds of flora. This new, artificial wilderness has come back to a desertified area. Imagine, constructing a new wilderness – God's work. This may become an important way of counteracting the pollution and destruction that results from economic success, at best creating new rainforests where possible. This act is a kind of a controlled "emergent", chaos theory applied on a huge scale. And, metaphysically, it gives birth to a new nature that we assumed the Deity used to create. Now, like genetic engineering, we are moving into this construction, for better and for worse.

No doubt, what is called Eco-Tech, or I call Organi-tech, tries to do the impossible. And it's why all the big firms like those of Richard Rogers, Renzo Piano, Ken Yeang and Norman Foster are moving very strongly into sustainability and yet, at the same time, producing glass, aluminium and steel buildings, which are unecological. They are saying, "well we face the great contradiction of late capitalism where we are forced to do things we know are unecological, but society is not going to go stop building highrise." This is another example of "quasi-complexity". In other words, we have to incorporate the building codes, the economic realities and pluralism into sustainable
architecture, and this produces an impure version of an ecological building, hybrid results that can be criticised – but appreciated for what they are.

22. *Swiss Re)* None has more quasi-complexity than Norman Foster's "Gherkin", with its many inventions the most ecological skyscraper in London. As an image, because of its interlaced spirals, I misconstrued its organic shape as a "pineapple" and "pinecone". I assumed it showed the growth of the Fibonacci series, evident here in the gold and red spirals, the famous close-packing patterns, which Brian Goodwin and others have celebrated for their self-organising beauties. 80% of plants follow the Fibonacci or similar series in their growth patterns, as if nature knew how to exploit physics, gravity and space-packing without having to go through the usual trial, error and Darwinian selection process.

23 metaphorical analysis) Foster's Swiss Re reveals nine different overtones – metaphors as well as malapropistic associations. This mixture is a direct consequence of the social situation. A typical high-flying architect today is forced into a difficult situation when designing prestige buildings: forced, on the one hand, to build the most expensive buildings in the world, asked to do a landmark that is new, stunning and without precedent yet, on the other hand, told by neither society nor the client, what these icons should signify. Moreover, architects are forced to give an alibi of sustainability (which may be partially real in the case of Swiss Re), and they're told to astonish people; provide the "wow factor" that John Prescot and Mayor Bloomberg demand. In short, they follow the Surrealist injunction "etonnez-moi". The only way they can do that is to create a slightly paranoid object. In fact, as Rem Koolhaas used to argue, the 'critical-paranoid method' of Salvador Dali works rather well. Thus this skyscraper looks like a "missile, a bullet, a screw", a whole lot of nasty mechanical things, as well as attractive and sexy objects. Only in Britain would it be called a "gherkin" (long live the euphemism). But it is the mixture of the two that creates the positive paranoia, a characteristic of the new genre, the iconic building.

24 Calatrava Science Center Valencia) An important distinction. The organic-tech or eco-tech tradition is partly in the New Paradigm and partly outside it. The work of Calatrava show this. He invokes many naturalistic methods and uses the biological analogy: his buildings have

"tendons, muscles and skins", as do many of the others in the same movement. Such buildings, often benign, are like Gaudi's, alluding to "eyebrows, petals, flowers, and solar relationships". They may be positively iconic, but in one way they are not in the New Paradigm: they are repetitious and not fractal. If you look at Calatrava's Science and Art Centre, you can see he takes the Gaudi petal-motif, reaching for light, and he repeats it hundreds of times. So, at the larger scale this is more a Modernist than New Paradigm building.

Iconic building

Turning to the iconic building, another movement, brings us inevitably to Frank Gehry and the Guggenheim in Bilbao, which set the recent stage. Of course, such expressive landmarks have been around as long as the pyramids and Christianity, but in the past they had a recognised function, and often a shared social purpose. As mentioned, there was a consensus about iconology, the deeper meaning, and the client told you how to represent it, because there was a shared iconography. Today people don't follow such distinctions but in the Roman and medieval periods, and to a degree in the Renaissance, there was a tradition of iconology and iconography. The Egyptian contractors, pharaohs and priests told you how to build pyramids; you didn't have much choice about whether to symbolise the sun, or how to do it.

Now, however, the client has walked off the job: society doesn't tell you what all this expense should mean, aside from the circular proposition that it should be iconic (autotelic, about itself). The most the client clarifies is the effect, the 'Bilbao Effect': "etonnez-moi". This puts the architect in a double bind. He doesn't win the competition if he doesn't make it astonishing, about something cooked up in his own fevered imagination, *and* paranoid. At the same time it must be sustainable, and gather the consent of the locals. It's like squaring the circle (or at least harder than 'form follows function', or 'ecology').

25 New Guggenheim Bilbao) So, Gehry's Bilbao took architecture to a new level of Surrealism, as it became a convincing version of that double bind. It also epitomised many hallmarks of the New Paradigm, including fractals – the 26 self-similar petal forms – production by computer, its space which relates to the river and mountains. Its digital design and construction was through using the 'Catia' software, that employed by the French aerospace industry. This method streamlined the walls, and cut the metal and masonry so that there was no wastage. The computerised production system ensured that all the three million different titanium panels arrived on time, in the right place, bent the right way. Amazing—only the computer era could produce such work, a case where the whole building is curved throughout, but costs only 10% more than if it was designed by a Modernist out of self-same squares.

This touches on an important point running throughout this seminar: intuition. It isn't the computer that Gehry follows, the computer tests what he already wants to do through having experimented with drawings and models.

26 Bilbao metaphorical analysis) As these drawings show, Bilbao was compared by critics to a fish, and mermaid and many other things. Some critics called it a "constructivist artichoke", others called it a "duck, a swan admiring itself", and as I see it—a "window box with urban weed that's is so rubust it won't die" – even though it's in a polluted part of Bilbao. It's also a building that takes up the cosmic background, its water context, the adjacent mountains and nature.

27 Selfridges Birmingham) So, the Iconic Building exists as a new type, and for landmarks it is now becoming dominant. Every city wants one, and as result we are producing the occasionally misfired, or malapropistic, version. The architectural profession is debating whether it wants such buildings and critics, such as Deyan Sudjic, Peter Davey and Peter Murray, are saying 'no, by no means.' We don't want the 'Costa del Icon', as Graham Morrison has termed the Thames River. They don't want the 'tits and bums', so clearly designed for Selfridges in Birmingham, the building described by its architects as based on a bejewelled body-hugging dress by Paco Rabanne. Yet the investors in the Birmingham Bullring *do* want the Bilbao Effect. If you look closely at this context, you can see the dilemma of public architecture, Mother of the Arts. Here, right next to the shopping centre, is the empty church next to its empty square, the desolate emptiness a sure sign of Post-Christianity. To the other side is this brazen hussy of commerce, another sign of how global capitalism is forcing architects to compete for such "jewels in the crown" (or "bodies in their jewels").

The universe as foundation

I end, *faute de mieux,* with my own work, because it illustrates my idea that, if the arts are to have a public place and comprehensible role, then new narratives must grow out of a waning Christianity. It is apparent from the arguments of sociologists and psychologists that narratives carry our identity, who we are, where we come from, and where we might go. Stories support character, meaning aids society; significance directs choice. Each person has a small voice narrating their hopes and fears, tying their destiny to others and the larger communities.

The notion is that "cosmogenesis" is slowly emerging as our contemporary story, and a main part of the New Paradigm. Furthermore, this cosmogenesis is sublating other positions – the Judeo-Christian myth, Taoism, deep ecology etc. and yet it is still not a religion, or even like Marxism, a pseudo-religion. I agree with those who say a new faith is impossible today, because we not in a magical age, where myths can prosper and be transformed artistically. The imagination is cut short by commercial calculation; as soon as we have a successful idea, we grow a celebrity to kill it. Nevertheless, we *are* in an age that knows a great deal about the universe from its first few seconds, and understands the story of the cosmos—the story that becomes a foundation, just as the Genesis myth did in the past. The Judeo-Christian orientation is still part of the background. In the west, many continue to depend on it for their identity, especially for such things as their legal status, *habeas corpus*, a sense of worth and individual significance, long after they have stopped believing in God.

28 Bassano painting of Eden) Such an evolution towards Post-Christianity can be seen lurking in this wonderful 17th century depiction of the Garden of Eden, with its celebration of nature's plenitude. On the upper left is the metaphor we have seen before of "God the architect of all things" creating, below, Adam and Eve in their perfect ecological paradise. Here the lion lies down with the lamb, all the beasts of prey are docile, a magical consensus reigns. Adam, to the right, longs for Eve, sitting under her four-square primitive hut— a classical piece of Leon Krier design made from branches. There is only one small detail that puts it all in doubt. Adam's belly button. Theologically it should not be there, because he was created *ex-nihilo* by God, had no mother. In other words, the minute you have a belly button you have evolution; then you have Darwin, then you have the struggle for existence and all the damnable things that form the next, Modern worldview. Here it is.

29 *Independent Front Page, 1992)* This modern virus, like the belly button, lurks in small corners of the large print that tells us how things are. The front page of the *Independent* in 1992 announces to its readers with blaring headline "How the Universe Began". "Began", it's a pretence we must keep up, to sell newspapers. The news came from the COBE satellite, the microwave background, and it was announced to all the world at a press conference by NASA. Positively, the drawing of the unfolding universe showed cosmogenesis at work, the emergent public mythos of our time. All well and good, except the fine print, at the bottom of this diagram, shows the world starting in "a big bang".

99 percent of scientists will use this metaphor, unconsciously, and say the world started in a ferocious blast. We scroll back billions of years and find – think about it—that your mother was "a firecracker". The words are Pentagon language, almost those of George Bush, reflecting the Modernist culture of our time. Just as Darwinism took Adam Smith and applied it to nature, so today scientists absent-mindedly are giving us metaphors that the universe came from a violent shootout, a video-nasty. And yet it wasn't "big" (merely being the size of a quark, stretching quickly), it wasn't a "bang" (no one heard it, noise and flashing were its least important qualities). And the significant news was completely missed. During this early phase, the hot stretching of space miraculously balanced the forces one part in ten to the 59th power!

That balance is why everything, including us, are here today, certainly something worth celebrating, certainly a narrative on which a new iconography can be based.

By February 11th 2003, we had further measurements of the cosmic background radiation, and a picture of the early universe. We now know it is 13.7 billion years big, we know how fast it's expanding and we can tell that story of unfolding from the first few seconds to today.

In the 'garden of cosmic speculation' in Scotland, I've tried to depict that story as one of increasing order, of symmetry breaking, of leaps accompanied by setbacks. Metaphorically, it's a *jumping* universe, not just one gradually evolving. In other words, there is not only Darwinian competition, but other forces and methods of change and transformation; evolution is radically plural.And here we are subject to another Modernist reduction. Richard Dawkins, the scientist in charge of the public understanding of science to the British people, has tried to reduce it to one single type, as if Darwinism explained everything. Whereas it is apparent that there is nine billion years of *cosmic* evolution before there's even life.

(*30 Universe cascade*) This 'universe cascade' of water and steps shows both a gradual and leaping evolution, as well as some catastrophes and regression. It is represented and presented with those wonderful liesegang rocks, with which I started, signs of self-organisation. Here they reveal the emergence of stars and galaxies, the whirlpool organisations and crystallisations of stars.

By analogy cosmogenesis is like the story told in Genesis—a narrative of the beginning, middle, but uncertain future, and, unlike the Biblical account, it goes in many directions. Here it leads towards the earth and evolution of culture, shown by the jump of the 'goddess culture', maybe twenty thousand years ago. This woman holds a Chinese rock on her head and hair. During the Neolithic period, there are various things invented such as burial of the dead, music (with flutes), numeration (to mark the monthly female cycle). Many such cultural artefacts were invented 20–50,000 years ago.

This is a coherent, yet interrupted story. So in the garden I've tried to show the basic moments that make up the plot, the fundamentals that make up the foundations of our world: the black hole, DNA, the ultimate particles, the most important laws of nature, fractals as a language of nature, folding, symmetry breaking, and so on. The new languages of non-linear dynamics, or new complexity sciences, are represented and presented, not just stylised, so that, for instance, you actually are pulled by gravity into "the black hole". You feel it, as well as see and understand the forces at work.

New iconography: cross-coding and parity

A question: should the architect/ designer present and represent these patterns of nature? Should a new iconography be based on the fundamentals of our world?

Let us say we in this room, more or less, subscribe to the New Paradigm. Let us also say we, more or less, agree with Philip Ball and Brian Goodwin's view of nature as a self-organising system, and that to uncover its patterns is a fundamental job. But is this enough?

A cosmogenic art not only celebrates the emergent patterns and their languages, but also challenges them with other patterns and metaphors, better ones than the "selfish gene" and "big bang". And challenges them with a narrative, and words written into and on top of the work. One starts with the story that science is telling us, the universe as a self-organising, continuous, creative event, and one can narrativise that. But this narrative is *more* than a pattern—it is both a story and a critique. Narrative meaning entails a certain attitude towards pattern that is non-neutral, that involves us in nature.

Put in theoretical terms, today we need a *cross coding and parity* between ourselves and these patterns. Natural patterns should be criticised with our own narratives of hope and desire, because there is a duality between us and the universe. We come from nature, but we are also slightly separate from it by our ability to reflect, understand and transform it. Our relation to nature is quixotic and interactive. It is co-creative and therefore we need a kind of pattern language that builds in nature, on the one hand, and builds in our antithesis and critique, on the other. Thank you.

Third Panel Discussion

Michael Mehaffy: Okay. So at last we move into the realm of architecture and sculpture and representation. Or 'presentation' as Charles says. And another theme that seems to be running through today is a notion of science as a model of how we act in the world in addition to how we represent. So I'd like to start by asking Charles: what are your thoughts on where the New Paradigm is right now in history, and which directions it is heading in, and have you heard anything from our guests that give you ideas?

Charles Jencks: Heading? For anyone younger than us, the New Paradigm is mother's milk. It is so prevalent and pervasive in science, and with the computer and globalisation, that young people think it is the normal way to consider the world. It is you and me who are going through a life crisis, because we didn't grow up knowing non-linear dynamics was a reality—we were trained as Modernists. Because the young think the new way, I'm with Brian, in believing that the future is bright. The big question, as Thomas Berry puts it, is how are we going to get out of the Cenozoic age and move into the Ecologic age?

This shift will not happen very easily, but will come quickly with many crises – very fast. It might take one major crisis. The disruption of the Gulf Stream would do it, would make America and Europe put aside their eternal disagreements and face "Siberia in London". It is virtually inevitable that some such crisis will happen, and the optimistic thing is that the knowledge of this is widely distributed. When people understand the deep causes of that, then the 'political will' might come from the bottom-up. Politicians are never going to change things on their own.

MM: Do you think that kind of crisis will provoke the end of what you call quasi-complexity? I'll tell you my thesis: that architecture is locked in a fairly limited purview at the moment and it represents and presents this new cosmology, but it doesn't move beyond it, because it is limited by the current power structure. Is that a fair representation?

CJ : If you look at economics you can understand the architectural situation a little better. I'd love Phil's comments on this. In economic theory, Adam Smith put forward a form of complexity science. He said, the 'hidden hand', not God, operates the economy. You can get a competitive mini-capitalist system, where you get a lot of people trying to produce similar kinds of things and competing, plus a certain amount of self-interest involved in that competition. And if you take self-interest as a motivator and you put in competition, they become two forces which produce a third. That third is the emergent. It produces the cheapest thing, at the right place, at the right time. That's how good competitive economies work.

It is not because of any morality, but because competition plus self-interest = hidden hand. If you take that model, then what's happened in the last 300 years is that we have a very complex economy where the government is intermittently intervening; so there is no such thing as a really "free" competition. And yet the global economy does self-organize, to a degree.

The same is true of architecture. At a huge scale, it is producing rather bad large buildings that take up an incredible amount of space. The landmark projects routinely are $50 million chunks of

the environment. That is mostly a result of the global economy, propped up by Keynesian economics, military spending and a whole lot of things that don't make it "free". In the same way, architecture is constrained by building codes, by large size, by big corporations, by taste cultures, by all of these limiting things that almost force similar methods of production, and similar styles. That's why 90% of the buildings, like automobiles, look similar.

The economic problems are like the architectural ones: they both discourage bottom-up creativity, while aiding top-down production. You can't start a small business without great trouble today – in spite of what Gordon Brown says. Even though everybody in this room might want bottom-up creation, it is very hard to achieve because the economy and society are geared to a quasi-complex system where control comes from the top. It's "quasi-" also in the sense that the existing, large economic structures constrain you.

MM: Phil, do you want to comment on that?

Philip Ball: I'm kind of surprised to hear you say that, because the perspective from the other side of the Atlantic is quite different. For the last thirty years the orthodoxy has been that all constraints on the economy are necessarily damaging, and if you get out of the way it will work perfectly. That's what has tended to be argued in the US. And I think that if you start to apply these new ideas to look at how the economy works you'll find it is more complex than that—maybe that's what you're hinting at. Maybe there are inefficiencies, there is Nobel Prize winning work that shows how sub-standard products can be preferred over better ones. There are all sorts of crazy things that the economy does.

I'm just aware that when Adam Smith wrote what he wrote, he was writing it as a moral philosopher. He was interested in what ultimately this system meant for the well being of society. I think he had as broad a perspective as that. He was quite critical of the merchant classes and the greed motivation, even though he recognised that this was one of the engines of the economy.

I have a sense that that sort of perspective is yet to be injected into the sciences we're talking of. A lot of the physical scientists are looking into these problems because they see things like urbanism and the economy as fantastic experiments; there's lot of data they can test with their tools. I think we've also got to be thinking about the moral dimension to that, and what the implications are. And with the economy we've got to always be asking in the end what is it that we want?

It may not be that the objectives we collectively agree upon are those that are going to be achieved by simply letting free competition run its course—we've got to keep our eye on the end result.

MM: Brian, I started the day with a couple of questions to think about. The last one was: how does science, if at all, tell us about the quality of the built environment and how it can be raised? Can you give us your thoughts on that, and particularly as it relates to top-down versus bottom-up order? How can science be applied and move onto the next stage of Charles' new paradigm?

Brian Goodwin: I want to start by thanking Charles for a really riveting account of where we've got to. This made me reflect on the characteristics of this later industrial age. What we like to characterise as the Post-Industrial Age the same way that Thomas Berry does. In terms of these narratives it is a culture of Literalism. In other words, the 'secular priesthood', to use Chomsky's term for those who are the ruling class, those who want to believe they have the truth—the one story.

Now for me what has happened in science, as I mentioned before, is the whole meta-narrative structure of science --- that is, trying to get a truth that is objective and clear and abstract and true for all times and all places -- that is what has broken down.

What we have are local narratives. Yet in the process of subscribing to Literalism what we've got is this homogeneity—this search for power. To some extent you can see it is based on fear, because the politics of fear is now the politics of the ruling order. In other words we in the West are ruled by fear: it's an extremely effective political device.

Now architecture is suffering from the same problem: iconic architecture. It is not free to express itself in ways that are rather more creative. And what I want to suggest is whenever you have this kind of super ordinate power-structure, it dissolves itself. We're not going to dissolve it; it's too powerful. It has all these domains of control, but it is going to break down.

What science is actually doing is giving us a domain of mythology, and by mythology I don't mean something other than the truth. Mythology is the domain of multiple truths. And the whole business about charm, beauty, elementary particles—this is a story. Black holes are a kind of cosmic demon and this is why they are so fascinating to the public imagination, because this is the domain of myth. These are 'daemons' as Plato would call them. So the whole structure is dissolving itself. Now how can science then help us to put in place an alternative structure?

Well the turning point for me is getting back to common sense. Complexity and powers that reinforce the notion that our ways of knowing are reliable and valuable. Mainly we live our lives in terms of qualities: our lives are relationships in terms of qualities.

I don't want to repeat this—about consensus methodology—but it is quite a powerful method especially for scientists of convincing that the domain of qualitative evaluation is actually reliable. Now your punter knows that already, so it's the scientific community that needs to recognise that qualities need to be brought back into the domain and there is a systematic way of doing it.

Now I don't think there's anything more than that I can say, except that this dissolution of the present order, which will come about surprisingly quickly because, as Charles says, the challenges from nature are becoming more and more severe. Forget terrorism—that's child's play compared to what's coming from the natural world.

My last comment is as Charles said: 'we know Nature better than she knows herself'. But I think it's the other way around: 'we <u>don't</u> know Nature the way she knows herself'. And this is the problem. We have told ourselves a story about Nature and we've proceeded on that basis and got ourselves in a mess, over and over and over again. We need to pay much closer attention to how

nature operates, because we're part of it. This whole aspect of meaning, that's a deep part of everything we do, and everything that happens in the natural world is something we need to pay much deeper attention to.

So, I haven't got any prescriptions or solutions. All I know is things are going to change and there is going to be a new freedom.

MM: So just to follow up on that, you think that the iconic architecture is more closely related to the old paradigm?

BG: Oh, it's a reflection of the old. It depends on power, centralisation, and very large accumulations of resources, so it's indicative of that whole process. That's what you were saying Charles?

CJ: Yes. I was saying that. Let me clarify some points, because there are misunderstandings. I didn't say "we know better than nature". Rather that even though we come from nature, we're *not* like nature in certain ways that Judeo-Christian and other traditions emphasise.

We can suspend the laws of nature: with flight, we can defy gravity. We can also pollute the earth so much that it changes its 'nature'. We have theories about nature, which nature doesn't have, and self-reflect in a way that is non-natural (i.e. very rare in nature). So we cannot assimilate ourselves to nature, or use it as a standard, as do some ecologists, and certain architects and artists in those movements. We're partly alienated from, while also being in dialogue with nature. We're neither superior nor inferior. We're embedded in it, there's no question, but we're not limited by nature. When we discover 'laws of nature', it changes the relationship to the world, and that is why I call for a "parity principle" with our other half, "co-equality".

On the question of economics, I wasn't arguing for laissez-faire. I would agree with Adam Smith that we must take a moral position, but it is not as much an emergent system as it was in his day—when you had mini-capitalism. Today, in America, we have what Marxists term 'military Keynesianism'. Not social spending per se, but 40–50% of the GNP used as pump priming through the military—$320 bn a year. That means the economy is more predictable, more controlled – again it is "quasi-complexity", not real complexity. It can be good or bad top-down control, and the same is true for architectural control.

Many people are neo-romantic about bottom-up design, and I'm in favour of it too, but it has to come through participation and political involvement, not design fiat from afar. What I'm against is Christopher Alexander, or Leon Krier, or the Prince, standing above me and saying, *de haut en bas*, they don't like multiple styles, hybridisation, post-modern mongrel. It is, of course, their right to speak their mind, as long as they show up at meetings and engage in the public realm, as does Krier.

But where is politics in the world of Christopher Alexander? Why is he not here? Why will he not face dissent or criticism? I don't inhabit his world, or that of the Prince. I wrote that book about the Prince, and although I sent it to him he never said, "thank you." Okay, it was critical but it

wasn't highly critical. [*Audience laughs*] I'm serious. We live in real power structures and they make the situation "quasi-complex." They take away some of our freedoms, and narrow the creativity we can have. I'm less critical of the iconic architects—but I think it's a dilemma for them as well. Instead of running away from iconic buildings, or hoping they will go away, my view is that we must face them with a new iconography.

MM: I think those are all fair points. But I think we thought the best way to discuss Christopher Alexander in great detail was to try to have the scientists discuss them as we did in Katarxis 3. Chris is a brilliant person who is not necessarily his own best spokesperson, and doesn't always work in the bottom-up way he would like to. I think the purpose of this discussion is to explore and not prejudge by saying this is wrong and that is right. Instead we're to explore the territory that Brian Goodwin certainly represents: is there a possibility to find new ways to engage? And I think that's what I would certainly say Alexander's project is all about. And we'll discuss that shortly.

Bill, you are a person who has been implementing many of these ideas. And not only representing or presenting, but engaging in some way. Is that a fair statement?

Bill Hillier: Yes. Can I put another angle on this? Over the last 20 or 30 years architecture has been liberated by becoming part of many, many streams of thought. It has had huge influences from linguistics, literature, philosophy and science. This has had an incredible effect in creating multiple developments this way and that way. Charles has been its chronicler—we wouldn't have understood it if Charles had not written his books tracing these developments. I think it has led to some marvellous architecture; marvellous experimentation with form, including your garden, which I think is a wonder.

But space isn't quite like that. The idea that we can somehow imitate forms of nature, and create things. I think there are other constraints in space. I tried to show in my talk that there are certain very simple, powerful things about space, certain natural laws that govern space. There are also relatively few things we can do with space. We can make things bigger or smaller, longer or shorter, more complex or less, but the fundamental differences in the ways which you organise space are not that great. Although with split cities I'm trying to say they're not natural order; they're the internalisation of laws of nature into a human mind. And a re-externalisation to create very distinctive patterns, which we call cities, which aren't really like anything else.

I think we have to understand cities in them themselves. We don't understand them by strict analogy with nature, although they produce similar effects like fractal distributions. Understanding how spatial structures emerge and how they relate to our lives is a very distinctive problem and I don't think it has exact analogies anywhere else.

I went to a conference in Boston recently. We were in the Frank Gehry building, which looks wonderful from the outside. And what was really interesting was the space inside, and how simply and elegantly and powerfully organised the activities were organised in there, in a way, which enhanced them and added a new dimension. It confirmed my view that there are more ways of experimenting with architectural form than with space. The space was right, it worked, and the space enhanced what we were doing by creating a certain kind of complexity in the interior. Now I think that society is more like space than it is like nature in that sense.

I think some of the things I am trying to say about cities can also be said about societies—the kind of forms and variations we find. Science fiction writers are always experimenting with ideas about how societies we had in the past might reappear in the future under a new form of technology—they explore the morphology of society.

It seems to me that we are all posturing about capitalism and forgetting that we have terrible fears about what may happen in the future and what's happening in certain parts of the world. The quality of life for large numbers of people and the level of freedom they have and value has never been like this. This is the best time there's ever been in history of the world.

Go and look at China and look at how it's freeing itself from the last 50 or 60 years. And Chinese kids are beginning to enjoy themselves. Now maybe that's a threat to the world because they'll all want cars and we'll have the natural disasters we're half expecting. But we have to look at some relationship between the quality of life at the everyday level, and the terrible fears and models of how our society is being run.

It seems to me that we're shirking the real job. Communism was the 20th century where we thought by rational thought we could make things work better. And nothing was worse than that: it turned places into prisons and it made everybody poor. By and large that has gone—that's disappeared into the past. And we have a real intellectual challenge of how do we have a free society that creates somehow its own order, which isn't an order of huge dominance of one group by the other.

Now what encourages me that this is possible is if you look at the thousands of societies that have existed on the face of the earth (1,500 of which have been studied by anthropologists) most are not hierarchical societies. But somehow they achieve and create the outcome that we call society, that makes us safe, and helps us to survive evolution.

I think there is a great misunderstanding of Darwin. Darwin is only about the production of progeny; it's not about struggle as a metaphor. It's only about the conditions under which we can successfully reproduce ourselves and therefore have more children and have more influence on the gene-pool in the future. And society is one of the fundamental mechanisms by which human beings do this. Successful societies grow because they're able to produce people more.

Now there is a real intellectual challenge here, which reminds me of the problem of trying to understand cities. But I think it's very specific: we have to understand what kind of a system society is, and I don't think it is a natural system. Something like space is something that has internalised certain fundamental things about how the world works, about how we connect together, how patterns emerge, which people are beginning to look at with complexity theory and other things. But I feel optimistic that we're beginning to understand how society does not form in natural forms, but it's own distinctive forms that have a lawfulness about them. I think the intellectual project is really to understand how this can happen. And how we can build a society that is both free and does not produce the huge inequalities that we've seen recently.

MM: Thanks panel.

Christopher Alexander's New Paradigm in Architecture

Brian Hanson

I do incidentally hope in the discussion that follows that we can return to the subject of Chris Alexander's supposed top-down approach given that he speaks about consensus and bottom-up. It's very interesting, I think.

We've talked about how institutional changes of the kind that Christopher Alexander and Brian Goodwin require need crisis to bring them about. I think there are many people here who can testify that when Christopher does a project *he* becomes the crisis for the duration. But this does achieve results—and I hope we can talk about that.

If you look at Charles Jencks' 'New Paradigm', if you look at Christopher Alexander's 'The Nature of Order', what becomes apparent is they share a good many footnotes and references. But, as will become apparent, the images on the screen now couldn't be more different from the ones Charles has just shown us. I hope if I do nothing else in this brief time, I can persuade Charles to call his '*A' New Paradigm*, rather than '*The*' *New Paradigm*. And I want to show that these same scientific sources and ideas can give birth to very different kinds of architecture.

I think if Chris was here he'd want to say that he came upon the complexity science / new science ideas firstly as a scientist. He was studying mathematics before studying architecture at Cambridge. His early reputation was built on the application of scientific mathematical methods to design-method. And in many respects, the ideas that Charles Jencks has outlined came as corroborations for intuitions that Chris had come to in his earlier work.

Some of you may be familiar with these works. 'Notes on the Synthesis of Form' was that seminal work on design-method. 'A City Is Not a Tree' was almost contemporary with Jane Jacobs, and applied a mathematical geometrical analysis to the nature of the city.

Then of course 'A Pattern Language', with its 253 patterns. It is worth saying that now Alexander sees the patterns as really part of a more general fundamental pattern that 'The Nature of Order' explores. But 'A Pattern Language' itself is still very useful as a tool in refining what Alexander calls 'centres in creating specific qualities of space'.

'A New Theory of Urban Design', which when I first read it found absolutely liberating. It is an anti-planning tract and spells out how a city can be created through numerous, very localised decisions based on simple rules (how you behave in respect to your neighbour for instance) rather than any overarching narrative or plan.

In 'The Nature of Order' there is an explicit criticism of 'New Theory' at one point, in that it neglects to attend to those larger scale structures that make a city properly work.

I think it's fair to say that as complexity science developed, and as a corroboration to many of the ideas that Alexander had been exploring experimentally and theoretically over the years, he was very much attracted to what the science was saying about things like wholeness, quality, order, and simplicity.

Charles has been very honest in his books, and made no bones of the fact that his New Paradigm been in part a way of getting postmodernism out of a hole—acting as a new 'brand image' for certain architects.

Michael said to me, 'would you like to explain the principles of Nature of Order in half an hour?' Thank you, Michael. I propose to do it in ten minutes—I hope it's not too dense. I'll follow the outline of the theory in 'The Nature of Order' with some images of Alexander's work. And I'm conscious that though many of you may be familiar with Alexander's theory (it is what he is best known for), you may not know his work so well. I'm showing images that will be appearing ultimately in Book III of 'The Nature of Order', which will appear later this year.

Alexander's theory in 'The Nature of Order' begins with a notion of the *whole*. And it's a notion of a whole that is discussible, apprehensible mathematically, although not fully describable. I think the best way of spelling out what this means is to quote from the ecological architect, Stuart Cowan, who reviewed 'The Nature of Order' for the magazine *Resurgence*:

"Wholeness is understood by Alexander as a rich non-linear field of interactions amongst salient entities or centres with surprising, yet empirically verifiable properties. Centres support larger centres, and in turn are recursively formed from smaller centres. As we know from experience, subtle changes may greatly affect the field of wholeness. The field has a number of postulated mathematical properties, but currently resists even approximate calculation. Fortunately we can access the field of wholeness through personal observation."

And this echoes quite a lot of what Brian Goodwin was saying earlier. In terms of complexity science and symmetry-breaking, this wholeness that Alexander begins with is similar to the manifold symmetries you find in an undifferentiated homogenous state of matter—before the symmetries are broken.

As the symmetries are broken—what Ian Stuart calls the 'collapse of chaos'—you exchange this greater symmetry for structure and local symmetries are formed. And Alexander calls these "centres".

Here we see one of Alexander's beloved Islamic patterns showing the interaction of many of these centres, some of them stronger than others, all of them mutually supportive. He also has quite an extensive collection of fragments of Islamic carpets, which were exhibited a few years ago in San Francisco, which he often uses as teaching materials.

Just as in his view the wholeness generates the centres through symmetry breaking, so in nature various properties and features of nature are formed through this same method of inducement by the whole. He calls them the 'fifteen patterns of natural morphology' (?). I suppose when I was saying earlier that 'Pattern Language' with its hundreds of patterns were descriptions of more general phenomenon; these I suppose would tend to begin to describe those more general phenomenon.

The important thing is when this highly theoretical (you could say highly abstract) idea of how space is structured is related in some step-wise fashion to larger wholes, larger entities, and ultimately to everything. It's when this changes from theory to modes of action that it comes closer to our particular concerns perhaps. This is because there is a very strong message in all of

Alexander's work that all of us engaged in building need in some way and in every action need to attend to the health of these centres, which exist in the environment.

And when I say "all engaged in building", it goes beyond the professionals and includes communities of the various kinds we've discussed today. I think in the current game player argot it would be called 'massively multiplayer'. That's what this process of creating a living environment is in Alexander's' world: it's massively multiplayer. It engages all of us, and however small the action may appear one can either be helping or hindering the inherent structure of the environment.

It's no coincidence that in the late sixties Alexander set up an office in Berkeley, which was called the centre for environmental structure, in other words trying to envisage and to help in various ways this structure, which underpins the environment around us.

Now, we've talked about power structures and I made that rather flippant remark about Chris trying to bring about crises in these power structures. But there is no doubt that once one begins to theoretically view the universe in this way and practically expect people to be constantly helping through their actions this latent structure in the environment, I think this does have enormous implications for institutions and the way building is conducted. It obviously demands much broader participation in the way decisions are made about the built environment. It has implications for building culture more generally. Alexander has a deep affection for traditional building culture. And if you look at traditional building culture you could say it is a system that is much better in it way of producing the kind of natural order we've been talking about earlier today, than the much more top-down, designed in advance plan system that dominate building culture today. It demands that economic and political institutions change. And the way in which individuals engage with the built environment and its structure is based on observation: observational science—quite the thing in the early 19th century under Goethe and given a boost by Ruskin. Observational science is in the work of scientists like Stephen Wolfram making a return. The conclusion being that really you can only understand the world or some of its more enduring aspects by observation and learning about the surface, not trying to imagine some invisible essence underneath it all. And I think it's very important that this kind of observation is aid by the kind of professionals that Brian Goodwin has talked about. I'll quote it again, because I think it is a very encouraging and provocative piece, Brian Goodwin's words on the planner of the future:

"I think for planning to be effective it has to be a kind of facilitation that is prepared to engage with hold a process of confusion and chaos long enough for something new and relevant to emerge from what has passed as city. The new order cannot be planned or predicted in advance if it is to be genuinely relevant to context. But as it emerges it can be experienced so that some judgement is exercised through feelings and intuition and observation as the process develops."

I think were we to take that seriously as built environment professionals then obviously we'd come up against things that would prevent us wholeheartedly carrying out that program. But I think were we in small ways to begin to put that into practice we would be in a better position to bring the kinds of natural complexity we've talked about today into the built world.

We've talked about the Prince's common language, which is Classicism, and I've never really understood where this comes from except it's good journalism. The Prince has always talked

about a 'common process' and I think it's important to distinguish between formal borrowings from nature and the belief that nature has processes that help it find better solutions. I think we talked about in one of our earlier discussions the idea that nature has ways of finding solutions through the inherent dynamics of the situation. I think that is certainly something that Christopher Alexander will see as defining the approach he would wish to take.

There are lots of these images that Michael has kindly supplied, and I'm really just showing you to keep you amused whilst I ramble on.

So, new kinds of professionals, individuals who both understand the structure of the environment and are able to engage with it. In 'The Nature of Order' there are various processes laid out, probably the most important one of which is what Alexander calls 'structure-preserving transformations'. In other words we're all involved in transforming the world in some way, the question is whether in our actions we are preserving and enhancing a structure that already exists, or whether we're imposing a new kind of structure on the existing structure. Alexander has been very careful in recent years to plot these structure-preserving transformations, which he would call health giving to the environment.

This slide of drawings charts the evolution of the Piazza San Marco in Venice over a number of centuries. But I think having explained this in a fairly complicated way, it's important to understand that there is meant to be an ordinariness and simplicity in what's built. The end result of attending to centres, of engaging in structure preserving transformations it to preserve a kind of simplicity and ordinariness in what gets built.

There was a debate not very long ago in Clerkenwell about the Prince of Wales—a sort of updated version of what Charles Jencks did. And I think what was called for by many of the panellists at the end was a better level of ordinariness in the environment. I think for all the high sounding language I think that would be very much Alexander's recognisable aim in lots of this.

Charles may not remember, but he and I had the same teacher, Rayner Banham, and to paraphrase his famous book: I think what we're dealing with here now is theory and design in the gene age. And I think the structure of DNA has some interesting lessons, because it was only really the beginning, it wasn't the secret of life at all.

Of course added to that since has been the 'genome sequence', which again is not quite the whole story. And there's what one of our panellist referred to earlier as those inter-relationships between genes, that sort of network of connections that is actually the substance that gives rise to life. It's the stuff from which life emerges. I think Alexander's progress, if you like, and his argument can be understood in similar terms. You first understand what the structure that exists in the environment is. You then might find sequences by which this structure can be both recognised and preserved. But ultimately in the way you build it, the way decisions are made etc, there is some kind of magic that causes form of a high degree of complexity and wholeness to emerge from that. So the 'gene age' and the way the secret of the gene has emerged over the years is, I think, very instructive.

Also, not to be outdone, there is a cosmology in all of this, which those of you that read Book IV of 'The Nature of Order' will quickly become aware of. It can best be summarised by saying that beneath all this structure the best points in the environment are those that are (in Alexander's

words) 'being shapes'. And in some profound sense the structure works best when it best mirrors the self. I'm not going to say very much more about that, but that it does purport to also put forward a cosmology, which is I suppose a more fine-grained cosmology—more 'bottom-up' than the big bang stuff we were talking about earlier.

Okay. That's my attempt to outline some of the principles in 'The Nature of Order'. I'm going to show 40 images of various buildings by Christopher Alexander that have been built over the last 30 years. They've all got heading or footings on them that relate to the way the images are presented in book III of 'The Nature of Order'. They relate too, to the way Alexander is recommending that all individuals engaged with the environment might start thinking about the order in which they engage with it, and I'll explain that a little more as we go along. So here are the works.

This is a university campus in Eishin, just outside of Tokyo designed and built by Christopher Alexander in the 1980s—wholes of public space. And obviously there is an echo here of what Bill was talking about in that Alexander's starting point is public space and the quality of public, whether it's in designing new environments or recrafting old ones. And he makes a very strong case in 'The Nature of Order' that it's very important to see these public spaces and envisage them in three dimensions in terms of space and volume.

And those who are familiar with the fact that one of Chris's early collaborations was with Sergey Chermayeff on the book 'Community and Privacy' when he first arrived in the states. It would be no surprise that he moves very quickly from the definitions of the wholes of public space to the individuation of the building and spaces, which are attached to these public spaces and give them their character. So the 'enmeshing' of the space and the defining buildings is very high up in the order of unfolding.

And of course it applies to the great hall at Eishin, and it applies also to the many houses in the States that Chris has worked on. This (*referring to slide*) is one of a group of three houses built near a lake in Austin, Texas. What you find happening in Chris's houses is an articulation down to the most fine detail in the room (the alcoves) as well as the rooms themselves. As many of you know, a lot of these are devised as the building goes up.

One of the revisions to the building process that is dear to Chris's heart is that drawing of the building comes at the end of the process, and the building has find its place, the doors their size etc, with the client on the site as the building is erected. Clearly this works quite well in an area where you have timber framed housing, but it has also been tried with other technologies too.

And then there is a kind of emphasis on this same alternation between the public and the private taking place within public buildings. In other words the large space giving on to the smaller space. This is me sitting in a gallery at the West Dean visitors' centre in West Sussex, which was completed around 1993, and is on many levels a fine example of Chris's work at its best.

We see the same thing in the very much larger spaces of the Megaron development in Athens that Chris was engaged with over the last three or four years.

And a work that I think captured many people's attention was the Linz Café, which creates these marvellously intimate places for meeting together and different qualities of convivial spaces in

which people meet and mill around. It's also true of one his great-unbuilt projects, which was the Mary Rose project proposed for Portsmouth dockyard in the early Nineties.

'The Nature of Order' also talks about gardens. This is a garden in one of his North Californian houses that he designed. The garden again having some stepwise proportional relationship with the internal rooms of the house. So that gradually the structure manifest in the house connects and reinforces the structure of the broader environment around. Again we've got the West Dean garden.

This is a garden on the edge of the lake where the so-called Back of the Moon development—the three houses in Austin, Texas—are based. This is space inside the Austin houses.

It's interesting how this idea of consensus and the collective vision has now a scientific voice, because it is clearly something that has preoccupied Chris Alexander from the very earliest years. This is part of the Eishin campus, the dining hall on a man-made lake.

Something becomes clear when you read 'the Nature of Order': the detritus of the city, the encroachment of cars on the city -- none of this is viewed as a despoliation of the grand artistic vision, or something that ought to be pushed out of the way. It very much becomes substance. It becomes something to create more life in the environment. So the presence of cars—the inter-relation of cars and pedestrians—becomes not a necessary evil, but a potential benefit.

As I say, the kinds of principles beginning with the public space and developing from there is as much a feature of his approach to reconstruction as to new build. This is a farmers market in Fresno.

He has been involved with Hyunais (?) in a couple of high-rise developments. This is Sapporo building in Tokyo, which showed that even a mult-occupancy building of this kind could be subject to the same kind of client engagement: varying the structural plan from floor to floor for instance. It showed a more complex building was still amenable to this kind of engagement.

This was a composition design for Mountain View Civic Centre, California, from the early eighties, which shows very well his emphasis on the use of positive space in creating the centre or focus of a development of this kind. And was similarly in the unexecuted design of a monastery on the left, Eishin campus and the plan of Mountain View with the spaces shown in black down in the bottom right.

What's also very radical is once the environment is seen in his terms as consisting of structure, which needs to be appreciated, apprehended and then either helped or hindered by our actions within it, is decisions about structure become as important as decisions about the layout of rooms. So it has become an increasing feature in his work in recent years that he attends to structural elements of a building, or entire structures like the proposal top left for the Oakland Bridge in California to create the same kind of complex order reflecting the generative principles of nature in the structure as in the rest of the building. There is a particularly fine example bottom left, which are structural trusses for the San Jose Homeless Shelter from the mid-eighties. You can see the same thing on the left in the hall at Eishin, and there are some other examples from California.

(*New slide*) You have to appreciate simply that the book's scope takes us from the design of building details right through to the prospect of settlements in the larger natural environment. What is also interesting is structure understood in this way, gives back prominence and meaning, and justification to the minor details of a building; whether it's a treatment of building elements or minor ornamental detailing, which maybe our too reductivist view of structure over the last century has tended to push to the sidelines. So ornaments and building elements become a crucial element in creating these living centres in the buildings Alexander is so keen to create.

The building on the right is the garden at the San Jose homeless shelter. You can see how very simple but well placed ornament plays its part in creating the fine structure of spaces like this.

That's detail of West Dean Visitor Centre, which Michael and I were at a week ago.

And then building as making. The implications of all this for building culture; the return to a much more 'hands-on' approach to making buildings. And this was the well-documented project at Mexicali, where a community set up a builders yard and from the local patterns and the local building culture a community of houses was generated. This was then published in a book called 'the Construction of Houses'.

Alexander's approach certainly does not try and limit itself to recognised traditional materials. His buildings are consistently using concrete. I remember at West Dean there was a huge 'hoo-ha' because he wanted to use exposed biton buits (?) alongside flint and brick. The planners had to come down and reassure themselves that this would work in a really very beautiful down land environment, and it works tremendously well to this day.

New techniques, new materials—this kind of process is inclusive in the sense that it does invite these innovations into it.

Maybe we're getting closer here to the cosmological ending of the book in the sense that there is a sense in which ornament and colour—these poetic elements as he calls them—are emergent qualities that sometimes surprise you. It's a kind of inner life breaking through, if other aspects of the structure of the environment are attended to in these buildings. I'll just finish with a few images of this kind. The great hall at Eishin on the left and the Linz Café.

I hope for those of you that didn't know Chris's work that's something of an introduction. For those of you that knew the theory, you can begin to see how that theory works itself out. And those interested in complexity science, the idea that this is as much a working out of that science as the other images, we've seen today. And if you pursue the application of complexity science in this particular way you seem to approach much more closely to traditional forms and ways of doing things, even though you're not in this straight jacket of style, that I think style-obsessed journalists are concerned with. Thank you.

Michael Mehaffy: That's another area we haven't explored at all, but can perhaps do when we meet again, and talk about the relation of tradition and how that might be a form of collective intelligence in the way we've seen with ants and other creatures. Okay, let's take a break and then we'll have our final panel.

Fourth Panel Discussion

Michael Mehaffy: We're very pleased to be joined also by the biologist Mae-Wan Ho, who has written extensively about architecture, and I'd like to get her thoughts on what we've been discussing up to now. Sorry to put you on the spot, but Mae-Wan, I wonder what you thought about this event as an observer, and not so much a participant?

Mae Wan Ho: I have to thank you a lot for inviting me here. And I'm sorry I came a bit late. This was a very important discussion, but I can't help feeling that it didn't quite get to the point. The point is there is a lot of un-freedom that was identified. I'm sorry—I don't feel we have a free market because corporations have taken over everything.

We don't have a free architecture, we don't have a free market, and we don't have a free science. So this magazine is the only radical science magazine on earth, and it is against the corporate takeover of science.

I did review Chris Alexander's book in the past issue of this magazine. And to make a very serious point, the reason I am here today is because I was so impressed with his work. I'm very honoured to be invited to join this illustrious panel.

MM: What are your thoughts on the 'new paradigm'?

M-W H: I think I'm very much with Brian and Chris Alexander. We do need to get out of this mechanistic science straightjacket to get to an organic way of being participatory, intercommunicating, and co-creating. This is a totally different kind of being, because you don't just rely on 'push' and 'pull', or controller versus control. You rely on what people might call consensus, but it is a kind of intercommunication in which you allow the creative process to blossom. You allow yourself to be taken by surprise and go to spaces, places and times that you would never have gone to yourself. And this is why I find this whole process exciting. It's not a point of being 'top-down' or 'bottom-up'. You can be simultaneously both.

As I think Bill Hillier said—in reply to somebody who asked, what should I be doing?—well, your expertise is there to maybe provide informed judgement, and to implement ideas that other people might have. So I think there is plenty of room for diversity, for creativity.

And I think I must be one of those neo-romantics that Charles was talking about!

MM: There's also a paper in Katarxis about 'top down' and 'bottom up' working together that Brian [Hanson] authored.

Probably Phil would like to reply to what was said about markets? Perhaps you could play the Socratic role I asked you to?

Philip Ball: Thank you! No, we don't have free markets, I agree. I don't think I would want them. I think big corporations are what free markets produce, and I agree that's a problem.

(*Pauses for words*) I guess I've been struggling to take away something concrete from what we've talked about. It sounds as though we're all agreed that it would be nice if there was less of a hierarchical imposition of received ideas in the way we do things generally. In both the way we do planning, and the way we approach science and the way we approach the organisation of societies. I suppose I'm still struggling to see what the role of science is in that, if it is to go beyond providing a metaphor for ways in which we do things. But that's a very good role for it, and there is a lot to be taken from the way eco-systems seem to find a way of handling diversity and complexity in a way that's relatively stable.

On the other hand, eco-systems do undergo natural crashes, and we shouldn't be lured into thinking they're nice stable states where everyone remains happy—species do go extinct, of course they do, all the time. Most species that ever existed went extinct.

So we need to be clear, if we want to learn lessons from nature, that nature might not always be telling us things that we would like to implement in our own societies. Beyond that, the question of how you go beyond the metaphor and put things into practice... I mean Brian has talked about a way of doing that; a certain way of finding consensus in a way that isn't a simplistic hands in the air and voting. It seems to me that would be a very useful tool.

I guess the kinds of science I very briefly mentioned, the kinds of phenomena that physics in particular, and I think to some degree biology, are able to see and explain. It's not clear to me how far we can go in terms of implementing those ideas at the level of society. It was no coincidence that I spoke about simple systems like pedestrian motion and traffic flow. In fact when I debated this with a sociologist once he said, 'oh, we know all about that–that's trivial'. And in a sense he was right, those are simple systems and it's not clear how far you can push that.

I talk in my book a little about things like alliance-formation and about international relations, and more complex systems like voting processes. But I feel that at the moment you have to be very cautious about applying it to those sorts of systems. I'm not clear the data are there to verify our models. And I'm not sure we know enough about what the rules of the system are. So I think that remains to be seen and I suspect that some of the issues we've talked about here about how you bring about institutional and governmental change. I think it's clear we feel that some of these ideas need to be taken on board. But I'm not sure how much science at this stage is going to be able to help us to do that.

MM: Isn't science really just about recognising what's already happening? For example, in the work we do here at the Foundation, we see enormous small scale but very diverse efforts to do things like the Enquiry by Design process—things that bring together information about a design problem in a very scientific way, in terms of observation. Doesn't science help us to recognise where we are, and how we can move forward, particularly when we have the sustainability crisis that we do?

PB: In terms of giving us a broader picture, life-cycle analysis of materials and so forth, yes, I think a scientific approach certainly has a role to play. From what I've seen today and previously of Chris Alexander's work, it seems to me that observation is a very important part of that. And it seems to me he has made fantastic use of observation in terms of looking at traditional design and modes of architecture, and trying to abstract from that what seems to work, and to get general principles that one can then apply.

It's not obvious to me that's a science. It looks to me more like the sorts of manuals for artists that are able to elaborate on what are good principles of composition and colour-use, and so forth. All of which seem to me to be perfectly valid. But in a sense what you end up with are some very good rules of thumb that help you to see what will work, and what doesn't. But again, it's not clear to me that it's a science beyond—

MM: Well it's not science in the early 21st century mode. But I would suggest it might be science in the, perhaps, tradition of Leonardo, or some other artist/scientist who sees the world as Chris certainly does.

Brian Goodwin: Phil is quite right to say that this is not part of conventional science. But it is the sort of phenomenological observation that is the actual foundation for Galileo's science, and it's the foundation of what we see as the new science. We actually call it 'holistic science'.

Now 'holistic' has a difficulty associated with it in terms of medicine, but it simply means a science of wholes: a science for the whole person. And the science we practise is a science that's primarily for the analytical intellect and control. There's a whole other part of the personality and the human being that is to do with the intuitive perception of wholes—the perception of health.

This is the tradition, which we take from Goethe, but you can take it from Leonardo. Leonardo was born before this split between the arts and sciences. So he was a scientist, but an observational scientist. He wasn't a mathematician; he was a technologist, a craftsman and an artist. Now Goethe, born in the second half of the eighteenth century, arrived at time when modernity had been well established. Kant had reflected on the structure of science, and people accepted Kant's view that the only way to get reliable knowledge about nature was through this observational method of science—detaching yourself from the world.

Goethe did not believe that. He went back to Spinoza in the 'Intuitive Science' and this moral engagement with the world in which you can perceive 'right action' through a contemplation or observation of the phenomena. You actually come into a relationship with the phenomena, just as a therapist is engaging in right action in relation to the person they are treating; you come into a relationship with participation to create a 'whole': a whole in you, and a whole in nature.

We've had the term 'Romantic' mentioned a couple of times. And I have no problem at all with a concept of "romantic realism," which is what I think Goethe was engaged with. It's romantic in the sense it's trying to create a whole human being. It engaged with a whole world, and responding.

So we have half of a science that's for the analytical mind, and that aspect of us that wants to control nature. The other half is participation, intuition. This is very simplistic—there are other bits as well; nevertheless we do need to balance it. It seems to me there was a very interesting phrase that Brian Hanson used: "Structure works very well when it reflects the Self."

I think that was the way Chris Alexander put it. This it seems to me is about meaning. Our lives are about meaning, and it's meaning in relationship. And science splits people in two. I see contemporary science as a rather pathological enterprise.

Let me be categorical: it splits people in two because it insists they put aside one half of their natures when they are engaging in science. And I think that this has now become dangerous.

We need to heal ourselves, and we need to be in nature. For me the new science - call it holistic - is a way of being perfectly rigorous, without getting rigor mortis! It can be very explicit, using methodologies, mathematics, and the whole spectrum of science. This is because we need science and technology in the conventional sense, in order to go sustainable. And we need it to understand the world so we can bring ourselves into a proper relationship with it, but we can only do this if we extend our 'ways of knowing' into these other faculties, which are part of the way we actually are in the world.

MM: Mae Wan?

Mae Wan: I just want to come back to Chris. I think it is so important, because there is another way in which knowledge is very important to us. Apart from us getting ourselves sustainable, it's almost going back to the way indigenous people 'know'. It's this knowledge that give meaning to their lives.

I spent my whole life looking for a science that I could love, and live with. I think that's important, because I really can't live with this reductionist, mechanistic science. And I found a way of 'knowing' that I'm comfortable with, which is why I resonate so strongly with Chris, because he started with feeling. If you do not feel what you are saying or writing about, then you don't understand it, I think.

For example, our body is very coherent when it's healthy. There is literally a wisdom of the body, in which every part is intercommunicating with every other part—it knows itself perfectly. Now when you know somebody or something as intimately as that, you are coherent with it. And when you are coherent, there is maximum local freedom and global correlation. This means that if you look on it as a perfect love affair -- two people are so correlated -- they are maximally themselves and maximally together.

Now this all comes out of the most rigorous quantum optics definition of coherence. It's called 'Factorisability' for those of you that are interested. For me this something that is so deep, that to put it outside of you—does it solve problems of the stock market?—is to trivialise this kind of 'knowing'. I think the kind of 'knowing' that Chris Alexander is talking about has that quality about it.

MM: But there are ways it can be used in the real world of daily action, as Chris Alexander's work shows?

Mae Wan: Yes, because if you see nature as whole in this thorough way, that you are entangled with every other being, then I don't think we would have so many conflicts and wars. But maybe again, this is my romanticism coming through! But I do think the romantic poets had a much more rational view of nature than the so-called rationalists.

MM: What's interesting to me, speaking not as a scientist, but a student of the philosophy of science, is that there are internal contradictions within science and within the way science operates. Quite apart from your own concerns, what I find interesting is how those contradictions might be resolved, and might imply changes in science that are quite distinct from romanticism or pure logic. Perhaps we could go to Bill Hillier as someone who does implement a lot of these ideas?

Bill Hillier: Can I put a slightly more optimistic gloss on science? We can't do science unless we're trying to find out things that are generally true. Science is a search for principles, for the understanding of what is generally true about phenomena. The way we tend to represent science to ourselves is, once we understand the principles, we can predict and control. But science does something else. With an understanding, or theoretical underpinning of how some phenomena work, it opens up possibilities: we understand that other things are also possible with the same underlying laws.

Now for me this is the reason I do what I do. I'm very often in conflict on projects with English Heritage for example; who are very conscious of the past, and it shouldn't be changed readily. What I'm always trying to say is, we do understand how space works. The way in which this city has evolved is because people thought hard, reasoned, and continually changed things and made it what it is. It was never a single historical creation; it needed correcting at certain times. So we have to understand how this happens.

It seems to me that if we understand there are lawful things and universal things about cities—I think cities are an object of science. I don't think we've got there yet, but certainly we can aim to get there—but once we say that, it does open up possibilities. I'm a great admirer of Chris Alexander's work, and I had not seen a collection of his built work and his projects together before. I feel I understand much more what it's about, and the delicacy and fineness of his observation, and the beauty of some of the ways in which he brings together everything. Much more complex than what I do, which is simply talking about space in a more abstracted way. But at the same time I agree with Philip, that this is something, which is synthetic and tremendously insightful, but it's not about trying to understand the universal statements you can make, it's more to understand the partial universe.

So my slogan is: 'theory liberates'. If you have a theoretical understanding of something, you can do things that no one has thought of before. This really is true in architecture, because at the moment we find on a big urban project, people say we should build as it was before. We should go back and treat Paternoster Square as it was before we built this modernist thing, when there was an abattoir there. As though somehow going back to a form of space that worked for an abattoir would work for the pattern of use it has now.

So it seems to me the great benefit of science—and I think you can be optimistic about this—is that by understanding things theoretically, we open our eyes to new possible ways of doing things. I think this is the foundational reason why theoretical understanding can open up the artistic possibilities, so we're not trying to reproduce everything about the past that worked, but creating something new.

MM: Charles, some of the areas being explored now in iconic architecture seem to be exploring areas specifically in violation of some of the laws that Philip says. I wonder if you'd amplify on that a bit?

CJ: Could I first respond to Christopher Alexander's presentation in absentia? Let me say that I do accept that it should be 'A New Paradigm in Architecture', if you're talking about architecture. But I wanted to put a stronger case, and that's what I did in 'The Jumping Universe' and 'The New Paradigm', but I didn't get into it in any depth.

With the sciences of complexity, examined by amongst others the Santa Fe Institute, which showed this field developing—I think this is a new theory, and I do think it liberates. I do think it sublates the earlier modernist theories. And 'sublation'—a Hegelian word—doesn't mean disprove: the theories of Relativity do not disprove Newtonian gravity, but what they do is make them more general and more particular at once. So I would say there could be an argument that this is *the* New Paradigm and there aren't any new paradigms coming. This is it, this is nature, this is the universe, here it is.

The thirty sciences of complexity I showed will grow to thirty-five, to forty, to fifty. But fundamentally they will, I believe, reinforce the New Paradigm in science, and not in architecture. I think you're right. It's 'a' paradigm in architecture, or *six* as I was suggesting, which are versions of the new paradigm in science, although mostly unconscious, because I wouldn't say that these architects understand or even follow science in any depth. So to a large extent we're speaking from a similar view I think on that score.

Does that sound right? *[Looking at Brian Hanson.]* That first of all I'm arguing about the new sciences of complexity, and not the new paradigm of architecture. There are many new paradigms—

Brian Hanson: The book is called 'The New Paradigm in Architecture' (*audience chuckles*).

CJ: But it's 'the' new paradigm of science as it has come into architecture. I've tried to make that clear. And it's not about science: read Philip Ball, or Brian Goodwin if you want to understand the new sciences of complexity. But I do think there is some complex overlap that relates to the new paradigm of science, and it is the new paradigm—it isn't just another one. Do you accept that? Or do you think there are an infinite amount of true theories yet to be discovered and other new paradigm theories? "The" paradigm is arguing something stronger than a worldview; stronger than metaphor. It's arguing there's a coherent theoretical framework for how *all* these sciences come together, and what they're saying about the universe. It's a strong statement; it's not a weak statement.

Brian Hanson: I would say that I interpret the title of the book as the 'New Paradigm of Science as applied to Architecture'. I think it's possible to come away from the book and think that is the application of that new paradigm to architecture. All I was arguing is there is another way of applying that very same paradigm. I think you say in the book that in a way what you describe is the best we can do under the circumstances. Which is why your argument is heavy on the formalistic borrowings from nature.

CJ: I agree that Christopher Alexander is part of the new paradigm in architecture, and an important part. I was put off, and I've known Chris for 40 years, by his incredible arrogance, and

the book by Stephen Grabow. So the personal thing put me off a bit. Let me just say as a historian-critic, if I look at his work I like his work as an architect. I think it's extremely seductive and right. I like it intuitively and with feeling. It resonates with me. But I have to say also, he's 'Bay Area architect and Neo-Maybeckian'.

MM: Hey, watch it - I'm one of those too!

CJ: Oh, so we've got in-group gossip. But there is a sensibility of building that's involved with a very important historical formation. It starts in the late 1860s, becomes the Queen Anne movement and arts & crafts movement, melts together and goes to America. I think Christopher Alexander is a very good continuation of that. His theories are also great recipes—I agree with Phil on that—and they're not total science, but there may be universalities in them too. So I respect him on both levels.

The part I find criticisable -- and I think it's our role in a dialogue to have criticism, not to just bow down to the absent guru -- so let me give you a little bit of critique from a political point of view.

He says "(I)n Book One I show how the knowledge of living structure is connected to the knowledge of our own self". Well it's nice to have the 'self' come back into science, along with Brian and Goethe.

Then he goes on later to describe in a rather pessimistic way the decline of the west: "but what is becoming harder and harder, even as people are becoming more and more sophisticated and education is increasing, the inner voice of the self is falling further and further into the background".

And this is Christopher's crisis, which apparently is very fruitful. He says "what has been lost is the inner language, which connects you (you) to your own soul (soul)". Now there's a Christian word—particularly Christian isn't it? Let's not beat about the bush.

There's a theory that comes with 'your soul', 'his soul', heaven, hell, the whole thing—it makes you know with certainty. Whenever I see a person who's certain, I'm certainly worried. What's going on here? We have kind of crypto-fundamentalism. *[Audience murmurs.]* We do!

Then he goes on: "which way is likely to be right, and which way is likely to be wrong?" He emphasises the 'likely'—he's not saying this is right or wrong, but he's getting very close.

"To be more clear about it; to feel it as a real thing, to know, to listen to the voice that is in your own heart."

Now I don't want to turn Christopher Alexander into a fascist, or Platonist, or someone who like a neo-romantic justifies everything by his feeling. But there is a danger. What happens if, like Leon's feeling, it produces this style of architecture, or like his feeling produces Neo-Maybeck, etcetera? In other words, there is a way in which the inner soul or the feeling of the self is being asked to be the final arbiter of things. I'm really worried that this is to be the judge. And I'm worried that he feels us in decline.

Of course you have to agree with him that rugs aren't being produced as they used to be, that taste has declined in many ways. But as many people have said today, how positive the freedoms and creativities are that we have. And these creativities are pluralist creativities, and they come from radically different worldviews and different tastes. We can't reduce them to the Prince's, to Leon's, to Christopher's, or anybody's. That's why I come back to the consensus of the five percent.

MM: Charles, I think you've stated very well many of the criticisms of Alexander. And I must say they are founded on a misunderstanding that he himself has probably done a heck of a lot to

create. But if you look on Katarxis, I did an interview with him there, where I challenged this very issue.
And I think the issue is whether you believe that personal taste, or personal meaning, becomes *ipso facto* a form of totalitarianism, or whether you think that is simply one agent having a feeling that means something that is really true, true only for them -- and yet that connects in a plural way with many other people.
That is what I think touches a lot of people about Alexander, and why they find him so moving. I don't believe he is a person who wants to shove a particular point of view down people's throats. However, he does have a Cambridge mathematician's personality!

B Hanson: I think what Charles has quoted from Chris could be read as a more poetic way of saying some of the things Brian Goodwin has been saying earlier today, about how you find your way to understanding the world if you apply a science of qualities. I think in the end, whether he speaks of 'soul' or other loaded words, it is ultimately about empowering the individual to make decisions about their place in the world. It's actually taking away the responsibility from the professional elite.

Questioner: I think what Charles Jencks has said is really important to have been said—it's the nub of the question. If you take Chris seriously then he is saying I do want to put this on an objective basis. But that is very difficult because what he's doing, and this whole new science is doing, is difficult. The birth of objective science had to very rigourously define itself and fight against medievalism. It was a hard fight: Galileo was almost killed by the inquisition, others were. It wasn't a joking matter to say the sun was the centre our world.
In movements that are born out of struggle you get quite a hard-edged approach. And science has had to continue to fight that hard-edge approach for a very long time. Darwin had to fight very had.
But as we've heard, and I think people here are sympathetic to, rational science, in defining itself so strongly, has to have put a large part of our personality and reality to one side. It is now becoming evident that it is irrational to continue to ignore the non-rational. It now becomes rationally imperative to address the non-rational, and hopefully that is what the new science is doing. In doing that you have to expand your method a bit. You have to be able to talk about things in a pseudo-scientific way to begin with. Just as, if you read Descartes and Newton, they are talking about God. But that was the language they had to work with at the time. It took a long time for better, clearer models and language to come along. I think we have to be very gentle and sensitive at the moment, in allowing different sorts of discourse to say things in different sorts of ways.
I have just one thing to say to Charles. Don't worry; Chris Alexander isn't interested in stopping what you want. He only wants nice buildings and houses, he doesn't really care about 'Capital A' architecture. You can do what the hell you want. And great for us, because it's all good stuff. What he really cares about are the ninety five percent of buildings which get built without anyone particularly creative or inspired having any interest in them. That's hopefully where people like me, at the bottom end of the food chain, can do something.

MM: Not wishing to put words in his mouth, but I think George Ferguson of the RIBA has said something very similar.
Phil, can I broaden the question? Do you think there is a new paradigm in science here? And what does it mean for architecture?

PB: I'm not going to answer the second part. And I was waiting for you to ask the first part. I hope, Charles, that you're not right that it is 'The' paradigm and the last one. And I suspect that every other scientist on earth feels the same. And I feel we probably at least have history on our side in imagining that it isn't going to be the last one.

Is it a new paradigm? I've argued that a lot of the ideas of complexity science have their route in an older science and an older mechanistic science. I was talking about particles interacting via forces; that's as Newtonian as you can get. And yet I think it has things to tell us about complex systems. So I don't necessarily think this needs to be dressed up as a terribly new thing.

On the other hand, it is clear that over the last 20 years science has felt itself able to start looking at systems that before were simply considered too difficult—basically non-linear systems or systems that were constantly changing. The fact that scientists even think about applying their ideas to the economy is an indication that they are prepared to get to grips with systems that are phenomenally more complex than we've looked at before. But there is a history to that as well. It is often said that chaos theory begins with Henri Poincaré at the beginning of the 20th century. In fact Newton figured out that the problem of figuring out how three bodies move under their mutual influence is one he couldn't solve. He recognised that was a problem of another order and basically left it alone. And the question of fluid-flow, which is another of these extremely complex problems has been one that scientists have left alone.

So I think there are always going to be precursors in the past. I think it's fair to say that there's a new emphasis in the sense that the scope of physical theory has expanded in terms of the sorts of questions that people will look at. And in the sense that there is more integration between them. You have physicists looking at biological problems.

MM: Charles?

CJ: I don't mean to suggest that science is coming to an end or ever will. Never. And there will be an endless stream of new theories. What I was saying is the paradigms of modern science have a worldview, and the paradigms of complexity have a different worldview philosophically. And they hang together in different ways—that's why I say one sublates the other.

Let me first say you are of course right about Poincaré, and Newton and the three-bodied problem. That's true, but these were repressed. Not in a violent way, but just not thought to be terribly important. Now if you look at the rediscovery of fractals—four times since Poincaré—and how they were suppressed. In fact the words, to put them down as Mandelbrot shows were moral aesthetic terms of opprobrium: they were considered to be 'monstrous', 'nasty', 'brutal', 'dirty', 'irrational', 'horrific'. That's applied to fractals—just new mathematics.

Okay, so the worldview mindset that can accept fractals didn't accept them for 70-100 years. The same is true of the chaos sciences in general. The same is true of plate tectonics. The theory of how cells die was discovered five or six times and also repressed because they thought it was anti-life. We now know that programmed cell-death is the most important thing for fighting cancer and keeping us alive.

Anyway, what I'm trying to get at is that there are a whole series of new sciences of complexity. Whitehead, Blake and the Romantics understood that the mechanistic worldview of Newton wasn't right. And the mechanistic worldview dominated. It was real worldview and it defined what was positive and measurable science, and a science of determinism. It was more or less deterministic science although there were probabilistic elements in it. And it gave us a picture of the universe that helped us discover planetary motion and a whole slew of things. But it seems to me the Santa Fe Institute is right to say the new sciences of complexity are the sciences of the 21st century. They are more generic sciences of how the universe works.

When you ask these scientists 'how much of the universe is fractal?' They say 'most'. Well how much is most? Is the 65.3% or 95.8%? I've been talking to them and asking these questions, because some of nature is best conceived, like planetary travel, through Newtonian mechanistic thinking. When I get in an aeroplane I'm hoping it works according to Newtonian physics! And buildings, by the way, are mostly Newtonian-like things. They're not the very small, and they're not the very large.

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Clearly the universe is more than describable by the new science of complexity. But what I'm saying is the New Paradigm **sublates**, in an important way, the Newtonian mechanistic paradigm, which I showed briefly in that picture—leading up to behaviourism. For instance Adam Smith said he wanted to be the Newton of economics, Darwin said he wanted to be the Newton of biology, Karl Marx said he wanted to be the Newton of dialectical materialism, BF Skinner said he wanted to be the Newton of stimulus response theory. All of these are modern sciences coming from the paradigm of the Newtonian atomism. I'm saying that is still alive and well. If you're over sixty you're bound to be in it. If you're under thirty you're bound to be in the other. In any case there is a broad shift, and this new worldview, paradigm, I think, is extremely positive because it is showing the universe to be self-organising. Now who knows if that's the final word—I'm not saying, but I think it is a new paradigm

MM: Can we have a question from the audience?

Questioner: Listening to Charles talking about 'paradigm shifts' -- and I sometimes wish Thomas Kuhn hadn't introduced us to this word that gets used quite a lot --- it's really interesting to hear the story of how fractals were considered ugly and are now considered beautiful. And I think this links to the whole question of taste and consensus we've been talking about. How is it possible that we used to think fat women were beautiful? And we used to think fractals were ugly? Scientific taste is as unreliable as aesthetic taste, and we therefore need to be suspicious of a methodology that rests either on aesthetic or on scientific taste. I'd like to bring us back to consensus and the problems of consensus.

MM: That relates to the point made earlier about beauty. Charles said beauty was something that was very mutable and tends to be an average—particularly in facial beauty—the average of all faces is considered to be most beautiful—

CJ: I was saying that was what the evolutionary psychologists like E.O. Wilson were saying—not me. I think beauty is a compound, radically compound, mixture of content and form if you like. So I wouldn't subscribe to the theory I mentioned.

MM: So you would say there is some quality of beauty that is structural, as opposed to a narrative or something that is entirely constructed?

CJ: No. I think when we perceive 'wholes', which I think aesthetic perception and our daily life perception is involved with all the time, we perceive narrative, plot, characterisation at the same as time we perceive form and all the aesthetic codes. I think the perception of beauty is a 'holistic' perception in which the story is as important a part of the beauty as anything the form is doing. The only difference is in a more purely aesthetic mode you are attending to the aesthetic plane of expression particularly. So it foregrounds the aesthetic language; in that sense the perception of beauty tends to be skewed towards a reductive experience.

But what is so fascinating about beauty, for me, and as a critique of this 'average beauty', is that if you look at any real woman and find her beautiful, you find her beautiful in action. Her character and what she is saying and being is as important to your perception of her beauty as anything aesthetic. It's true, you attend to the aesthetic dimension, but you experience her as a whole. I know that what I've just said is true of most people. And only when you show people photographs of still faces that aren't talking do you get these Vogue polls of averaged faces.

MM: Brian?

B Hanson: I was wondering about the question. When you talk about taste in science, do you distinguish between the socially determined kind of science and the more objective side of science?

Questioner: I don't know how to distinguish that. If science used to regard fractals as ugly and now finds them beautiful, then in order to explain that I've got to have some kind of historical account of science that describes science as social process. I don't know what science is. If I take all the history and sociology out of science, there's nothing left.

MM: Aren't you also talking about a very crude reductive form of fractal? That's part of what's happening in science: it's becoming more sophisticated in understanding these things.

Questioner: Maybe I could give another example, which is the sort of bureaucratic aesthetic, which is perhaps behind a lot of ugly buildings. Of course we might think them ugly, but there is some kind of aesthetic built into regulations and bureaucratic procedures that generates these buildings. So there is an aesthetic embedded in our bureaucratic culture, which is one of the things we need to address. Again, there are tastes that have a generative effect.

B Hanson: I think Phil would agree, there is clearly a culturally or socially determined aspect to science. There is a kind of agreement among peers of what is important at any particular time, but to call that taste… distorts?

PB: There are fashions in science—that's undeniable. I might be wrong in this, Charles, but I had the impression that the horror with which fractals were greeted was partly because people thought they would be so difficult to handle mathematically. It wasn't that they were necessarily having an aesthetic response. They just thought 'oh, my god, how are we going to develop a mathematics for that?'

CJ: Yes, there was that problem. As Lenin said: 'scientists only work on the things they hope they can solve.' Yes, taste and fashion of course exist. Eight years ago I read a back-page editorial of 'Scientific American' by a retired professor emeritus, an astrophysicist who said:
"It isn't possible to go anywhere today in the new cosmology if you don't subscribe to the big bang theory. You won't get tenure. You can't write papers. You can't even study. You can't even object."
He's talking about more than fashion, he's talking about the way in which it is only possible to think in a certain way at certain times. Science is much more varied and dynamic than I am suggesting by this, but it has more than taste and regulation going on. Because it's so hard to have these big experiments, because big science donates university money, you can't afford to have crazy theories, or even dissenting theories that don't look as if they are going to go

anywhere. So science imposes its own form of Stalinism, as Arthur Koestler continually pointed out, on itself.
There is no easy way out of this. It has to have these thought patterns. It has to work with traditions. You can only solve certain problems at certain times. But architecture isn't that way. I think in architecture there is much more possible in our plural cultures, and certainly in our house cultures.
One of the things we haven't said, and I think should be thought about just for a second: architects design one percent of the buildings around the world. They design (because of the RIBA) more here than any other culture in the world, but they still design less than 20%. Architects are really a marginal profession with a terrific power and impotence. That's what Rem Koolhaas keeps saying. On the one hand they go into situations where they have a lot of leverage, whereas on the other hand they don't design that much. In other words, most of the environment is built by quantity surveyors and civil engineers.

Questioner: I think the interesting thing about sustainability is, it is true that architects don't design, but nearly all things designed in the 20th century were following architects' models. It was architects who started the air-conditioned glass box, sitting in a sea of asphalt. Almost everything horrendous, although it wasn't built by architects, is following architects' models. So although we don't build so much, we must take the blame. And I find this an awful cop-out: 'we build so little, it's simply out of our power'. It's simply not true if you look at what was done.

MM: Certainly it's a fair statement that architecture has got away from the aspirations of the Usonian house of Wright, or the bungalow of Stickley or any of those things where architects were leading the building culture. It seems to be a fairly remote enterprise. Anyway, Bill?

B Hillier: I just wanted to say something to break the consensus about science. I think Charles is exaggerating: science is not Stalinist. Everyone knows there are paradigms, but within them there are 'research programmes'—different ways of approaching the same kind of phenomenon. They are very competitive with each other, and if one particular group gains power then they tend to keep the other out for a bit. But this is a sociology of *scientists*, not of science itself. One of the best cases I can think of this is, when Newton first published his theory, it was widely rejected as being not 'holistic' enough. If you look at what Leibniz wrote, he said 'this is a mathematics, but it is not a physics'.
This was because there was no conceivable mechanism by which what Newton describes could be happening. The reason for this is, Newton's theory at that stage depended on action at a distance, and that seemed to belong to the world of the occult. And the word 'occult' was actually used by Leibniz to describe Newton's theories. I think when we talk about mechanism we shouldn't forget that.
The Newtonian theory at the time seemed to be a very abstract set of mathematical propositions about the universe, almost devoid of physical context, but could nevertheless be used to understand a huge range of things about how the world works. I think this is how it happens: the sociology is in scientists, it is far less in science, because there is an evolution of knowledge. There are competing ideas, and different research programmes, some advancing and some going backwards. But it does produce something that is discernibly a shift towards something through which we understand things better. It's not a truth. Science doesn't have the concept of truth anymore—all theories are refutable. It does mean we can get a deeper, more generalised understanding of a greater range of things than we have before.

I don't think we should throw this idea around that science is just a bunch of square heads, and it's run by a Stalinist consensus. I think it's much more flexible and immensely creative. And some of the things Philip has been talking about -- the ways in which physicists have begun to interfere in all sorts of other areas.

CJ: I didn't mean to suggest it was. I just mentioned one example where you couldn't have a theory. I accept what you have just said about research programmes, but there are conventions and fashions that become strangulating for whole fields. You can find behaviourism getting wrapped up in them—from Watson to BF Skinner—that was an orthodoxy. I agree that sociology and knowledge have to look at why this orthodoxy lasted until Chomsky's attack in 1957. But the fact was, there was an orthodoxy.

I was at Harvard when Skinner was teaching the pigeons to play ping-pong with each other on the 20th floor of that horrible Yamasaki Building. So orthodoxies exist; orthodoxies are cruel.

MM: Maybe that's also a question of the top-down and bottom-up working together, because sometimes new theories, new creative ideas, can emerge from an orthodoxy. We have time for one more question.

Questioner: Of all the examples I've been listening to in this session: Galileo to Einstein can be explained by Lenin. Lenin had a theory of uneven development based on Marxist analysis of Greek society. I think we can actually apply that to the scientific community as well. Not everything follows at the same speed, and corresponds with each other. There is always unevenness: in the scientific community the paradigms, the methods, the discoveries, the technology, etc. So there is uneven development of science. And I think all the examples you have been discussing now, subscribe to that.

PB: Can I just say something on an optimistic note? I think that when these orthodoxies do develop and there are sudden shifts in them. And what I think drives this is not on the whole some brave scientist trying to get his ideas heard and then finally they are—it's the world. The fact that we discover something that doesn't fit at all. The fact we discover the universe is accelerating and we've got to completely revise the cosmology. And in fact at this moment in time you can get away with lots of very speculative cosmological theories—too many, yes. But it's a wonderful time.

The same happened with quantum theory. It wasn't anyone's idea. The world forced it upon us. That's the exciting thing about science—that there's no alternative but to let that happen.

MM: So there is a structure out there we have to account for - it's not just a narrative!

Okay, thank you all very much.