

Codes and the Architecture of Life

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I want to give you a report on some recent ideas in urban coding that we have begun to explore with the pioneering architect Christopher Alexander, and with the UK government and others. But before I do, I want to give you some of the theoretical backdrop for this work, and why we think it's such an important and promising area for exploration.

By way of a setup let me share a very interesting quote from Rem Koolhaas, who was to have spoken here this evening. He says:

Modernism's alchemistic promise – to transform quantity into quality through abstraction and repetition – has been a failure, a hoax: magic that didn't work. Its ideas, aesthetics, strategies are finished. Together, all attempts to make a new beginning have only discredited the idea of a new beginning. A collective shame in the wake of this fiasco has left a massive crater in our understanding of modernity and modernization.

□□□□□□ □□□□□□ - Rem Koolhaas, *Whatever Happened to Urbanism* (in *S,M,L,XL*)

I would certainly agree that there is today a massive crater in our understanding of modernity – that we are mired in a mechanical understanding of nature that still largely guides our acts of planning and building. But the fascinating and hopeful thing for us is that the most recent science shows us a path out of that crater – a path that holds intriguing and exciting possibilities. And that's the idea that I want to develop with you today.

This is the revolutionary new scientific understanding of the structure of nature, and in particular of living systems – the science of organised complexity, networks, fractals, so-called “**strange attractors**

.” And it is the science of the behaviour of small, rule-based iterations, or algorithms – cellular automata and the like, and the so-called “

emergent

” patterns that they create.

Perhaps the most familiar such system is of course the DNA code of life itself, made from just four molecules – but through an adaptive morphogenetic process acting over time, it produces the astonishingly varied patterns and intricate wonders of life itself.

These insights form the basis of what the architectural theorist and designer Charles Jencks has called the “**new paradigm**” in architecture, and rightly so, although I think even he doesn’t grasp the real revolutionary implications of it. In fact I suggest to you that we’ve only scratched the surface.

There are many people who believe – and I am one of them – that this new science, this new understanding of the structure and the organisation of things, may in time revolutionise everything, just as the old science did previously – markets, institutions, the very structure of civilisation itself. Indeed I would argue that it has already begun to do so. And it holds out the promise of deeper understanding and reform of the horrific mistakes of the early industrial period. These are mistakes that it looks increasingly like we had better reverse, and soon, or else we are all in a great deal of trouble. So this is not just an academic discussion.

I recently had a fascinating conversation with Charles Jencks about this subject. He had just completed a very interesting presentation on the exuberantly sculptural new architecture and what he called its “enigmatic signifiers.” That is no doubt a very fascinating realm of connected ideas to explore in art.

But it is precisely that – a realm of *ideas*, not the realm of nature and of connected natural structure *in itself*. That is, this architecture is *about* complexity, but not necessarily manifesting emergent *properties* of complexity. For example, Jencks' own fascinating landscapes of strange attractors aren't *really* strange attractors, but forms based on scientific *diagrams* of strange attractors. It is as though we were to create houses made of *blueprints* of remarkable buildings rather than making the kinds of buildings that the blueprints described.

This is an interesting and perhaps quite lovely artistic idea, to be sure – but it is not the thing about which the idea was generated. It is a form of art that is of course quite far abstracted from life. Hold that thought.

Now make no mistake, the celebration of ideas -- the adventure of ideas -- is a profound and worthy goal of architecture, and of all the arts. This is exhilarating stuff. But architecture has to do something else of course, unique among the arts: it has to serve as *the place where we live*. It has to serve as the connective fabric of human life. And whatever ideas we may signify and celebrate in our architecture, nonetheless we must somehow account for the fact that it will shape our use of resources, and our patterns of interaction with each other, and the patterns of activity and change on the earth, in a way that no sculpture or painting or piece of music ever need do. It shapes and conditions the *emergent* structures of human behaviour – for better or for worse.

Now some people will say that we should stick to the realm of art and stop trying to change the world, because there's little we can do save free ourselves with the truth: after all, our understanding of nature is socially constructed. I would agree that our understanding of nature is always *conditioned* by social construction; and to the extent to which that social construction is done by a privileged elite, it is a perfectly valid function of art to explore this truth and perhaps to “deconstruct” it.

But the lessons of the new science are clear: whatever we think of it, the vast complex structure of nature is real enough. It may remain beyond our full comprehension, and our knowledge of it may indeed be forever dependent on social construction. But that is not to say

that it is beyond our ability to intelligently interact, and learn to produce better or worse outcomes for human beings.

This, I would argue, is nothing other than the continuing phenomenon of emergent “collective intelligence” in the human species. It is the level at which our new understanding of nature begins to transform our understanding of the nature of human processes and human patterns – human culture, technology and art.

And it is on this level that things start to get very complex and very interesting indeed.

The question then becomes: what does the new science tell us about the complex structure of human life, in the form of settlement patterns, economic processes, social patterns, interaction with complex ecosystems, and sustainable development? What does it say about urban pattern, urban morphogenesis and architectural morphogenesis?

And what tools might there be to manipulate these complex phenomena to richer human ends, in art and in life? Can we learn something from genetic coding, for example, about the astounding variety and the robust success of life? Can we devise codes based upon similar morphogenetic principles?

You can perhaps begin to see where I am going with this.

Now the passage I quoted earlier was from Rem Koolhaas’ famous paper, *Whatever Happened to Urbanism?* And that is a question that is on many people’s minds right now. Charles Jencks confessed his concern about what he called the “basket of icons” that seems to be dominating architectural practice today, in place of coherent urbanism. There is a near-exclusive focus upon the radical creativity in each building act, and yet no means to produce a larger connective system that is more than the sum of its parts. We’re still in the crater.

George Ferguson, president of the Royal Institute of British Architects, has expressed this same concern about what he calls “iconitis.” After all, the vast majority of so-called “background” buildings are simply not that good, and the civic spaces around them are often quite horrible.

That's not a sustainable state of affairs. So he wants a new emphasis on coherent urbanism, and new tools and practices to address it. I am pleased to report that we are working with the RIBA on this, and George will be speaking on coding at the Foundation next week.

Now the "new science" of organised complexity has already begun to be applied to urbanism. You may recall that as far back as the early 1960's, seminal thinkers like the American Jane Jacobs already recognised the powerful implications of complexity science in challenging the then-existing basis of architecture and planning, the rigid modernism that Rem has challenged, and arguing a persuasive case for reform.

The last chapter of Jacobs' "The Death and Life of Great American Cities" is a classic and definitive piece on the subject called "the kind of problem a city is." In it she talks very lucidly about the history of scientific thought and the way it has shaped human action, and in particular the way it has shaped how we think about and act upon cities.

She describes how modern science really took off, around the time of Newton, when it mastered so-called two-variable problems, like linking how many houses you have over here to how many stores you can have over there. Or in physics, the laws of motion, for example, are two-variable problems.

But in the early twentieth century, something interesting had begun to happen: through statistics and probability we learned to manage very large numbers, where you had myriad variables interacting. The interesting thing that we found was that you could manage those phenomena as statistical averages without knowing much about the actual interactions.

This statistical science translated into the phenomenal technological power of the industrial revolution of that period. Much of our industry and the prodigious output of 20th century modernity was rooted in these powerful new statistical methods. And indeed, Jacobs points out that the early ideas of Le Corbusier and others, and the later ideas of planners -- often to this day -- rely upon this notion of large statistical populations.

So just as there has been a progression in science, there has been a progression from, say, the rigidly formal, "rational" plans of, say, Haussmann, or of Ebenezer Howard and his neatly segregated Garden City plans, through to the more statistically informed plans of Le Corbusier,

implemented around the world by the likes of Robert Moses and others.

In either case the problem of cities was seen as one of devising reductive engineering schemes, seeking to isolate smoothly-functioning mechanical parts in place of “messy” organic conditions. This was seen as advancement and modernisation. But in the former case it was two-variable engineering, and in the latter case the problem of cities was also seen as one of statistical mechanics operating on large numbers. The newer science was added to the old.

Meanwhile, the biological sciences had reached a dead end with the statistical science of so-called “disorganised complexity” and had to come to terms with the emergent phenomenon called “organised complexity” – the area in the middle, between simple two-variable problems and vast numbers of variables. Biologically speaking, that’s where the phenomenon of life occurs.

It was clear even then that the problems of the human environment were in many respects emergent problems of “organised complexity”. But Jacobs pointed out how the planning and architecture professions were still at that time, 1962, mind you, mired in the old scientific world-view. She says:

Today's plans show little if any perceptible progress in comparison with plans devised a generation ago. In transportation, either regional or local, nothing is offered which was not already offered and popularized in 1938 in the General Motors diorama at the New York World's Fair, and before that by Le Corbusier. In some respects, there is outright retrogression....

So Rem’s “crater of modernity” has been around for a while...

Now Jacobs’ ideas for planning reform have gained wide currency if not yet very deep implementation. The so-called New Urbanism movement in the US certainly seeks to implement these insights. But even here these ideas on *process* have not yet been fully taken up, particularly at the scale of individual buildings. The conditions can be too rigid, or the designers resort to a literal copying of historical precedent and historical style, and the result is still a rather lifeless human place.

In other cases the architecture can be a dazzling sculptural idea that only exists in a narrow conceptual range of expression, and does not function as a complex connective structure in the larger system. It is rather a severed object inserted into a foreign ecosystem. As we've noted, this is true even for the sculptural objects that *signify*, but do not yet *embody*, insights of the new science.

Often the problem with these object-buildings is most severe at finer scales, such as the crucial pedestrian experience, where the detailing drops away in a mess of ugly concrete or poorly-weathering blank surfaces. Or there is a severe failure at the level of the emergent urban pattern, which is nothing but left-over space or "SLOAP" – space left over after planning.

Of course dumb economic processes leave us the same mess, or worse. One has only to look at the horrible sprawling suburbs and treacly traditional "McMansions" to see this problem. There may be an emergent pattern in these complex processes, but it is nothing we want as human beings. It is rather a Frankensteinian version of Le Corbusier's Radiant City, a mechanical plan based on the "old science" but metastasised in the new global economic reality into a pervasive and unwelcome form.

So what are the newest insights from the new science, both about the *structure* of complex human settlements, and about the *process* of their morphogenesis? What about the cultural processes, the economic and technocratic processes that we are going to have to account for?

It turns out that the new science tells us a great deal indeed. And like a biological problem, in which a living whole cannot be treated as a mere collection of parts, we find that the problems of the built environment are interconnected, complex and emergent.

But saying that the built environment is not merely a collection of parts is not to say that it cannot be acted upon. It is just that the actions will not be the usual manipulations of objects from the old paradigm.

Now we know that we can code or zone in a top-down way. For example, we can say that offices go here, residences go there and so on. But can we write a bottom-up code – a code that delivers the emergent complexity of nature? And can we do it in a way that produces a livelier, more desirable outcome? I think the new complexity science suggests that we can, and begins to show us how.

While nature is vastly complex, it turns out that many of its processes are surprisingly simple. But in their operation, the interaction of sheer vast numbers creates patterns and ripples of astonishing, mind-numbing complexity. Yet the emergent structure still has great coherence, because it is adaptive over time. And often that simple process functions as a kind of code.

For example, life itself arises from a code, as we said earlier: the genetic sequence of only four molecules that comprises the genome. The incredible variety and beauty of life is coded, in what is at its heart a remarkably simple way. As we study it and begin to tease apart its secrets, we have found to our surprise that even the entire genome is simpler than we had expected -- that much of the complexity of the organism emerges in the *process* of stepwise differentiation of tissues.

So to repeat, the individual steps can be quite simple, but the emergent pattern is often vastly complex. And the complexity of that pattern emerges over time, in a *process*. It cannot arise from a single structural blueprint, or a single act, or a single conception. This is a crucial point.

Another important trait of the code of life is that it's collective. That is, DNA that has become well-adapted in a previous environment is imported and combined, often through a sexual process. Then it is expressed in a morphogenetic process, and then adapted and selected out by the environment. In this way, a bottom-up process -- the emergent results of a somewhat random combination of genetic material -- is combined with a top-down process, the selection pressures of the environment, and collected and stored in new genetic material. So this "collective intelligence" is another important point about the processes of nature.

Of course we humans use codes too, and we store our collective intelligence in them just as nature does. Codes for the built environment have been around for a very long time, of course – both literal building codes, and also the larger economic and political rule-based processes. They are very much like the algorithms of cellular automata, in which many actors take many adaptive steps in relation to one another.

But what is interesting about the last several hundred years is that as our technology has gotten more complex, the regimes with which we have ordered our built environment have paradoxically gotten radically simpler and more weighted toward the top-down side of things. And as a result the morphologies of these structures have also gotten much more rigid and less adaptive – with woefully unsuccessful and even disastrous results.

Meanwhile, a number of reform movements have arisen to develop better codes and better algorithms, to improve the liveability and the sustainability of the built environment. I mentioned the New Urbanism movement, which does explicitly use collective intelligence in the form of stakeholder collaboration in the design process, the charrette – and often the result of that charrette is a form-based code.

One of the most recent and influential of these is a generation of codes based upon the notion of a “transect” spanning between the most intensive human uses and the most pristine wilderness. □ **Andres Duany** has been working on this, and we are collaborating with him on several aspects of this work. In fact he will be at the Foundation next week, teaching a Master Class on this subject.

The work of **Christopher Alexander** is more explicitly dynamic, and builds upon his earlier pioneering work in the complexity of morphogenesis and computer synthesis of design, influenced by, and perhaps influencing, the pioneer of complexity **Herbert Simon** and others.

Now Alexander has gotten into some fascinating areas of metaphysics – and speaking as a philosopher, I find him in very good company with Whitehead, Bergson and a number of others – but some people lose sight of the fact that his scientific approach to architecture has never left him. And in fact his work on pattern languages has been taken up as a major new initiative in computer science.

Alexander simply wants to know how nature achieves the kind of order that we see everywhere around us. His book *The Nature of Order* is a magnum opus inquiring into that question, and he comes up with three remarkable answers.

One is the familiar lesson from biology: that nature does not invent from whole cloth, but adapts and transforms from existing conditions, in a series of step-wise transformations. He calls these “structure-preserving transformations.”

Second, it is of the essence that these transformations are not re-arrangements of a collection of parts, but rather, transformations of wholes. That is, one cannot abstract the parts from the context without losing the essential connective structure of the entire system. Trying to do so is like clutching at a piece of jelly: everything slips through one’s fingers.

And yet there are ways to better understand the structure of these wholes, and indeed to engage and manipulate them, in a new generation of dynamic codes. Alexander the mathematician uses detailed mathematical formulas to describe this.

The third conclusion is a much more radical idea, although it will be familiar to more advanced students of complexity science: that these structures are a class of actual emergent life. This is a kind of life that is connected to us as human beings in the way that, say, an ecosystem is a living extension of an organism. We can also recognise it as connected to ourselves *a priori*, intuitively, and not in any abstract way. For Alexander, our own perception of value and meaning as living creatures is identifiable in these structures, and can no longer be excluded.

This is not unfamiliar territory for the new science, as it finds itself going into deep questions about life and consciousness in fields like neuroscience, cognitive psychology and others. It seems we are at the point where progress is only possible if we address the metaphysical aspects of experience. And the answers are rather surprising, and powerful.

It follows from Alexander’s structural observations that we can construct processes that amplify the life in these structures in the built environment. We can develop adaptive, iterative, rule-based algorithms to do this, very much as nature does.

This offers us the basis for a new generation of so-called “dynamic” codes.

We have been working with Alexander on several projects employing these kinds of dynamic coding processes in ecologically sensitive settings, including two large communities in Oregon. The early results are very intriguing and encouraging. We are also working now on an initiative to develop a pilot project for such a coding scheme in the UK. There are enormous practical issues to be worked out, of course – what Alexander calls “massive process difficulties.”

But there is also what I regard as a very robust and well-informed theoretical approach to these problems, and the solutions are evident but they will take time to implement. The intriguing thing is the way in which such a dynamic code can in principle be inserted into the existing technocracy, rather like a virus inserting its DNA into an existing cell.

So what are the characteristics of such a code? Let me give you the outlines, and then I'd encourage those of you interested to stay in touch on this work:

1.

The code specifies a step-wise, generative process.

2.

It specifies that in that process, human beings will take certain rule-based actions, in combination with evaluations based upon feeling, and in adaptation to what has come before.

3.

At each step, it acts upon the then-existing condition *as a whole*.

4.

At each step, it identifies the weakest parts of the structure and acts to improve and amplify them.

5.

At each step, it may apply previously-coded solutions and patterns, *and adapt them to the novel conditions*.

6.

At each step, it differentiates the space according to a scheme of “centres.”

7.

The centres are differentiated via 15 “structure-preserving transformations” (see below).

8.

Infrastructure follows. □ As with the morphogenesis of organisms, where the tissues come first, and the veins and ducts follow, the human patterns and human spaces come first, and then roads, sewers and the like follow – not the reverse.

9.

Similarly, *visual expression follows.* □ The human patterns and spaces come first, and then the visual ideas and “signifiers” follow – not the reverse. Otherwise we are simply making people live in disconnected sculptures.

10.

At the end of each cycle, the result is evaluated and the cycle is repeated.

The 15 “structure-preserving transformations” are based on 15 properties that Alexander has identified in natural morphologies. They are properties that have very much to do with what we might call the “architecture of complexity”, the structure of centres and fields within a system of wholes. Again, recall that Alexander was one of the early pioneers of complexity theory back in the late 1950’s and 1960’s, and this is very much an extension of that work.

I will simply display these very briefly here, and I encourage you to learn more in this remarkable book. And note that although some of these names may sound rather mystical, do not be fooled: they are in fact grounded in the most specific structural theories -- as you might expect from a Cambridge-educated mathematician.

1.

Levels of scale.

2.

Strong centers.

3.

Boundaries.

4.

Alternating Repetition.

5.

Positive Space.

6.

Good shape.

7.

Local Symmetries.

8.

Deep Interlock and Ambiguity.

9.

Contrast.

10.

Gradients.

11.

Roughness.

12.

Echoes.

13.

The Void.

14.

Simplicity and inner calm.

15.

Not-separateness.

The important observation is that these properties are seen over and over again throughout nature, and throughout the cultures of human beings across time – but they are conspicuously missing from our own technological age.

Why is this? I suggest to you that this is because we are still in the infancy of our technological age, and captivated by a particular class of elementary technological morphology. The danger is that this morphology is still tied to a destructive and unsustainable *morphogenesis* – the force of the old modernity, that “crater” that Rem spoke of. It threatens to destroy the richness and even the sustainability of nature, and the collective intelligence of human traditional culture, turning everything into a simulacrum of culture. Even the architectural arts become little more than “product styling” within a sea of junkspace.

But I suggest to you that just as the old modernity was profoundly shaped by the old mechanical science, the new sciences imply the dawn of a New Modernity that we're only just beginning to understand. And in that there is the stunning theoretical possibility of a new synthesis of science and architecture and, in time, an organic fusion between technology and human culture. Instead of the old paradigm of object-manipulation and mechanical replication, we will learn the powerful morphogenetic processes of life. We will learn to make our own "seeds" to produce astonishing richness, variety and quality, with the adaptive morphologies and the ecological coherence of natural systems.

So let me leave you with the suggestion that before us lies the next great modern advancement. This is the revolutionary promise of the new science: the path out of that old "**crater of modernity** ." It does indeed offer us a New Paradigm: a more humane, more advanced "New Modernity".

http://www.kataraxis3.com/Mehaffy_Codes.htm