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The Radical Technology of Christopher Alexander

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Chances are, you have heard of Christopher Alexander because of his most famous book on architecture, A Pattern Language. What you may not know is that Alexander's work has spawned a remarkable revolution in technology, producing a set of innovations ranging from Wikipedia to The Sims. If you have an iPhone, you may be surprised to know that you have Alexander's technology in your pocket. The software that runs the apps is built on a pattern language programming system. How did an architect come to have such influence in the world of software — and as it turns out, a lot of other fields? (To name a few: biology, ecology, organization theory, business management, and manufacturing.) It's a fascinating story — and it might just have something to say about the state of architecture today, and where it might be headed.

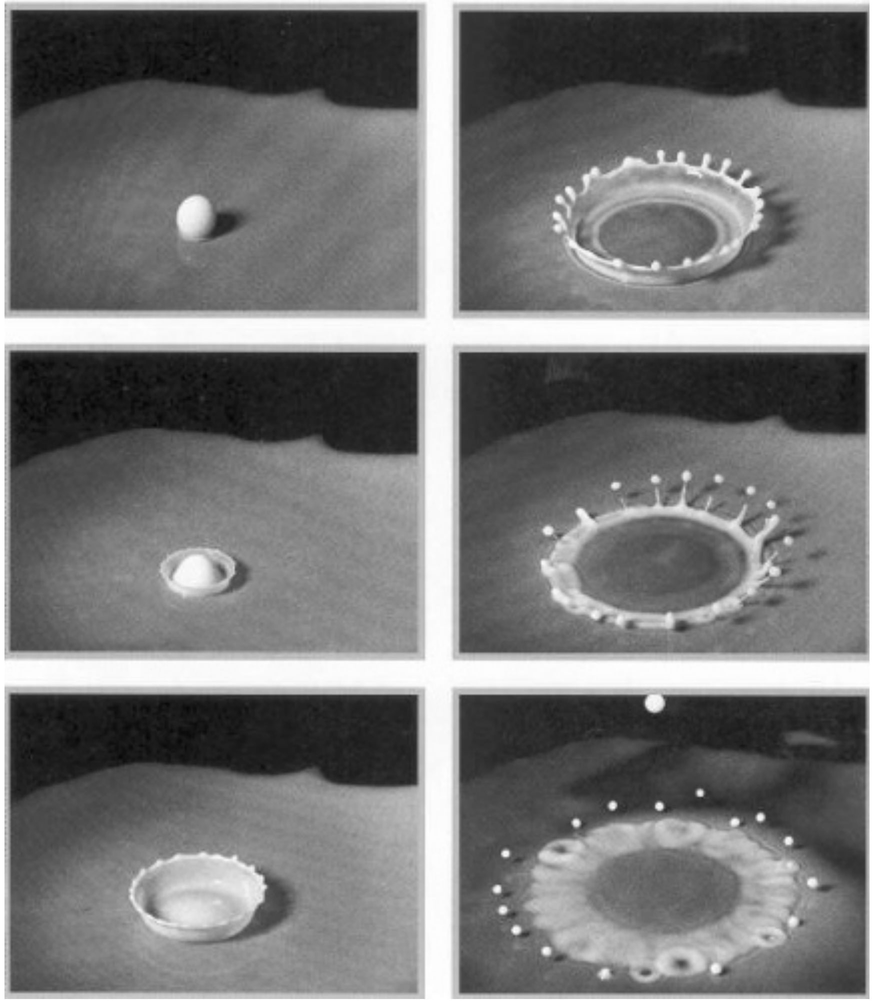
Among architects, Alexander is often thought of as a kind of trendy architectural mystic. But in fact his career spans half a century, with work that is almost universally acknowledged as landmark theory on fundamental topics of design and technology. His first book, Notes on the Synthesis of Form, was widely hailed at the time; a typical review by *Industrial Design* magazine described it as “one of the most important contemporary books about the art of design, what it is, and how to go about it.” And from the very beginning, Alexander's work has always been concerned with the fundamental processes of technological creation.

Alexander, the mathematician, was always concerned with the processes by which parts transform into wholes. He wants to know how we are implementing this part-whole synthesis; how nature does it; and especially, where we, in our own human version, might be getting it wrong. This core interest was what occupied his work documented in Notes on the Synthesis of Form. As it happens, an earlier generation of computer programmers, organization theorists, design theorists and many others, were struggling then to figure out how to generate and manage the large new design structures of that era — computer software being one prominent example. Alexander gave them some very helpful conceptual tools to do that. In essence, the tools were patterns: not things, but relations of things, which could be identified and re-combined and re-used, in a language-like way. (We will have more to say about this kind of relational technology in an upcoming post.) But this was more than a useful innovation. That first book — and the classic paper "A City is Not A Tree," and really every work by Alexander since — amounted to a kind of technological critique, revolving around the observation that we're doing something wrong in the way we make things. We're substituting an oversimplified model of structure-making — one more closely related to our peculiar hierarchically limited way of conceiving abstract relationships — in place of the kinds of transformations that actually occur regularly in the universe, and in biological systems especially.

Ours is a much more limited, fragmentary form of this larger kind of transformation. The result of this problem is nothing less than a slow unfolding technological disaster. We know it as the sustainability crisis. That's where this discussion touches on what's happening today — economically, ecologically, and culturally. Growing numbers of people do recognize that we have to get our houses in order. But whose house, to what extent, and in what way? That's the big question of the day. What Alexander argues is that we have to make some very fundamental reforms — not only in our specific technologies, but in our very way of thinking about technology.

We have been isolating things, as mechanical sub-entities, and manipulating them. That works quite well, but only up to a point. As any systems theorist or ecologist will tell you, the context, not the thing, is the key. So it seems that we have ignored an incredibly important aspect of natural systems — namely, the fact that every structure is embedded in a larger structural context, and ultimately, in the entire structure of the cosmos itself. What Alexander offered was not just the recognition of this truth, but the basis of a new technology that could incorporate it. Why does this matter? Because the structure around the thing we made can come back to bite us, with unintended consequences. This is the classic form of technological failure. We can make an antibody, and then find that later new pathogens have mutated to resist it. We can make an automobile that solves our transportation problems, and then find out later that we have also engendered traffic jams, strip highways full of gas stations, and even climate change.

This is why, in biological systems, there is more than a single linear reaction to each of the series of challenges that face an organism. There exists a kind of whole-systems optimization, a way of sorting through many contextual variables and finding a solution that not only satisfies any single condition, but is likely to be perfect in balancing and coordinating a great many conditions. (That's how organisms achieve resilience — but that's another long story!) Nowhere is this more evident than the way that organisms generate form — what biologists call “morphogenesis”. The form is not a mere collection of parts that are stamped out and gathered into a composition; rather, it emerges from a continuous transformation of elements, in an unfolding process that follows something called “symmetry-breaking.” That means that the original symmetrical form (say, a round egg) gets broken down the middle, and a new symmetry forms — the beginning of a tube, say.



Harold Edgerton's famous 1937 photograph of a milk drop transforming through symmetry-breaking, and articulating remarkably well-ordered new structures. A very similar process occurs in the morphogenesis of living structures.

Alexander noted that in this process, there is usually a step-wise sequence that re-uses and articulates what came before, and that differentiates it into more articulated parts. The egg cell starts as one whole… then it divides, and makes more wholes with a differentiated order. And in complex processes like embryogenesis, this form-generation continues through more stages, until, through the power of compounding, the result is fantastically complex and ordered. A useful analogue to visualize this is in the way that Origami folds start out as simple, and very quickly become very complex and remarkably delightful, often gaining some of the aesthetic qualities of a living form. That's not entirely an accident: the process of embryogenesis, we now know, follows a similar origami-like process. Like a recipe, it uses a coded process to govern the steps — and then it reacts to its own previous steps, and modifies the result. Like a good cook, it “tastes the soup” — it adapts the following steps to the results of the previous ones, to create a much richer and more complex result. In the case of a real recipe, the result is something that has a rich complex flavor.

Adaptive design — a pre-requisite of evolutionary success — is highly dependent upon initial conditions, existing structures, surroundings, and human needs, just as it's dependent on similar factors in natural systems. The same adaptive design algorithm will result in drastically different end products according to the larger-scale influences and conditions on the ground. Design is adaptive only when it is done in steps, and each step accepts feedback from the existing structure. In fact, an isolated (self-contained) design method can never be adaptive. This has important implications for the future direction of sustainable design. In natural systems, even though this system-generating “technology” is largely self-organizing, it works extraordinarily well — it's resilient, it's functional, it does all kinds of amazing things. We need to learn much more about this kind of generative process and how we might exploit it within our own technologies, which are still embarrassingly crude and primitive by comparison. (For all the sophistication of a 747 aircraft, it's nothing next to the complexity and agility of an eagle.)

The transformation of patterns in morphogenesis creates high adaptivity and great beauty. This process is fundamentally different from the processes of mechanical design — with important consequences for sustainability, as we are beginning to learn.

Photo: Michael Mehaffy

This is the key to an important realization about natural systems and how they generate form — one that, as Alexander has long noted, is distinct from how we humans typically generate form. And this is not a mere philosophical matter of humans being different from nature, or “having culture.” It's a question of how we humans can also have a technology that is actually more complex, resilient, and sustainable — quite literally, more life-like.

Ultimately what is at stake is how we are going to survive, within nature, and as elements of nature. Ultimately we cannot stand apart, without destroying ourselves. In a sense, says Alexander, we are then “making life” — we are making the kind of living structure that is made through any other natural process. This is an exciting frontier for our technology of design — pointing the way to a world that has the sustainability of living systems. Among other things, this recognition means we must re-think the way we “make things” in a sustainable world. Rather than the usual method of creating stylized objects, stamped out in repetitive processes, we must learn to make structures that are mutually adapted and transformed, using resources that continue their transformations throughout the life cycle, and into recycling — the idea of “cradle to cradle.” Computer manufacturing processes (often using Alexander's technology) are beginning to show us how to do this. So are some surprisingly familiar techniques, coming from the old crafts-based processes.

And rather than stamping out disposable industrial products for a consumer culture, we need to create durable structures that are fitted to our lives, and that can be customized, repaired and adapted to our needs. They need to be thought about throughout their life cycle, as they interact with local conditions and local resource cycles. What about architecture and the built environment? Alexander's conclusions here are nothing short of iconoclastic. Most of the architecture we have been making since the 1920s — however visually appealing it might be to some people — uses technology in a highly incomplete and deeply flawed way, with serious consequences for the adaptivity of the human environment. Its various design stylings — modernist, postmodernist, deconstructivist, blobitecture, etc. — are really just varieties of elaborate decoration, masking an underlying kind of fragmented, objectified structure that is incompatible with evolved, sustainable form. They are visually exciting compositions — great art (perhaps?), or merely fashion — meant to help market what is at heart a series of commodified industrial objects.

However exciting and promising they may first appear, in the end they can only add to the growing disaster that is the human built environment. The radical transformation we need must include the system of industrial production of buildings. What kind of transformation is required? We think Alexander's work points the way to a new understanding, and a new kind of technology — and there is much more to explore. Like Alexander's work, our own work shows that living architectural and urban configurations are generated through interactive computations, creating a structural and temporal hierarchy on many distinct scales. There is an integrated relationship between the scale of the city, the scale of the neighborhood, the scale of the street, the scale of buildings, and the scale of fine details. The city is not a composition of objects, but a web of these evolving relationships. Fragmented, objectified and commodified architectural and urban geometry is thus itself part of the malaise of our unsustainable consumerist society, and must be challenged, along with other unsustainable aspects of our technocracy. For those of us who subscribe to this radical idea, the built environment is an inseparable part of the reform that must occur. Our world can never recover from its downward environmental and economic plunge, until it learns to implement these insights, which include a much more adaptive kind of geometry in the built environment.

The new model of affordable neighborhood transformation: An abandoned gas station is transformed into a neighborhood civic node through use of inexpensive food carts, planters and furniture, in Portland, Oregon's Alberta Arts District.

Photo: Michael Mehaffy

In future posts, we will dig into some of the specific ways that Alexander and his colleagues have been exploiting these insights — and the surprising benefits that have already come from them, and more that might still await.

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Nikos A. Salingaros *is a mathematician and polymath known for his work on urban theory, architectural theory, complexity theory, and design philosophy. He has been a close collaborator of the architect and computer software pioneer Christopher Alexander. Salingaros published substantive research on Algebras, Mathematical Physics, Electromagnetic Fields, and Thermonuclear Fusion before turning his attention to Architecture and Urbanism. He still is Professor of Mathematics at the University of Texas at San Antonio and is also on the Architecture faculties of universities in Italy, Mexico, and The Netherlands.*

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