Design Should Follow Human Biology and Psychology

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ABSTRACT

A built environment that promotes human health is adapted to user needs and non-obvious sensibilities. This paper brings together new design techniques that achieve this goal. Do post-war buildings and urban spaces give appropriate psychological responses for encouraging human life? How do structures adapt to our bodies, to the psychological spaces that groups and individuals crave, and to our complex range of movements? Do the hard places we build for our soft bodies work optimally for our senses? Scientific evidence from environmental psychology, evidence-based design, and post-occupancy evaluation suggests not. Industrial surroundings do not "belong" to us. The reason is because we — the current and future users — never contributed to creating them, and even if we find them terribly aggressive and hostile, we are often legally prohibited from modifying them. We can never "belong" to such spaces if their geometry and surfaces are contrary to what our sensory system seeks.

Keywords: biophilia, design patterns, architecture, urban design, complexity, neuroscience, environmental psychology, biological structure

INTRODUCTION

For much of the twentieth century, mainstream architects applied formal design criteria having to do with severe and simplistic forms. Practice focused primarily on the exclusive use of industrial materials such as plate glass curtain walls, reinforced concrete, etc. Those typologies and design approach have a totally distinct goal from adaptive tools such as Design Patterns, which seek human wellbeing and health through an accommodating geometry (Alexander, Ishikawa, Silverstein, Jacobson, Fiksdahl-King, & Angel, 1977; Leitner, 2015; Mehaffy & Salingaros, 2015; Salingaros, 2016; 2017a). Human-oriented design relies on useful interaction among the elements of architecture, therefore a building's image as a formal statement is never our top concern.

If we decide to build our environment as an extension of our own biology, then its design must obey geometrical rules for living structure. A group of us proposes using rules discovered in nature, not invented or imposed by aesthetics, design ideology, or formalism. The rules we seek come from our knowledge of the mutual interaction of humans with their environment. One of these models is Biophilia — our instinctive love of life and its geometry (Browning, Ryan, & Clancy, 2014; Kellert, Heerwagen, & Mador, 2008; Mehaffy & Salingaros, 2015; Ryan, Browning, Clancy, Andrews, & Kallianpurkar, 2014; Salingaros, 2015). A large body of evidence on how users interact sensorially with their surroundings highlights what makes environments healing. Experiments reveal how we are drawn to organized information, but not to blank surfaces; how we prefer curves in our environment; how colors impact our psychological state; how we expect an emphasis on the vertical axis, etc. These and other preferences will be explained in detail below. Such factors arise from our biological nature, and impact human health, often in subtle physiological and psychological ways (Salingaros, 2017b).

As long as practitioners, professional groups, the media, and academia consider buildings primarily as isolated sculptural objects, it is difficult to introduce Biophilia and Design Patterns for designing the human habitat. Hopefully, enlightened clients, public and private, will grasp the enormous long-term benefits of a healing environment, and will start to demand it from architects. The new defining paradigm of our technological society is connectivity, not isolation. Adaptive design establishes an essential healing connection between people and the environment, through human biology.

BIOLOGICAL DESIGN USES PATTERNS

Traditional buildings and structures on the urban scale show recurring similar typologies. This similarity is due to fundamental invariants of human physiology and anatomy. Christopher Alexander and his colleagues discovered and documented invariant socio-geometric constraints as Design Patterns (Alexander, Ishikawa, Silverstein, Jacobson, Fiksdahl-King, & Angel, 1977). Traditional typologies evolved within distinct societies, yet their selection criteria depend on human senses and sustainability, and are independent of any specific geography and time. Particular socio-geometric solutions arose from a process of convergent evolution of designs. Similar climates will tend to independently evolve similar typologies (but not finished designs), even when the populations are geographically distant.

Physical settings that make us feel secure from threat elicit a positive emotional response. Our brain is reassured on a subconscious level. There are many layers of creation and pleasure above this baseline of emotions. Going beyond the basic and necessary feeling of security, our imagination produces Art in seeking to satisfy our craving for sensual pleasure. Art beyond ornament is part of biophilic design (Salingaros, 2012). This has been an inseparable aspect of the built environment ever since the first humans invented architecture. People from the most impoverished settings, to those belonging to a social class with power and wealth, used biophilic design to inject delight, personal meaning, and serenity into their living spaces. We experience a sense of wonder in our most glorious (usually religious) architectural creations.

Adaptive design works very much like our immune system. There, an invading pathogen triggers the production of an enormous variety of antibodies. Those few that are effective (even just one) are recognized for their success, and are subsequently produced in large numbers. The failed varieties in the first response are experiments to find what works, which are subsequently discarded. In the same way, adaptive design generates an enormous variety of solutions, which are then tested before or even during implementation. The ones that survive and are built are those that conform to practical constraints, such as available space and materials, climatic adaptation and energy savings from directional orientation, and, in general, the feedback loop maximizing the wellbeing of the user/builder in the actual created spaces.

Today, however, it is not evolved solutions so much as simplistic geometries that are re-used. Those are far easier to implement, because they do not adapt to context. An architect is not required to combine tried-and-true adaptive solutions to generate the large scale: monotonous repetition is enough. Regardless of the expressed intention of individual architects, buildings within the industrial-modernist rubric do not approach the complex articulations on many interlinked scales that one finds in traditional architecture and urbanism (Alexander, 2001-2005; Salingaros, 2005).

Even those recent buildings that embody complexity contain the wrong type: disorganized instead of organized complexity. Disorganized complexity results from having many components that are not linked. The brain has to process each unit individually, leading to informational overload (Salingaros, 2018). The task of organization is performed by connections established among all the elements. In the architectural context, elements are connected by using many different types of spatial symmetries (reflectional, translational, rotational, etc). Coherence on the large scale is taken care of by having scaling symmetries (where similar units in a composition exist at distinct magnifications).

The continuing dominance of minimally-satisfactory and even unhealthy typologies in design contradicts the process of historical selection that normally would favor the healthiest living patterns. Today's dominant typologies also preclude sustainability (Mehaffy & Salingaros, 2015). How is this so? Selection stopped after nobody was interested in testing adaptive design variants. Architectural culture accepted an extremely limited industrial-minimalist typology, and the profession seemed happy with that (but not the users). The reason that unhealthy design typologies now thrive all over the world is because they have been institutionalized as building codes, standardized materials and dimensions, standardized mass-produced building components, etc.

Once non-adaptive design typologies became established, convention and regulations decreed what designers are allowed to use. Risk-averse clients want the most economical budget, while unimaginative designers either cannot or do not want to go outside the familiar box. More enlightened building codes and standards (for example, the New Urbanist form-based "Smart Code") could be used as a stepping-stone towards adaptive designs. But introducing them meets stiff resistance from the establishment. And society as a whole becomes numbed as it gets used to hostile spaces and urban dysfunction, and cannot imagine anything different. People simply accept an unhealthy *status quo* now almost a century old (Alexander, 2001-2005). On the other hand, signature buildings get erected precisely because they embody design variants — but unfortunately those are of an unhealthy kind. Our ability to build any shape and dimension we want, if unchecked, can easily lead to an inhuman environment.

THE BUILT ENVIRONMENT AS AN EXOSKELETON

Industrial Modernism has spread (in many cases, imposed) an inflexible homogeneity on the built environment worldwide. This typology, strongly promoted by globalization, is very poorly adapted to context, the environment, or local culture (Mehaffy & Salingaros, 2015). The biophilic model, together with complementary adaptive design tools, provides a basis upon which a more human-oriented design practice can be built.

Let us try to bypass formal discourses on architecture going back decades, and approach the discipline as part of biology. We need to apply scientific analysis to understand the problem, but should not fall into superficially copying biological forms (Alexander, 2001-2005; Leitner, 2015; Mehaffy & Salingaros, 2015). Human beings create families and societies, and those groupings represent living structure at one or more levels of scale larger than the individual. Those living human scales need protection and physical support, which is the reason why we construct an exoskeleton consisting of buildings and cities out of available materials.

The geometry of the built environment is the exoskeleton of living structure. In much the same way as insects, crustaceans, and mollusks, humans are intimately attached to their "built exoskeleton". What we build could perfectly fit our needs, both physiological and psychological, our movements and daily functions, etc. A variety of environments will satisfy these criteria, as long as we can easily adapt our behavior to the built geometry. Moreover, our immediate shelter is an organic part of us, without which we would perish sooner rather than later. We can no more *arbitrarily* change our exoskeleton than a lobster can radically modify its own shell. The infinity of allowable perturbations that maintain fit is still a restricted set. Yes, the lobster molts, but then builds a slightly larger shell that is otherwise the same. This way of thinking about the shells that enclose our activities is not new: Gaston Bachelard and Constantine Doxiadis used these terms.

We certainly adapt the built environment to our needs whenever we can (and where permitted to do so). Ironically, informal settlements are the most adaptive, whereas living and working spaces created within formal design are the least adaptive (Salingaros, 2005; Mehaffy & Salingaros, 2015). The do-it-yourself building process uses available materials, adapting economically to environmental conditions, and is driven by social conditions and religious beliefs.

The construction of a single room, a house, or an entire city district seeks to satisfy requirements for shelter that arise from the interactions and exchanges of human society. Adaptive forms and typologies channel spontaneous movements and flows via interaction and cooperation rather than by adhering too strictly to a formal plan. Very specific indoor and outdoor spaces should be shaped so as to adapt themselves to, not to dictate, human activity. In a process of organizing myriads of different needs according to a set of constraints such as Design Patterns, there is no top-down artistic "design" *per se*. This approach represents the opposite of modernist social engineering.

The largest scale in an adaptive design is influenced by the arrangement of its internal components and the smaller scales. Room shape, dimension, and volume, when successful, depend upon both the perception of coherence and the accommodation of physical activities. In achieving adaptivity, geometrical forces coming from both the large and small scales have to compromise the least possible way with human neurological responses. Whenever spaces and surfaces are imposed by following formal concerns exclusively, or as an arbitrary artistic flourish, they become irrelevant for containing human activity. Traditional architecture, which can be both artistic and formal, is based on inherited biophilic design principles understood subconsciously. Those practices constrain a building or urban space to adapt to flows, and to nourishing visual complexity.

Another biological analogy also proves helpful. In most animal bodies, free components — e.g. blood cells — move about internally. Those mobile components are essential to living structure, while the framework through which they move is essential for their survival and the survival of the entire organism. People moving about their private domestic spaces and public urban spaces remind us of blood cells flowing in the circulation system. No part is independent: container and contained form one system. Organisms represent complete, tightly-dependent components of biological processes that define living structure in the systemic sense.

Twentieth-century transportation systems mimicked organic circulatory systems, but made several errors, thus getting the analogy wrong. Bodily fluids flow through a hierarchy of channels of decreasing capacity: the blood flows from arteries down to capillaries, with an inverse-power law distribution — i.e. few arteries, but an enormous number of capillaries. This is fractal scaling, which is found in many complex systems (Salingaros, 2005). Highway engineers, however, cut expressways through city centers, thus wiping out the equivalent of the capillaries. Promoting fast flow through streamlining, they skewed the network towards the largest scale. In the sprawling suburb, there is only one oversize type of road, hence no path intimacy in the network. That unnatural situation contributes to the pathology of suburbia.

RESILIENCE OF MULTI-SCALE SYSTEMS

Designing with human senses, and knowing how different built elements affect them, vastly improves the fit between a city and its users. As an important bonus, this practice makes a city more sustainable for several reasons. First of all, a city that is loved by its users will be taken care of and survive normal wear and tear. Second, adaptation to human senses skews the built system towards the lower-dimensional human scales, thus making it less fragile from the systems theory point of view (Salingaros, 2005). It is only when a system becomes dependent upon its largest scale — e.g. new skyscraper cities built in the desert — that a disturbance can knock out the entire city.

Sensory feedback has implications for how cities deal with change. A city is a complex system composed of people interacting with the built environment. This urban system becomes more resilient when it acquires analogous biological characteristics (Alexander, 2001-2005; Salingaros, 2005). For several decades, many cities have failed to obey the mechanisms of living structure, except perhaps for small pockets. Gluing a techno-solution on top of a rigid anti-natural system cannot solve problems of fragility. The technocratic approach to resilience continues to rely on a dangerously limited perspective. Fundamental philosophical and systemic changes are needed.

The "metabolism model of cities" has proven useful in pushing urban planning towards sustainability (Decker, Elliott, Smith, Blake, & Rowland, 2000; Newman, 1999). As we have learned from ecosystems, responsive networks of resilient systems embody inherent diversity and redundancy. Diversity comes from linking system structure and processes together at many different scales — a complex system never runs on a single scale. Unless living systems had built-in redundant connections, they would die from minor injuries. Redundancy is the opposite of optimization for maximum efficiency for a single process, which instead creates fragility. Yet, planners have been doing exactly this (Salingaros, 2005).

A variety of structural and response mechanisms are needed for the city to recover from shock. As in the human immune system, threats are fought by generating as large a variety of responses as possible, until the effective one is found. A discovered response is then stored in memory, providing immunity from a specific pathogen. Our society needs to anticipate this process through adaptive scenarios and stored learning. However, we seem to have no memory, since the ephemeral pursuit of fashion erased past learning as contained in Design Patterns. Trashing lessons of the past forces people to live in an eternal present without accumulated resources of knowledge.

Our responses to system threats are handicapped by inertia, intellectual confusion, and stubbornness. Architects and planners optimized city form for one goal — fast automobile traffic — thereby neglecting all other subsystems. Industrial Modernism pushed fluxes as well as forms onto the largest scale, and eliminated all the smaller scales (Salingaros, 2005). The resulting system is extremely fragile because it lacks mutual support from linked structures on different scales. Even more alarming is that most people associate modernity with how this fragility "looks", thus encouraging endless construction in this same style.

Top-down architectonic expressions impose unnatural scales but do not attempt to adapt. The arrogant stand-alone "look at me" building isolates itself from context. Buildings as giant sculptural forms represent reductive, shallow simplicity that drastically shapes the way we think. It is not that biophilic design principles were unknown before: they were internalized into traditional design practices, but those are now discarded. Sleek, mechanistic images pose a problem. The modernist form language trains the brain not to see the complex reality of living systems. Current design philosophy tends to oppose natural multi-scale systems, for stylistic reasons. Design driven by irrelevant artistic fashions disorganizes complexity, loses useful Design Patterns, and leads away from healthy environments.

FIRST SET OF DESIGN GUIDELINES: SHAPING THE ENVIRONMENT

A new design practice — or re-orientation of current design practice — utilizes sensory responses in building rapidly growing cities (Alexander, 2001-2005; Salingaros, 2017a; 2017b). These same principles can be used to repair unresponsive portions of a city, and individual buildings. The aim is to use minimal interventions in what already exists, and re-shape it into a more humane environment. Even in the developing world, where competing needs such as health care, social services, clean water, sanitation, housing, transportation, safety and security seem to overwhelm available resources, healing design is not a luxury but a necessity. Once this goal becomes a priority, it is not difficult to implement a living connection between users and built structures in a sustainable way, with no additional cost. All we have to do is to fill in some too-large open spaces, re-structure spaces (interior and exterior) that are unwelcoming, replace or re-finish "unfriendly" surfaces, etc.

General design guidelines address the existing barriers towards promoting human health necessary for creating thriving neighborhoods. The following list is useful for designing environments that can have a positive impact on the experience and perception of place. Most readers will not be familiar with the background material from which these generic points are summarized: please see the references for details.

Table 1: Design elements that elicit a positive sensory response.

1. Built elements intimately linked to pieces of nature in which we feel comfortable and reassured. A building embraces trees and gardens — not flat lawn.

2. Structural information intrinsic to natural forms and materials. Their small and micro-scales usually contain richly-ordered complexity.

3. Geometrically coherent structures and spaces built from artificial and natural materials. This coherence is achieved from an uncountable number of links and symmetries.

4. “Safe” spaces, as determined by our neurophysiology. Many spaces make us feel anxious, but we are discovering the geometry of those that do the opposite: make us feel at ease and welcomed.

5. “Friendly” surfaces, perceived neurologically. Experiments are underway to determine why we feel attracted to touch a particular surface, and are repelled by another.

6. Mathematical symmetries that cooperate on all levels of scale. A high density of subsymmetries of all types that overlap in a mathematically harmonious manner.

7. Different structural scales linked to each other through scaling symmetry. Similar elements at different magnifications co-exist in proximity.

8. Colors that harmonize and do not clash. Artists working up until the end of the 19th Century knew how to achieve this effect.

The key to adaptation is that large scales subdivide into smaller scales: not arbitrarily, but to accommodate human senses and dimensions. This helps to understand how nature adjusts dynamically and acts on all interconnected levels of scale. Formal approaches to design that suppress the intermediate and smaller scales create unnatural results (and perhaps this is their unstated intention). But that is not adaptive to living processes.

Using Biophilia and Design Patterns has radical consequences. First, a building mixes intimately with nature, with views onto real trees, mini-gardens enclosed or semi-enclosed by the building, a crenellated building footprint to join with gardens, etc. Second, geometries employing fractals, scaling symmetry, similarity-at-a-distance, nested sub-symmetries, and reference to a vertical axis trigger positive physiological and psychological responses from users. (Deviation from the vertical axis is sensed by our inner-ear mechanism, which responds by generating nausea.) This novel approach to contemporary design merges the building with its immediate surroundings. Context, position, orientation, main approach, paths, and connection to the urban fabric are all essential features.

Contrary to what some readers may hastily conclude, one does not need to go back to the Classical, Arts and Crafts, or Art Nouveau form languages to benefit from healing environments. Any project today can make either a small or large move towards satisfying the design guidelines proposed in this paper (and detailed in the references). Even a minor change towards the direction of adaptive design could prove enormously beneficial to the users, since the effects are cumulative in the long term. Small adjustments to otherwise conventional design can be easy to implement, yet help far beyond their size or extent. Ideally, the design will benefit most if adaptive techniques have a chance of influencing the process beginning with its first steps.

SECOND SET OF DESIGN GUIDELINES: HOW WE LOOK AT THINGS

Here we use the latest findings from visual tracking, which confirm the insights coming from Biophilia and Design Patterns. Ann Sussman and her collaborators observed which geometrical features draw the visual interest of pedestrians (Sussman, 2018; Sussman & Hollander, 2015; Sussman & Ward, 2017). Sensory information decides how people navigate and use a place, without being conscious of the reasons driving their behavior. This groundbreaking research reveals how a user's sensory system reacts with the built environment. Unlike older experiments that used questionnaires to determine environmental preferences, this data measured gaze fixation directly. Results from many participants were superimposed to show subconscious preferences. Those findings lead to practical tools and methods for planning and urban design practitioners (listed below in Table 2).

Table 2: Guidelines for adaptive design from eye tracking.

1. No large undifferentiated walls, either opaque (bonded brick, stone, or concrete) or transparent (curtain glass). Those present a void in the visual field.

2. A person's biological navigation system requires a sequence of visually focused goals, each one defined by coherent complex elements. The complexity and intensity of those visual goals have to match examples from nature.

3. Recognizing our evolutionary need to see faces implies an attraction to façades and individual design components with bilateral symmetry (about the vertical axis) suggesting abstract eyes, mouth, and nose. This preference is verified by the data.

Visually seeking the "face-like" suggestiveness of a building façade is built into our biology: it is part of Biophilia. The attraction goes beyond a preference for abstract bilateral symmetry about the vertical axis, to an effect apparently due to specific facial-recognition neurons in the brain. A recognizable entrance may appear as a mouth, with windows and other features distributed in a bilaterally symmetric manner (Sussman & Hollander, 2015). Its opposite, an ambiguous entrance and either the absence, or monotonous repetition of windows and other design elements creates alarm and disorientation. We evolved to seek safe paths, to recognize other animals, and to interpret the emotions in a human face; therefore, we try to find similar features in a building as we approach it. Of course, we are capable of adapting to and approaching any non-toxic environment, but the further that diverges from what our evolution leads us to seek, the higher the cognitive burden we have to overcome.

The above design rules implement a built geometry that is consonant with our senses, but which at the same time differs radically from formal design practices applied throughout the world for the past several decades. Without getting into polemics here, it should be obvious that the industrial-modernist vocabulary eliminates most of the techniques we support. Elsewhere, we argue that a certain type of visual innovation that runs through early modernism right to contemporary architectural styles achieves its "look" by violating our proposed design rules (Alexander, 2001-2005; Alexander, Ishikawa, Silverstein, Jacobson, Fiksdahl-King, & Angel, 1977; Mehaffy & Salingaros, 2015; Salingaros, 2016; 2017a; Sussman, 2018; Sussman & Hollander, 2015; Sussman & Ward, 2017). The negative qualities of architectural design practices do not work to establish empathy with the user because they are perceived as unnatural, hence threatening.

Design rules for urban spaces that will actually be used with visceral pleasure come from specific Design Patterns (Alexander, Ishikawa, Silverstein, Jacobson, Fiksdahl-King, & Angel, 1977; Salingaros, 2016; 2017a). An enormous amount of information correlates frequency of use with spatial dimensions, access, entry points, transverse paths, types of boundaries, urban functions in the immediate perimeter, and population density in several surrounding blocks. That practical information will not be detailed here (Salingaros & Pagliardini, 2016). Suffice it to say that the design of urban space became a lost art after it was intellectualized. Yet dysfunctional places affect human health in subtle ways, and keep people from ever using them. Potential users approaching an urban space pick up visual cues: certain design elements attract, leading to entry and lingering in the space; other elements repel, making it more likely that someone will avoid crossing the plaza. A correctly-designed urban space can have a profound and positive impact on the users' perception of place.

THIRD SET OF DESIGN GUIDELINES: GRASPING OUR ENVIRONMENT

A combination of experimental research and theoretical conjectures produces a picture of a healing environment that has very particular geometrical features. Those design elements, which should naturally be incorporated into any new designs and in retrofitting older structures, arise from neuroscience (Salingaros, 2017b). Insights result from practice-based research into how architecture and urban spaces affect our wellbeing both on the short and long terms.

Animals use all of their senses in navigating their environment, and we do the same (Pallasmaa, 1996). Vision, smell, hearing, and touch help us to establish our position in a place. We have a primary need to situate ourselves in our immediate environment. Most important is that our tactile sense has two distinct components: actually touching a physical object, and the visual estimation of whether some object is touchable/graspable or not. The second mechanism of "virtual touch" and "virtual grasping" is underappreciated in design. Nevertheless, it determines much of our behavior in the built environment. We can summarize some recent findings in the following list (Salingaros, 2017c):

Table 3: Guidelines for adaptive design from virtual grasping.

1. We seek graspable elements of a size that fits our hand because those reassure us about a place.

2. Their shape should invite comfortable hand contact and grasping, whether that can actually occur or not.

3. Their material (opaque, not transparent) should invite grasping.

4. An object that would appear to cause discomfort or injury when physically grasped repels us instead.

5. Virtual grasping acts more strongly at short distances within physical reach.

The psychological mechanism underlying the effect of prehension (grasping) is called "object affordance". Our brain is continuously assessing whether our immediate surroundings "afford" such physical supports for our body. Juhani Pallasmaa first discussed this in an architectural context

(Pallasmaa, 2009). It does not have to be an actual physical object (though those arguably provide a stronger connection), but could also be a visual representation of graspable objects. This observation validates ornament that presents necessary graspable dimensions to a user. “Object affordance” acts subconsciously and can be satisfied by ornament and moldings.

The above guidelines have far-reaching implications for design. Smooth, minimalist surfaces neither present, nor even suggest prehensile design elements. On the other hand, architects wishing to apply the suggestions listed above in Table 3 are led to bring back surfaces with specific articulations into the core of design. Traditional architectural components provide the required prehension effect: these include frames, trim, moldings, baseboards, window grilles, mullions, and muntins, door levers instead of doorknobs, etc. Hand-size graspable components enter the architecture of the future not as an old-fashioned, nostalgic throwback to past times, but as a necessary design feature that satisfies essential conditions for our neurological wellbeing.

CONCLUSION

Good architecture should be gauged by what it does for the common good —for all of us. The combined set of design guidelines presented here contributes to creating a healing environment. This is immediately perceived as “welcoming”, “compassionate”, and “friendly”; yet experiments have shown the long-term effects to be beneficial to our health. People connect to a building through its spaces, surfaces, and details much as they will connect cognitively but subconsciously to a tree, a domestic animal, or to another human being. Physical material, if it follows the correct healing geometry, engages us on a visceral level so that we feel at home with our environment. This deep sense of connection has come to be misrepresented (and condemned by some) as “traditional”. It is traditional only in the sense that for millennia, humankind strove to achieve it as intensely as possible in everything it created.

Professional practice has to apply only tested design methodologies for health-promoting urban environments. Industrial-modernist architects chose to break away from the human need for a healing environment by dropping adaptive design rules. The end result ranges from being psychologically neutral (non-nourishing), to alarming and hostile. Architecture has been stuck in this unhealthy direction for decades, so that it is now very difficult to find any healing qualities in mainstream contemporary buildings. Nevertheless, smaller firms that use Biophilia and Design Patterns, working outside the limelight, and thinkers at the margins of architectural culture are spearheading improved living conditions. Political forces, professional organizations, the official media, and our educational system will all have to join in this effort towards generating more responsive environments.

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