

BEAUTY, LIFE, AND THE GEOMETRY OF THE ENVIRONMENT

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Introduction

Moving towards sustainability and a greater understanding of how human life is connected to the earth's ecosystem goes beyond mechanistic notions. Totally consistent with the Greek concept of geometry underlying life, increasing evidence shows that the geometry of the natural and built environments is responsible, to a large extent, for the quality of human life. Certain geometrical characteristics of natural and living structures, such as fractal scaling, mathematical symmetries leading to complex coherence, and structural invariants (patterns) found in disparate forms seem to be responsible for a fundamental healing connection between the body and its environment.

In what is known as the "biophilic effect", we draw emotional nourishment from structures that follow general biological rules of composition. It is perhaps not surprising that natural environments should nourish us, but what about artificial environments: the environments we build? Artificial environments that are the most healing emotionally and physiologically embody traditional design techniques that themselves arose from imitating nature. Superficial imitation does not provide the intended effect: a form (artifact, building, urban space, or city region) has to be built according to principles that derive from the organization of living matter. This discovery opens up two major topics of application: (1) validation of older design techniques as ultimately healing, and which should not be rejected in the interest of achieving novelty; and (2) applications of the biophilic effect on the urban scale to restructure alien urban environments.

We are thus led to a re-appreciation of traditional-scale urban fabric, with the added benefit of energy sustainability, since traditional methods of design and planning necessarily had to be sustainable. Applying geometrical rules of design as

derived from the latest scientific findings about biological structure promises a new beginning for architecture and urbanism.

How can people live in a way that is more fully human, engaging all our advanced capacities for appreciating beauty? Quality of life comes in large part from contact with nature, and from processes that evolved from our intimate contact with nature. The unwanted (and unpredicted) effects of industrialization and mass production have unfortunately led to dehumanization. Confusing humans with machines represents the negative side of the industrial worldview. In parallel with scientific and technological advances that raised the quality of life to unprecedented levels compared to what humankind had to accept before the industrial age, there followed a concomitant loss of human qualities. The predominant worldview in the developed countries now neglects effects on quality of life that come from non-quantifiable sources.

The machine aesthetic is part and parcel of the machine society. A mechanistic worldview negates the complex mathematical properties of nature, and in so doing it reduces nature and detaches us from the biosphere. Increasing efficiency has to do with industrial production, but nothing to do with human wellbeing directly. Society by the 1950s had accepted the faulty equation linking the quality of life proportionally with energy expenditure. This relationship is false: it held true for a brief period in our history, but the effect is indirect and is misinterpreted. Governments the world over now promote social fulfillment through increasing energy use, which is catastrophic because it is unsustainable. Following Christopher Alexander (2001-2005) I will introduce different metrics to measure the quality of life through factors that do not destroy our natural environment.

Re-orienting our worldview means rediscovering our biological connection to our surrounding sensory space. Certain very specific geometrical properties of the natural and built environments exert a positive, uplifting effect, which can be measured in the laboratory (Alexander, 2001-2005). The mechanism depends upon the intimate informational connection between us and nature, emphasizing that we are indeed part of nature. Therefore, enhancing quality of life includes coding the geometry of the built environment to a considerable degree. This effect does not require the expenditure of energy: on the contrary, obtaining informational nourishment from the built environment could replace the present alarming consumption of fossil energy in the pursuit of a consumerist lifestyle.

The crux of the biophilic effect in the artificial environment is that science has discovered and demonstrated patterns in building that either objectively contribute to, or detract from our psychological and spiritual wellbeing. Current Western-inspired architecture not only lacks such patterns; it teaches architects and planners to build in such a way that the biophilic patterns aren't present. The irony is that we worship an image of science that is misused to eliminate biophilic patterns: this is not scientifically credible. To make that point clear, we need to set the stage for a change in consciousness in the reader.

The new scientific discipline of Biophilia describes how we connect in an essential manner to living organisms. Introduced by the American biologist Edward O. Wilson, biophilic effects are increasingly well documented, and these include faster postoperative healing rates and lower use of pain-suppressing medicines when patients are in close contact with nature (Salingaros and Masden, 2008). Biophilia includes the therapeutic effect of contact with domestic animals. Explanations of the biophilic effect are still being developed, yet what is incontrovertible so far is that the very special geometry of natural and living structures exerts a positive effect on human wellbeing. It could be that Biophilia works largely through a mathematical effect, in which our perceptual system recognizes and processes special types of structures more easily than others. The actual biophilic patterns, however, are the results of our biological evolution.

The most basic component of Biophilia is the human response to natural environments, and surroundings that contain a high degree of living matter. Since we evolved in living environments, we process that information in an especially easy manner, and even crave it whenever it is absent from artificial environments that we ourselves build. Hence the primordial human desire for a garden, or an excursion to the countryside to restore our internal equilibrium.

An information-theoretic approach to Biophilia would make sense out of our evolution as it occurred in very specific visual environments. Yannick Joye is working on this theory (Joye and Van Den Berg, 2010). Our neuro-perceptive system more easily processes a structural environment that embodies fractal properties and the organized complexity found in nature, than an environment whose geometrical order contradicts the spatial complexity of natural structures. Our instinctive ability to recognize unnatural objects through alarm lies deep within our neurological makeup and is responsible for our being here today due to evolutionary adaptation. Certain geometries that we perceive as “unnatural” generate anxiety and alarm, and thus degrade psychological and physiological comfort when we are exposed to them for too long.

In the thesis proposed here, a major component of human physiological and psychological wellbeing is directly attributable to biophilic effects from the environment. Therefore, quality of life depends upon the presence of those very special mathematical properties. Since a major factor of Biophilia requires having intimate contact with natural forms, then saving the natural environment becomes a priority that is distinct from the usual arguments for conservation. Up until now, Western conservationists have argued that saving the environment is necessary to maintain biodiversity, which is an explicit benefit for the biosphere and an implicit benefit for humankind. I am arguing that the natural environment has immediate benefits to our health, so that saving it provides not an implicit, but an EXPLICIT benefit for humankind.

What is Biophilia?

Human evolution occurring over the past several million years (from the era of a common ape ancestor not recognizably human who however possessed all of our sensory apparatus) determines how we interact with our environment. Living in nature predisposed us to process fractal information, color, and to interpret spatial experiences in a very precise manner to guarantee our survival. Our neurological imprinting then determined how we began to construct our built environment, mimicking and developing upon prototypical concepts of spatial experience, with interesting natural details becoming ornament, and color used to enhance and provide joy in the artificial environment. In this manner, the mathematical structure of the built environment evolved right along the lines defined earlier by human biological and social evolution. As in all evolutionary developments, subsequent adaptations had to rely upon previous elements in place. It is therefore essential to re-discover archetypal qualities that generate human wellbeing directly from the built environment.

To apply Biophilia to the artificial environment, consider our sensory apparatus. We have evolved to process complex information that is of a very specific mathematical type: organized complexity where a lot of information is presented in terms of detail, contrast, pattern, color, and texture that mimics in an essential manner similar information already found in nature. At the same time, all of this information needs to be organized using mathematical techniques such as connections, symmetries, patterns, scaling symmetries, harmony among distinct colors, etc. (Salingaros, 2006). A delicate balance between the two complementary mechanisms of increasing information and increasing informational coherence generates an optimal state of biophilic information in the artificial environment.

There are significant implications of this thesis to the large scale. The original geometry of human settlements underlies a form of “urban genetic code”, and subsequent developments in the industrial and electronic ages develop on top of these original pieces of code. We can discover these early segments of urban code as “patterns”: buildings enclosing a central plaza, low-rise but high-density occupation and mixed-use buildings, a pedestrian network connecting distributed plazas, a vehicular network superimposed on the pedestrian network, etc. (Alexander *et al.*, 1977). When cities are instead planned according to abstract and formal designs, then we have rejected the urban code that evolved along with us. Replacing genetic code in biological systems could lead to an unsustainable disaster because evolution has been violated. That is analogous to species extinction or even genocide, since the process is deliberate and is carried out by humans themselves upon a particular set of inherited “genetic” information.

In the urban case, building cities according to a code that is neither evolved nor tested generates one of three situations: a) a dysfunctional region that is abandoned by its original inhabitants and may later be occupied and transformed by squatters; b) a dysfunctional region that cannot be abandoned (e.g. social housing blocks) whose brutal geometry generates rage, crime, and self-destructive behavior; or c) an urban region that is kept functional only via a tremendous expenditure of energy. Cities with an urban geometry poorly adapted to human activities can indeed be

propped up by extending the normally requisite energy and transport networks that drive a city to function, but their geometry requires wasteful energy expenditure. (Philosophers such as Heidegger have already described the notion of fulfillment versus deterioration in urban environments). Most cities today suffer from the imposition of such non-evolved urban typologies, misleadingly labeled as “modern”. Someone pays for showcasing the sculptural geometry of such non-evolved urban fabric.

The first human settlements defined a connective geometry that enables people to interact on the pedestrian scale, and to coordinate the many distinct functions of simple human society within a very compact spatial region. That is the definition of a city built on the human scale. Contemporary cities are most successful in those regions where the original “genetic” material has been respected, and a hierarchy of subsequent developments has been added on top of the original code. By contrast, where the original code has been erased and substituted entirely by twentieth-century urban typologies, the urban fabric is found to be dysfunctional, unsustainable, or dead. True, in large metropolises the population forces are so strong that even dead urban fabric can be kept artificially alive, but the energy cost is tremendous, and the cost to residents in terms of psychological stress is even greater. A city that welcomes and keeps its dwellers in a self-supporting urban environment does not conceal reality.

Quality of life comes through the nurturing environment. Five points for regeneration

Several factors contribute to a positive quality of life for us. I am going to focus on those factors that are related to the immediate environment (and thus relevant to architecture and urbanism) and ignore all the others. Let me list some of the necessary points here:

- 1) Access to clean air, water, shelter, and living space.
- 2) Access to biophilic information in the natural environment: plants, trees, and animals.
- 3) Access to biophilic information in the built environment: texture, color, ornament, and art.
- 4) Access to other human beings within an anxiety-free environment: public urban space, open-access residential and commercial spaces.
- 5) Protection from anxiety-inducing objects: high-speed traffic, large vehicles, threatening human beings, cantilevered and overhanging structures.

I clearly distinguish between nourishing and anxiety-inducing environmental information. Although this distinction is fundamental, events in the art world have

confused our natural instincts with fashions. Natural instinct is about care, family, and everything that it takes to enhance our daily life, while fashion is disguise, indoctrination, and a search for the opposite qualities. It just so happens that much contemporary art avoids connecting positively to a viewer via visceral physiological responses. Regardless of how this type of Art may be valued in the art-gallery circuit, appraised on the art market, and promoted in the press, it is not healing. Any doubt is resolved by referring to Biophilia. Healing emotions include a set of physiological responses that reduce distress and empower the body's natural defenses to work so as to maintain a healthy steady state. Art that generates healing emotions uses our senses to induce positive neurological, hormonal, and other responses within our body, but Art is not healing if it generates the opposite feelings of alarm and anxiety.

From gallery-type art — objects, sculptures, installations, etc. — we move into public art such as urban installations in public places: large sculptures, fountains, monuments, benches, tree planters in plazas, etc. For the past several decades, such public art objects have also been representative of geometries that are not biophilic. Those objects tend to range from non-healing (neutral) to anxiety-inducing (negative) provocations and therefore directly influence the quality of the urban space in which they are placed. For stylistic reasons, very little biophilic structure is now being erected in the public realm. And yet, our experience of a public space is determined to a large extent by its public art installations. “Upgrading” an older public space by inserting non-healing objects destroys the space's useful biophilic function.

Every human being responds physiologically in the same manner, and thus is able to judge viscerally whether a work of art or architecture is providing emotional nourishment, or its opposite. This is really a key point. In my description above of what healing emotions entail I assume that psychological conditioning cannot alter our biology, and our instinctive reaction is the one we need to pay most attention to. It matters very little to the user's physical experience if a non-biophilic object or building is praised in the press and by newspaper and magazine critics. Whenever persons face such a deep contradiction between emotions and bodily responses that are antithetical to the authority of experts, the individual goes into cognitive dissonance and is confused. A person can either remain in cognitive dissonance indefinitely (itself a state of high emotional and physical stress), or eventually come out of it by deciding to trust his/her own bodily responses. The anxiety-inducing objects are supported by an ideology or selfish agenda.

Let me now discuss the five points listed above for the quality of life. The first requirement, Point 1, concerns a person's private domain, the inside of one's dwelling. For a large portion of humanity basic housing itself still remains a problem, because there are not enough living quarters. People in the developing world have to build their own houses out of scrap material, often in unhealthy or dangerous terrain. The result is the slums and informal settlements of the world. Nevertheless, it should be noted that many slums are economically vibrant, and the quality of life there is enhanced by ornamentation by their owners, something that

is forbidden in a state-sponsored social housing block (Turner, 1976). As outlined elsewhere (Salingaros *et al.*, 2006), the forced move from informal settlements to government-built social housing blocks gains in health but loses in biophilic qualities.

Point 2 addresses our contact with nature. It is possible to achieve a balance with the natural environment such as occurs in traditional villages and cities that are not too poor. Even in slums, if vegetation is abundant, the residents profit by having intimate contact with nature. Nevertheless, there are examples of the degeneration of the natural environment in informal settlements that ranges from dwellings built among vegetation towards the other extreme of a city built from junk without any trace of plant life. The need to use wood for heating and cooking can soon destroy the biophilic component of an informal settlement. On the other hand, the wealthiest Western societies habitually cut down trees to build suburban sprawl, and replace the native vegetation with lawn. The grass that makes up a lawn is a monoculture plant that is non-native to the majority of sprawling suburbs. A lawn is thus a reduction of nature and a cruel joke on people who buy those suburban houses.

Urbanists after World War II created a city fit only for the car, applying a fundamentally reductive conception of nature. “Green” in the city or suburbs is substituted by its superficial appearance from afar, thus lawn glimpsed as one drives by is judged to be enough for a contact with nature. But this is a deception: the biophilic effect depends upon close and intimate contact with nature, and definitely increases as the complexity of the natural environment increases. Human beings experience its healing effects from having contact with a fairly complex natural ecosystem, even if that only means a tree with some bushes, but not from just looking at lawn. Biophilic interventions in hospitals create small complex gardens inside hospital public spaces, and interweave complex gardens with the fabric of the hospital wall so that patients can experience the plant life at an immediate distance.

Point 3 concerns architecture itself, and underlines a drastic schism between the architecture of the twentieth century and all architecture that occurred before then. Ornamentation was banned from the built environment after 1908 (minimalist environments becoming a fetish with architects thereafter), so that we progressively lost the healing effects of ornamentation in both interior and exterior built spaces. The intensity of the effect is not in question here: studies of Biophilia repeatedly demonstrate that ornament which is derived from natural structures induces the same healing effects as actual natural structures themselves, only to a lesser extent (Salingaros and Masden, 2008). Although some architects refer to this as mere “copying”, I do not believe this to be the case. Yannick Joye argues that the biophilic effect depends upon the brain’s ability to effortlessly process complex information, and thus it is irrelevant whether this biophilic information comes from a living or an artificial source (Joye and Van Den Berg, 2010).

Point 4 forces us to focus on the destruction of the public pedestrian realm in our cities following planning practices after World War II. Governments the world over

engaged in a frenzy of rebuilding that replaced human-scaled city centers with environments fit only for fast-moving vehicles. The human pedestrian city was erased by forces linking the automotive industry and the steel industry with governments that satisfied every wish of those powerful political lobbies. Just as public space was erased from the built environment, however, private space was being offered in shopping centers outside cities, isolated within a car environment. People still crave personal contact in an urban space, but in many locations this is only possible in a commercial shopping center or mall. Governments now used to working with builders and real-estate developers who build such malls promote this model.

Point 5 focuses on certain environmental forces from which we have to protect ourselves, because they degrade our quality of life. The growth of the car city means that most outdoor environments are now threatening to humans unless they are protected inside their car. Automobile connectivity and the infrastructure it requires have been allowed to take over and replace the human-scale city. Therefore, the vast open spaces in the world's cities are either psychologically unsafe, or are fast becoming so. Such spaces are not spaces to live in, because they are threatening and anxiety-inducing. The actual living city of sheltered pedestrian experience has therefore been reduced to internal space, whether private living space, private commercial space inside restaurants or bars, or to equally private commercial space in shopping malls.

Another aspect of being protected from anxiety regards structures perceived as threatening, and this can occur for several different reasons. We cannot re-wire our perceptual apparatus to suppress neurological signals of alarm at buildings and structures that are twisted, unbalanced, or which protrude towards us. Such buildings generate feelings of alarm. This is an important point: why threaten us, why attempt to violate our wellbeing? It's done for reasons of fashion and ideology. Perhaps those buildings are interesting to look at from afar, but having to be next to them, enter them, and use them generates psychological and physiological anxiety. The same is true for sheer impenetrable walls and glass floors: the former communicate exclusion and lack of escape, whereas the latter generate anxiety and vertigo. These anxiety-inducing features routinely appear in contemporary buildings, but that does not change their negative effect on our sense of wellbeing within the built environment.

Experienced space and socio-geometric connectivity

The twentieth century's scientific and technological advances enabled a whole new level of living that brought quality of life in terms of vastly improved medical care, transport, energy availability, and communications. In our time we have come to take all of this for granted. Nevertheless, in parallel with these developments, humankind lost a timeless connection to the world that did not involve science, because this connection is not quantitative (Alexander, 2001-2005). We tend to forget and dismiss our inherited socio-geometric patterns whenever they cannot fit

into the mentality created by advancing technology. This loss of patterns has caused the loss of essential aspects of our existence, and it has profound implications for energy use (Salingaros, 2000).

Talking about connecting viscerally to a building characteristically makes people in our contemporary culture uneasy. We have lost part of our sense of attachment to a place, even if we normally don't notice it consciously. Effects of friendliness or hostility are ignored, and they are claimed not to exist. We have grown accustomed to buildings that emphasize the look and feel of technology: buildings that are, in fact, little more than an image. How, really, do we connect with a building, with a space, with a place? How do the parts of a building connect with each other? Connectivity can be described in mathematical terms through processes occurring in space; it depends on how we perceive that space. For millennia, our ancestors built sacred places and buildings that connect us to the location, and act as a catalyst to connect us to each other. For them, living in a pre-industrial age, it was easier to understand this connection than it is for many of us today.

We connect to our environment — as distinct from merely reacting to it — only through coherent complex structures. Coherence and symmetries of form make possible the continuation of the biophilic effect from living systems into artificial complex designs or structures. Twentieth-century and contemporary buildings that have either minimalist or disordered forms cannot connect with the user. The result is an intentional lack of coherent complexity in the built environment (Salingaros, 2006).

A dramatic demonstration of the principles of Biophilia and human socio-geometric patterns can be seen when they are violated. Failing to respect evolved architectural and urban typologies, twentieth-century architects and urbanists went ahead and constructed block housing and high-rises with segregated functions as the solution to urban problems. These implementations were uniformly disastrous.

Firstly, architects and planners ignored evolved urban codes that had proved themselves through the centuries. The reason given (but never tested) was that a new, industrial society needed an entirely new form for the city. Instead, they built monstrous blocks. These architects showed incredible arrogance in their approach to design, believing they could force their will on both people and urban functions and override forces that shape urban form and human use. For example, they designated the fourth storey and roof for specific commercial activities that never took place. Socio-geometric patterns of human use preclude such spaces and locations from ever being used in the imagined manner, just as the “playgrounds” and “plazas” designed according to some abstract geometry have remained despised, feared, and unused.

Secondly, architects and planners constructed dwellings and neighborhoods devoid of any intimate contact with nature. A family isolated inside an immense block housing project is detached from nature. Their quality of life drops. Even the fundamental pattern of “2 Meter Balcony”, which could at least be used to grow plants, is stubbornly ignored by architects of apartments in high rises (Alexander *et*

al., 1977). The new style and the ideological attraction to its visual vocabulary overrides any other concerns, and thus architects fail to address these crucial issues. Having some trees in a vast windswept plain outside the block is totally useless. Most twentieth-century attempts at living environments have failed because they contradict all the rules for the traditional design of urban spaces and gardens in the interest of a “new style” that is image-based.

Thirdly, architects and planners created monofunctional urban segregation, which violates the most basic urban patterns that make a city grow in the first place. Cities exist in order to connect people with each other and to mix activities. Incredibly, twentieth-century urbanism took the anti-urban slogan of spatially separated uses as a starting point, and governments used it to reconstruct their cities after World War II. These anti-urban practices were legislated into zoning laws so that it became illegal to build living urban fabric. The problem is that self-proclaimed experts were offering toxic advice on architecture and planning, and some of these people held positions of great academic and media prestige. Politicians and decision makers followed their advice simply out of respect for authority. There a deliberate obstruction here of the decent, free, equalitarian spirit, which is replaced by a totalitarian approach to planning (Salingaros *et al.*, 2006).

Connecting beyond everyday experience

I highlight here questions about connecting to place in a more complete manner. How far can we intensify our emotional connection and still explain it biologically? Emotional highs come from love, music, art, architecture, poetry, and literature. Mechanisms of response are all biological (sensory apparatus), although the most important elements are still incompletely understood. Connection is achieved through dance, music, art, and architecture. The common properties among these creations include patterns, regularity, repetition, nesting, hierarchy, scaling, and fractal structure. They are demonstrable geometrical patterns, perceived by our ancestors and more traditional people today as mystical properties. Going further, the highest artistic expression is related to religion. Bach, Mozart, Botticelli, Michelangelo, generations of anonymous artists and architects of Islamic art and architecture, and mystics of the world achieved such profound connection. By seeking God through beauty, human beings have attained the highest level of connection to the universe (Alexander, 2001-2005).

For millennia, human beings have sought to connect to some sacred realm through architecture. Though we have as yet no scientific explanation for such a phenomenon, we cannot deny either its existence or its importance for the quality of human life. We experience this connection — a visceral feeling — in a great religious building or a place of great natural beauty. The Egyptian architect Hassan Fathy speaks about the sacred structure even in everyday environments (Fathy, 1973). Christopher Alexander (2001-2005) describes connecting to a larger coherence, and such a connection is in fact one of the principal factors in enhancing our quality of life. Nevertheless, we hardly even have the vocabulary to talk about it.

Without specifying any particular organized religion, spirituality grounded in physical experience can lead to connectivity. Is this connective mechanism by which we try to interact with our creator the same effect as Biophilia? Maybe it is, only possibly more advanced and thus a far more intense source of emotional nourishment (i.e. fulfillment, joy, elation) than that obtained from strictly physical experience. Can we transcend biological connection as the source and standard for aesthetic appreciation and enjoyment so as to achieve an even higher spiritual connection? As opposed to religious experience or a religious attitude, religious belief itself is abstract, being resident in the mind. But the connection associated with religious experience can occur through geometry, the physical senses, music, rhythm, color, etc. Religious connection can be very physical, oftentimes intensely so. This physical connection gives us the materialization of sacred experience.

Dance, song, and music express temporal rhythm. Classical Indian Bharatanatyam dance, African shamanic dance, Native American religious dance, whirling dervishes in Mevlana, Turkey, and Hassidic dances are all mystical dance forms that contain geometric qualities of periodicity and temporal scaling coherence. Greek culture historically interlaced mystical dance with musical experience giving birth to Classical Tragedy, features that evolved into the main emotional component in the celebration of Christianity. In the West the Masses of Bach, Haydn, and Mozart show fractal temporal structure — an inverse power-law scaling. Sacred chant in all religions connects human beings to a story, ritual, and precious cultural reference point. Holy days are marked by special song, such as the Byzantine Easter service, Passion Plays, Kol Nidre during Yom Kippur, Buddhist ceremonial chant, etc.

In architecture all over the world, the House of God displays the connective qualities we seek, often to their highest possible extent. Independent of the particular religion or style, this effect is found among all religious building types. Architects of the past instinctively built according to rules for generating scaling coherence. All the examples I have mentioned — whether music, dance, art, or architecture — have common mathematical qualities: fractals, symmetries, rhythm, hierarchy, scaling distribution, etc. Deliberate creations by traditional humanity the world over were trying to connect to a reality that expresses truth, order, and measure beyond our everyday experience.

Sponsored disconnection

Within this biophilic framework, some religions have been more successful than others in fighting against the despoliation of nature and our dehumanization. (This very crude technology/nature opposition was justified by falsely presenting it as a condition to economic and technological progress). The more conservative of the organized religions seem to have fared much better at saving their heritage in recent decades. Fearing the intrusion of foreign cultures and the exploitation by foreign commercial interests, they have tried to shield themselves from what are rightly perceived as consumerist and nihilistic currents in Western art and culture. Ironically, many established religions in the West have embraced those same artistic

trends in an effort to remain “up-to-date” so as not to lose members. We have concrete examples in recent churches that, far from evoking the love and image of God, instead conjure the image either of secular neutrality (warehouse/garage) or an expression of evil (slaughterhouse/crematorium).

An established Church that sponsors and builds religious art and its own temples in a style that induces anxiety will likely be judged as an accomplice to a global nihilistic movement. Buildings that generate anxiety, consciously or unconsciously, compromise the very continuity of such a Church. Anxiety, alienation, and consumerism have little to do with love, charity, and compassion. Anxiety-inducing forms are instead associated with power, transgression, and sadism; therefore their attraction is that of a cult of power. Negative reaction by more traditional religious authorities against contemporary church buildings in the West is not usually reported because of its politically explosive implications, but it exists, and it is damning. New churches that are praised by the western press are condemned as anti-religious by Eastern religious authorities (who apparently have not lost as much of their sacred connection) on the basis of the fashionable churches’ geometry.

A State, too, can commission prominent public buildings that through their style objectively evoke anxiety. A hostile reaction to buildings in a nihilistic style that the government has sponsored turns into hostility against the government itself. This does not bode well for political stability in the coming decades, when citizens wake up to the fact that public money spent on anxiety-inducing buildings promoted by an ideological elite drove their country into debt. The past few decades have seen a building spree of unpleasant structures (museums, art galleries, schools, hospitals, libraries, government buildings, monuments, etc.) and environments in an ill-conceived desire to conform to a “contemporary” architectural fashion. These trigger aggression, visual violence, and embody utter pointlessness in their design.

We have already witnessed foreign reaction to such nonsensical and psychologically aggressive buildings in the rich Western countries but we misinterpreted it as hostility towards the West’s economic wealth rather than a legitimate critique of the architecture proper. Nevertheless, similar buildings and urban regions built in developing countries by those same “star” architects who build showcase buildings in the West arouse the same hostile sentiments among the local population. Don’t be fooled by a superficial biological analogy between monstrous offices and apartment blocks with beehives: we need entirely different patterns to live an emotionally healthy life than insects do. I believe that a correct interpretation of the negative reaction ordinary people experience around contemporary buildings in the fashionable style is based upon its rejection of biophilic patterns, but the soundness of this negative reaction is conveniently negated by a powerful architectural establishment that promotes such buildings all over the world. The accusations of nihilism from both within and without Western society are deflected onto “foreigners”, while critics of Western fashionable architecture are deemed not sufficiently “contemporary”.

Spatio-temporal rhythms in the city that attracts talent

A living city works well because it encourages actions, interactions, and movements, all of which depend upon certain scales in space and time. Spatial scales are defined by physical structures from the size of a 3mm ornament on a park bench or public lamppost up to the size of a city's region that can be identified as more-or-less coherent within itself. To achieve a positive biophilic effect requires the existence of the entire range of scales corresponding to the human body (1mm to 2m) extending into the range of scales of pedestrian movement (2m to 1km). With various forms of transport our spatial experience expands to scales of the entire city and beyond. Quality of life depends proportionally on how we can experience all scales in a non-threatening manner, with a priority placed upon the smaller scales corresponding to the human body.

Twentieth-century urbanists disdained the human scales, turning against them because smaller scales are a defining feature in traditional urbanism. The complex spatial rhythms of traditional environments are therefore missing by design from city regions constructed during the past century. Even when a new environment is labeled as being a "quality" environment, that label most often refers to how closely the built structure (building, cluster of buildings, urban plaza, public sculpture, etc.) follows a minimalist sculptural ideal that eschews complex spatial rhythms. In the built environment of the past several decades we find scales irrelevant to the range of human scales, except in those crucial exceptions (restaurants, shopping malls) where retail overrides design ideology. Our civilization has got into the habit of subjugating and mechanizing human activities, and forgot our need for biological scaling. This is definitely not the improvement it's usually claimed to be.

An even more neglected aspect of urban life concerns its temporal rhythms (Drewe, 2005). Everyday life is defined as a complex coherent system of actions and movements on many different time scales. Some time phenomena are spatially independent, but many depend critically upon the urban geometry. Again, the shorter periods affect us most, as they have an immediate correlation with our own bodily rhythms. We are dependent upon events that occur over times of 1 sec to 24 hours. Quality of life can be positive or negative depending on whether our bodies interact harmoniously with the temporal events caused by a city and permitted by its geometry. The temporal dimension of urbanism is a poorly-explored topic.

Time is defined either in abstract intervals, or much more physically in terms of body movement. Motion could be a response to a physical need, yet any movement is constrained by the physical space — furniture, room, corridor, urban space — we occupy at that moment (Schrader, 2005). The geometry and material quality of the physical environment impacts on our possible movement; we perceive spatial constraints from non-biophilic structures, which limit us from freely designing our own rhythms. Apologists for such non-accommodating environments falsely claim that they are necessary for technology. Technology can shape our environment to suit us, not the other way around. Our daily routine involves a range of movements and any pattern in our daily activity defines a temporal rhythm. Periodic events could occur throughout the day, or as once-a-day longer-term rhythms. Some

movements in daily routine are necessary, whereas we choose to perform others for our physical enjoyment. We try to establish such rhythms out of a natural need for temporal order.

A city wishing to attract new talent has to offer, among many other things, an urban morphology that accommodates daily life on a range of temporal scales. This is the “dance of life” (Hall, 1984), and like classical dance forms from all cultures, urban movement has its rhythm, complex fractal structure, and continuity (Whyte, 1988). People may not immediately perceive the effects of this dance upon themselves, but our life accumulates either the positive or negative effects of our daily routine, and our body will start giving us signals. Positive signals translate into wellbeing and being able to cope with unavoidable stress, whereas negative signals wear us out so that we become decreasingly able to handle normal stress in our daily environment. Our health suffers because a weakened state of being makes us prone to both external infection and to internal imbalances.

For example, a commuting trip of over 30 min generates stress, regardless of the means of transport. Research has discovered that people are willing to commute for up to one hour daily (round-trip), whether it is through walking, private car, public transport, bus, subway, or commuter train (Newman and Kenworthy, 1999). When this time is exceeded, however, quality of life diminishes. Therefore, the massive trade-off of enjoying a suburban front/back yard with lawn in exchange for two hours or more of round-trip commuting is actually not cost-effective as far as Biophilia is concerned.

Having access to a pedestrian environment (not necessarily strictly pedestrian; the traditional city with wide sidewalks lined with stores does very well) offers the possibility of excursions on foot that can be of any duration. A complex connected pedestrian geometry allows periodic actions of, say, 15 min (e.g. a trip to a coffee shop or park), which are unfeasible in a car city. Such trips do not need to be planned, just enjoyed if the visual stimulation and other factors are positive, and the duration of trips that are necessary for a specific function can be adjusted according to the occasion. This flexibility in time is not possible when driving to a destination, and the situation is only slightly better for public transport. In the Metropolitan transport of some central cities, a passenger can profit from the commerce located in and around the stations, but bus stops tend to be located in dreary places, with stations exposed or in hostile environments.

“Innovation” requires an environment that encourages a state of physical and emotional wellbeing (Ward and Holtham, 2000). The new dematerialized economy relies more and more on the material structure of the immediate surroundings. Persons who are not dependent upon the physical city for their work still rely upon the physical city for their wellbeing, demanding an environment that permits spatio-temporal rhythms. They judge where to locate using spatio-temporal and biophilic criteria. People who work with ideas and who drive the knowledge economy are those most able to relocate, and they will do so if repelled by a city with an alien geometry, towards a city with spatio-temporal attractions on the human scale. Many

knowledge workers nowadays occasionally base themselves in coffee shops with a wireless high-speed internet connection.

It is the wish of almost every city to position itself as a magnet for talent, for then it can attract knowledge industries such as Information and Communication Technologies, finance, advanced technology, arts industries, etc. to create a hub for the “Knowledge Society” (Tinagli, 2005). These are occupations that are relatively “clean” as far as industrial repercussions, yet have a very high value generation. It is well known that a concentration of talent and educated workforce pushes a city’s economy up to international standards, with corresponding feedback that benefits the entire city. Ever since the West’s manufacturing base shifted to the developing world, industrial production became much less attractive. Even in the developing world that has now captured industrial production, however, key cities compete to attract knowledge-based industries.

What attracts the educated and the talented to a city? It is quality of life, measured in part by the criteria I have outlined here, not by an alien urban morphology that follows a modernist design ideology. The point is that the highly-educated workforce for these technologies is more able to value environmental wellbeing that is described in this paper. Citizens wish, above all, to enjoy a stimulating and pleasant everyday life, in which normal tasks can be accomplished without too much stress. Their professional activities reside on top of this basis of wellbeing. Examples abound of intelligent professionals leaving a “magnet” city because everyday life has become too stressful or expensive. Much of this has to do with spatio-temporal scales: in the first case when working and living environments do not offer the biophilic range of scales; and in the second case when daily life is skewed towards uncomfortable time periods, as for example a long commute to work, getting children to school, food shopping, accomplishing regular out-of-house chores, etc.

I realize that the above thesis only presents a small part of a broader scenario, and, given human nature and human interactions, we may live in an earthly paradise and still be stressed from local crime, a corrupt government, or hostile colleagues at work. I do not deny any of that. What I wish to bring to attention is the much-ignored component of “pleasantness” that comes directly from architecture and urbanism. This includes respect for the natural environment so that buildings blend intimately with nature in a biophilic setting; design of cities to optimize a pedestrian experience of richly informational buildings; visual variety emphasizing the scales most responsible for a positive biophilic effect, etc.

Myths around energy consumption

We have been led to accept the myth that quality of life increases proportionally to energy consumption. While true for the onset of industrialization, this correlation is also responsible for an unsustainable global economy. The basic premise is a falsehood that has to be disputed before it can be reversed. Early technological advances permitted an improvement in the quality of life, but this does not mean

that increased happiness comes from wasting energy and natural resources. Unfortunately, major world industries have developed that work upon encouraging consumers to waste energy. The throwaway culture of shoddy consumer materials in the wealthy countries destroys the environment of the developing countries that produce all that stuff.

For example, we have developed an entire mythology (motion pictures, literature) around the pleasures of driving a car. There is undeniably a remarkable freedom in having a private vehicle that moves us fast on the surface of the earth, and this is a liberating notion in many ways, but it is a terribly expensive action as far as energy wastage is concerned. As much of the world's economy entails companies that extract, process, distribute, and sell petroleum products, it has made sense for them to create a car-oriented society through movies, media, and other components of manufactured culture. Just note that at the speed of a moving vehicle, biophilic effects from the environment diminish to the point of insignificance, except when one is actually driving through wooded countryside.

Put very simply, quality of life depends upon nourishment from the environment, and not upon energy consumption. The consumer society has done a very thorough job of convincing people the world over of an imaginary link between quality of life and energy wastage. That conjectured relation has only served the large part of our economy that runs upon energy production and consumption. Because of both the size of those related industries, and the present state of globalization, it is going to be very difficult to reverse the consumerist trend in the near future. Of course, the world will be forced into a totally distinct mode overnight after an energy catastrophe (due to shortages because of exhausted supplies, military action, or disruption in delivery channels), but past experience with transient energy shortages does not seem to have taught anyone a lesson about the future.

Placing this essay in the broader evolutionary context of humans and human technology, most of the things we once thought of as solely human — tool use, language, etc. — are now seen as more common to other animals. We distinguish ourselves, however, in being able to influence our environment on a massive scale. At the very heart of this process is the building of settlements, which uses up tremendous resources. The unsustainable system now in place in much of the world, supported by a consumerist philosophy and taken for granted, is that development and Gross Domestic Product depend upon increasing energy use. This system has a runaway positive feedback, and nature cannot possibly support it.

The discussion of geometry becomes central, because life that depends upon the geometry of the environment is an emergent system property, which is qualitative, not quantitative. Certainly, Biophilia is essentially structural — it arises out of complex structures involving fractals, networks, etc. — but it is not easily quantifiable. Hence what is basically a totally rational phenomenon requires very different tools for understanding and managing, and necessitates those who wish to stop the older, unsustainable paradigm to develop a different worldview. The profoundly simplistic limitations of our present thinking neglect and consequently

help destroy the complex emergent properties that allow life to flourish in the built environment.

The threat from deceptive high-tech sustainability

The global industrial system has learned the appeal of sustainability, and it is applying clever and deceptive techniques in order to perpetuate its world business. Perhaps the greatest threat faced by human-scale urbanism today lies in the nightmarish “sustainable” cities and urban projects proposed and built by fashionable architects. The global system has picked up the sustainable vocabulary and has used it to re-package their extraordinarily expensive and fundamentally unsustainable products (glass and steel towers, monstrous buildings, industrial-style cities in the middle of nowhere) as “sustainable”. The trick consists of using some technological gimmicks, and coming up with numbers for energy saved through having some solar panels and double glazing on the buildings’ glass façades. But this is a fundamental deception, since the city or country that buys one of these eco-monsters becomes totally dependent on the consumerist energy system.

As the companies selling such industrial products are the major multinationals tied into the power of Western states, it is extremely difficult to counter the publicity effort that is devoted to their promotion. Also, the selling occurs at the highest government levels, far above any decision-making that can be influenced by ordinary citizens. The client nation blindly trusts the giant Western-based multinationals to deliver a sustainable product because that is what the media promises. At the same time, the controlled media acting as a mouthpiece for the multinationals praise the client nation for its “great foresight” and its adoption of “progressive urbanism”. Since national pride is involved here, even the most blatant urban disaster will not be discussed openly. Maybe we will read of a new city that proved to be totally dysfunctional, or too expensive to run, after several decades have passed, but certainly not sooner.

Centralized governments have always been enamored of large-scale industrial solutions, industrial cities, massive five-year building plans, etc. Despite all good intentions, such projects proved to be totally dehumanizing in the past because they ignored human psychological needs and the human scale. Such initiatives are now reappearing as globalist urban applications, but with a newly-polished high-tech glamour. Many persons continue to support such projects, seeing them as proof that technology can solve every social problem. Old-style centralized industrialization is made toxic, however, by skewing everything towards the very largest scale.

By contrast, genuine sustainability uses small-scale technology linked in an essential manner to traditional socio-geometric patterns that connect a society to itself and to its place (Salinger, 2010). A genuinely sustainable approach enjoys the natural kinship of bottom-up entrepreneurial initiatives such as the Grameen Bank. We begin from the smallest scale and move up through increasing scales. A peer-to-peer network empowers the individual to work and act within a society in a way that benefits that society (Bauwens, 2005). Just as in any stable complex

system, different layers of functionality are added on increasingly larger scales, yet the working whole requires a balance of mechanisms acting on all scales, interacting horizontally as well as vertically. The new techno-cities, tragically, are designed to work on only one scale — the largest scale designed as an abstract sculpture on a fashionable architect's drawing table — in which case they may not work at all.

Readers of this essay may accept its premises on Biophilia and sustainability supporting cities on the human scale and decide to adopt my suggestions, but could be led astray by imitative contemporary design trends. I feel the need to raise an alarm against a group of fashionable architect/urbanists that are misusing science to advance their own agenda. Supported by our top schools and the media, this group embodies a superficial grasp of popular science, using words such as fractals, complexity, emergence, etc., and claims to offer a variety of sustainable urbanism. Ordinary people are attracted to these false promises, because they cannot tell the difference between true and bogus science. Nevertheless, the purpose of this movement is entirely self-serving.

In presentations that read very similarly to what could be one of my own texts, this group's discussions also introduce the keywords: "diversity", "unpredictability", "accidental", "indeterminacy", "optimism", and "opportunity"... Couched under a pseudo-scientific cover, however, the message says that there is no science of urbanism and no shared framework for effective design; therefore we have to build according to randomness. This assertion is as false as it is irresponsible. Its true message is the exact opposite of biophilia and sustainability that are based on scientific knowledge. What this group proposes is the continuation of inhuman ego-based experiments on the lives of human beings begun by industrial urban typologies used as agents of social engineering. As if its theoretical statements were not alarming enough, this group's marketing ploy always concludes by recommending its handful of favorite "star" architects for large urban projects.

Conclusion

It would be a tremendous move forward if people could be divested of their indoctrination that quality of life necessitates high energy expenditure. To replace the pleasures of daily living now provided through wasting energy resources, I propose a return to emotional nourishment from the built environment. This is very easy to accomplish, and only requires re-structuring our built environment to provide biophilic information. At the same time, the proposed restructuring necessitates a shift away from the energivorous car-oriented society towards a human-scaled urban fabric. Already in the past several decades, cities are embarking upon such a program of restructuring. Their motivation has been to save energy. What I am proposing is altogether different and goes much further towards improving the quality of life.

Biophilic nourishment is a positive experience that can substitute for giving up the thrills of riding around in cars at high speed. I believe that this is the crucial factor that can make a new sustainable society possible. The vast majority of people

will not give up their present wasteful lifestyle out of an altruistic desire to save their planet. We know from history that populations would rather proceed towards their own extinction rather than engage in self-sacrifice for the common good. What I'm proposing is different: you simply get your pleasure from a different source. And it works: environmental nourishment from Biophilia has sustained and satisfied people for hundreds of millennia up until the twentieth century. We are not talking about an untried experiment, but a return to something that we know works.

Lest critics raise objections about returning to the past, I would advise them not to worry. We are going to apply all our technological knowledge to solve problems that were present in urban living in previous times. Clean technology replaces dirty technology. There is no going back to a pre-industrial past of rampant disease unless it is brought on by economic collapse due to energy depletion. All we are recovering through Biophilia is the positive emotional experience, not the old problems in coping with everyday existence that we have now bypassed.

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