

Bio-regenerative rating technique: a critical review

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Abstract

Since the energy crisis in the 1970s, there has been a rising concern to energy efficiency and the influence of building on the natural environment and thus, innovative architectural designs should satisfy the natural environmental desires as much as the client's desires. Bio-Eco Architecture harnesses and replicates the principles found in nature in order to create built environments which benefit people and other living creatures as well as safe-guarding the biodiversity of the environment. Biomimetics in architecture will help develop a culture of active environmental design. This paper represents a comparative critical revision of five selected checklists aiming to reflect the changes in attitude that have affected sustainable design in the past 15 years as well as to combine all these concepts of sustainability for achieving the most helpful example which will not only help in creating a healthy environment but will also produce positive environmental impacts. It has been commonly noted that the main perception of nature influenced forms is basically aesthetic while little concern is given to the importance of inspiring from nature in the construction and structural performance of buildings, thus, this paper will present a comprehensive analysis of the roles that bio-inspiration (inspiring architectural form, function and construction process from natural organisms) plays in developing the concept of sustainable, ecological design and construction in contemporary architecture. This paper will discuss the significance of quantitative rating systems and checklists which could be applied to a technological worldview and are inappropriate for living system understanding and adaptation, thus, a better understanding of biological morphogenesis can usefully inform architectural



designing which aims to resolve challenges that have often already been resolved by nature.

Keywords: biomimetics, wilderness and regenerative based checklist, living building certification, biophilic design, LEED, inspiration from nature.

1 Introduction

Over many years of human intervention natural sites are unfortunately alerted by the act of building. “Green” or “sustainable” buildings can be characterized as buildings with a conscious effort to minimize their negative impacts on the environment as well as encouraging positive environmental and social impact of buildings. The UNEP [United Nations Environment Programme] and IUCN [International union For Conservation of Nature] also describe sustainable development as: “*Improving the quality of human life while living within the carrying capacity of supporting ecosystems*” [1].

It was 30 years ago when an architect (Malcolm Wells) authored a simple guide for design and construction of ecological green shelter in 1969 which was called the Wilderness-Based Checklist for Design and Construction. This checklist was the key concept for *the leadership in energy and environmental design (LEED)*, in 1998. Wells’ original checklist has been updated slightly during the summer of 1999 by the society of building science educators (SBSE) and is now referred to as the Regeneration-Based Checklist for Design and Construction. Natural analogies or biomimicry offer numerous inspirational lessons, they provide examples of how designing with nature can produce more effective, regionally sensitive and energy efficient buildings. Thus, Kellert [in his book *building for life 2005*] developed a set of *biophilic standards checklist* as he believes that “people don’t live by efficiency alone”. Low impact design as exemplified by LEED standards rarely enhances people’s physical and mental well being. In a further effort to create an advanced checklist that aims to achieve net-zero building impact, a step above LEED platinum but below *regenerative design*, the Cascadia Region Green building council had launched *the living building certification program (LBC)* in 2006.

Thus, this paper represents a comparative critical revision of the above five checklists in order to reflect the changes in thinking that have affected sustainable design in the past 15 years as well as to combine all these concepts of sustainability to achieve the most efficient example which will not only help in creating a healthy environment without any harmful effects but will also have a positive environmental and social impacts.

2 General review of selected sustainable rating systems

The following represents a moderate revision of most applicable green rating systems in today’s market as well as reviewing the old concept of regenerative checklists in order to create a comparative table aiming at exploring new concepts of bio-regenerative design.



it’s so important to recognize the value of the lessons the wilderness offers and the need to apply them right now [3].

2.2 The regeneration-based checklist for design and construction, 1999

The society of building science educators (SBSE) organized considerations for sustainable design and construction into two categories, Site and Building. Elements within each group, such as energy use and air quality, are then graded based on whether they are (regenerative) positive score which gives back to the environment or (degenerative) negative score illustrates the ecological damage done by ignoring concerns of sustainability. A sum of zero achieves sustainability. There’s no gold or platinum score in this checklist, just a healthy built environment and a happy planet [10].

		Project:									
		degeneration			sustainability				regeneration		
		-100 always	-75 usually	-50 sometimes	-25 a bit	0 balances	25 a bit	50 sometimes	75 usually	100 always	
the site	pollutes air										cleans air
	pollutes water										cleans water
	wastes rainwater										stores rainwater
	consumes food										produces food
	destroys rich soil										creates rich soil
	dumps wastes unused										consumes wastes
	destroys wildlife habitat										provides wildlife habitat
	imports energy										exports energy
	requires fuel-powered transportation										requires human-powered transportation
	intensifies local weather										moderates local weather
the building	excludes daylight										uses daylight
	uses mechanical heating										uses passive heating
	uses mechanical cooling										uses passive cooling
	needs cleaning and repair										maintains itself
	produces human discomfort										provides human comfort
	uses fuel-powered circulation										uses human-powered circulation
	pollutes indoor air										creates pure indoor air
	is built of virgin materials										is built of recycled materials
	cannot be recycled										can be recycled
	serves as an icon for the apocalypse										serves as an icon for regeneration
is a bad neighbor										is a good neighbor	
is ugly										is beautiful	

negative score 2200 possible	positive score 2200 possible
final score:	

Figure 2: Regenerative based checklist for design and construction (source: McClure and Bartuska [10]).

Wells and the sbse group explored the variables of an integrated, sustainable systems to design an approach that emphasizes the dynamic, symbiotic integration of human-environmental, ecological processes of the earth. This approach has come to be known as “Sustainable Systems and Regenerative Design (SS/RD)” which emphasize that the comprehensive set of factors discussed are not stand-alone, static variables but rather interactive parts of a dynamic biological/ecological system [10].

environmentally superior, considering its use of green technology and building techniques and many other aspects. These standards include prerequisites (required as a baseline for sustainable design) with points accumulated from many optional credits, LEED has worked well in part because its standards are clear and objectively measurable, and the results of meeting LEED standards are visible in employee health, energy costs, and resource use [9].

2.4 Biophilic standards checklist

Kellert (in his book Building for Life 2005) believes that the prevalent approach to sustainability is to look at nature and how it adapts itself without harming the ecosystem and while recognizing the significance of “LEED” he argues that “*people don’t live by efficiency alone*”. Low impact design as exemplified by LEED standards rarely enhances people’s physical and mental well being as he also says: “*By ignoring the human need to connect with nature and place, low impact designs are often experientially and aesthetically deficient*” [2].

Attributes of Biophilic Design			Elements and Attributes Biophilic Design		
Environmental Features	Natural shapes & forms	Natural patterns & process	Light & space	place connections	evolved relation to nature
Natural materials	Botanical motifs	Sensory Variability	Natural Light	geographical connection place	prospect & refuge
Natural colors	Animal motifs	Information richness	filtered & diffused light	Historical connection place	order & complexity
Water	Shell & spiral forms	Age, change	light & shadow	cultural connection place	enticement & curiosity
Air	Egg, ovular form	Growth	reflected Light	ecological connection place	change & metamorphosis
Sunlight	Arches, vaults, domes	Central focal point	Light pools	indigenous materials	Affection & attachment
Plants	Tree & columnar supports	Patterned whole	warm light	landscape orientation	Attraction & beauty
Animals	Shapes lacking right angles	bounded spaces	Light as shape & form	landscape ecology	Exploration & discovery
Natural views	Simulation of natural system	transitional spaces	spaciousness	Integrating culture & ecology	Fear & awe
Facade greening	Resemblance to natural features	Linked series & chains	spatial variability	sense or spirit of place	Information & understanding
Geology & landscape	Geomorphology	Integration of parts to wholes	space as shape & form	avoiding placelessness	Mastery & control
Habitat & ecosystem	Mimicking organic function-biomimicry	similar format different scale-fractals	spatial integration of lightness	landscape features that define building form	security & protection
Fire		dynamic balance & tension	inside & outside spaces		Reverence & spirituality
		complementary contrasts			
		hierarchically organized scales			

Figure 4: Biophilic standards checklist (source: Kellert [2]).

In an effort to create restorative and regenerative design Kellert developed a set of biophilic standards checklist based on 6 elements and 75 attributes, calling it “A pattern language to help people who want a checklist”. According to Kellert, biophilic design has to make sense in context and must make sense culturally. Biophilic standards checklist provides a base to design in harmony with nature but don’t offer a meaningful Bio-Eco regenerative checklist.

2.5 The living building checklist (LBC)

According to leading biomimetic thinker Bill Reed: (*who co-chaired the development of LEED standards from the outset*): “*We could have a world full of LEED platinum buildings and still destroy the planet, these greener designs,*



though progressive, often stick too close to the existing standard in a way that is simply “less bad” [7].

According to Jason McLennan, AIA: (*Living Building Challenge Creator and Cascadia CEO*): “A world full of typical green buildings doesn’t get us where we need to be to avoid environmental catastrophe” [6].

So, it was believed that a LEED certification is not enough for a better healthy regenerative environment, thus, systems and strategies are needed to avoid environmental catastrophe. Consequently, the living building certification (LBC) has been established in 2006 by the International Living Future Institute grew out of the Cascadia Region Green Building Council which certifies the World’s Greenest Buildings aiming to recognize buildings meeting the highest level of sustainability [7].

	NEIGHBORHOOD	BUILDING	LANDSCAPE+IN FRASTRUCTURE	RENOVATION	
SITE					LIMITS TO GROWTH
	<i>Scale Jumping</i>				URBAN AGRICULTURE
			<i>Scale Jumping</i>		HABITAT EXCHANGE
					CAR FREE LIVING
WATER			<i>Scale Jumping</i>		NET ZERO WATER
	<i>Scale Jumping</i>				ECOLOGICAL WATER FLOW
ENERGY			<i>Scale Jumping</i>		NET ZERO ENERGY
HEALTH					CIVILIZED ENVIRONMENT
					HEALTHY AIR
					BIOPHILIA
MATERIALS					RED LIST
	<i>Scale Jumping</i>				EMBODIED CARBON FOOTPRINT
					RESPONSIBLE INDUSTRY
					APPROPRATE SOURCING
EQUITY					CONSERVATION+REUSE
					HUMAN SCALE+HUMAN PLACE
					DEMOCRACY+SOCIAL JUSTICE
BEAUTY					RIGHTS TO NATURE
					BEAUTY+SPIRIT
					INSPIRATION+EDUCATION

Figure 5: Living building certification checklist (source: www.ilbi.org, retrieved 15-1-2012).

The main strategy of this rigorous certification is to contribute to the ecosystem, emulating the natural systems of the world by pushing architects to think not about doing less harm to the earth, but about doing no harm and even restore the environment. At a minimum, LBC projects aim to achieve a net-zero building impact, a step above LEED Platinum but below regenerative design, in which a building would give more back to the earth in terms of ecological services than it takes away. From there a project can either be regenerative or restorative. Buildings must meet stringent site requirements, achieve net-zero energy and water use, avoid the system’s red-listed materials, and source materials locally. A project not only must require no recourse to renewable

energy, but it should give back to the local community and/or eco-system. One of the main differences between LBC and LEED is being based solely on actual recorded performance. A project cannot be granted a Living Building Challenge certificate for at least a year after completion to properly monitor energy use and occupant behaviour. Achieving LBC Certification, with all prerequisites and no complicated credits and points (*In contrast to most other rating systems, including LEED, with points accumulated from many optional credits*) is difficult but not impossible. LBC has 16 prerequisites divided into a half dozen categories (called “petals”). Project teams can choose whether to pursue all of the prerequisites and achieve full certification or pursue one or two petals and be recognized for leadership in specific areas. In both cases the requirements for each prerequisite are all or nothing. The system is not designed to measure or even rate buildings in the traditional sense but it is intended to change the way of designing and to transform the way code officials and manufacturers think about buildings and products. The rating system looks relatively simple but behind the apparent simplicity are nuances that deal with the reality of current market conditions in the form of a variety of exceptions particularly those involving materials and water. These exceptions are granted when a team is unable to meet one of LBC’s requirements despite significant effort. The exceptions make LBC possible in today’s market conditions as McLennan noted: *“It may be bloody hard, but it’s achievable”* [6].

3 A critical analysis of the previous checklists

Although, green architecture is much more than one that is conserving energy and minimizing pollution, many green rating system approaches are used to show “false positive”, this is because the concept of green building in contemporary usage is intended to imply buildings above and beyond minimum code requirements with the primary focus and intent being to protect the environment. It is important to note that being rated does not mean a building has no negative impact on the environment.

Some critics of LEED rating system have concluded that *“there is evidence that society is not using LEED as guideline to reduce ecological impact, but rather as an asset for positive publicity”* [4].

Other critics have pointed out that the application of rating systems are very subjective process with few criteria which are truly measurable. Further criticism define rating system is based on checking certain components on the building without assessing the ability of the building to continue providing outstanding service for the future. For example, a sustainable proposed development could have landscape roofs, geothermal energy production, photovoltaic panels, high performance window and extensive use of recycled and renewable materials, but be a hulking structure, out of scale with the neighbourhood. This cannot be taken to state that green buildings methodologies are unsustainable, but it does suggest that vital point has been missed in current green building thinking and practice.



3.1 What is missing in current green building thinking?

The missing vital points in green building thinking could be: the sense of place and mimicking the natural organisms as well as the occupant satisfaction.

3.1.1 Lack of sense of place

Although, the heart of ecological design is to design with and for place, in the era of globalization, cheap and abundant energy and materials, place seems not to matter. One place seems interchangeable with another. Architects and their clients have created a “geography of nowhere”, disregarding the physical and cultural context that makes one place unique from another.

A living building in the future should act like all living creatures which use specialized strategies for adapting to the dynamic conditions of their environment, for example, desert plants and animals have evolved specialized strategies for adapting to the extremes of temperatures, sunlight and moisture, taking cues from these creatures, an ecologically designed desert structure might apply analogous adaptations, using the building’s skin to convert sunlight into electricity or perhaps integrating radiations and cooling towers with the building’s communication systems. The idea is to design as nature does: optimizing systems by finding multiple functions for each part.

3.1.2 Lack of the occupant satisfaction and comfort

It was 30 years ago, when psychologists and architects, [including the senior author, Van der Ryn and Silverstein, 1967] pioneered the post-occupancy evaluation of buildings in an effort to build an objective reliable database on how designed environments affect occupant’s health, well being and performance. Unfortunately, architectural profession resisted this effort at objective evaluation as an infringement on professional prerogatives and institutional clients discouraged outside evaluation as a potential source of criticism of their decisions. As a consequence the majority of rating systems measure the intention of designer rather than the performance of the building. That’s why there is a need to provide a satisfaction scale that can measure the satisfaction of the building occupancy in the operation stage as well as measuring the human productivity. also it should be noted that improving occupant health, Comfort, productivity, reducing pollution are not easily quantified, but it may result in sort of qualitative analysis through a post occupancy questionnaire collected during the operation of the building before it could be certified.

4 Sustainability concept within bio-eco rating techniques

According to the previous review some of the key concepts of any sustainable development can be classified as shown in Tables 1 and 2.

4.1 A comparative analysis of different sustainable checklists based on the previous classification of sustainable bio-eco regenerative rating techniques



Table 1: Some of the key concepts of sustainable development.

CREATING A CLEAN ENVIRONMENT	Clean Air
	Clean Water
	Clean Soil
MIMICKING NATURAL SYSTEMS IN THE WAY THEY ACT FOR SURVIVING OR ECOMORPHISM	Store, Filtering And Re-Use Rainwater
	Use Renewable & Clean Energies And Store Solar Energy
	Recycling Everything Or Consuming Its Own Waste
	Produces Its Own Food
	Maintains Itself
	Minimize Materials Use While Providing High Efficiency
PROTECT WILDLIFE HABITAT	Use Local Materials
	Habitat Exchange
PROTECT HUMAN HABITAT	Limits Of Growth
	Occupant Satisfaction And Comfort
BE A GOOD NEIGHBOR	Sense Of Place
	Creates Silence
	Be Beautiful And Have A Nature Inspiration

5 Conclusion

A philosophy of ecological design will eventually have profound impact on architecture and technology. In the future world will be designed to function like living organisms, specifically adapted to place and able to draw all of their requirement for energy and water from the surrounding, while the main role of the architect will be how to design an “Ecomorphic buildings” buildings that mimic natural systems and have the capacity to reconnect people to nature. A healthy environment and pure air can enhance human mental well being and by consequence will enhance human productivity. Plants are the true producer of oxygen able to absorb and ameliorate the effect of air or soil pollution. Thus, by considering the importance of creating a clean environment for all species health, architect should cooperate with agricultural, biologist and other experts in the design process of any building, so they can calculate the amount of oxygen emission per hour for each type of plant, while the architect with the biologist can calculate the amount of CO₂ emission per person per hour and by this equation they should provide in the design green areas which will help the building to present a positive contribution to the natural environment. This is because if human act of the construction embodied carbon footprint could be neutralized and they could stop using materials with a voltaic organic compound emission, stop burning fossil fuel, they could never stop breathing and emitting CO₂ to the environment. There is also a lack in integrating the protection of the topsoil as well as considering the importance of producing the own food of a neighbourhood in the advanced sustainable rating systems, however, it has been presented in the very early checklist of Malcolm Wells but unfortunately people don’t take this point into consideration.



Table 2: Some of the key concepts of sustainable development.

Imperative	Elements	The Wilderness Checklist	The Regen. based Checklist	LEED	Biophilic design Checklist	LBC
Creating Clean Environment	Clean Air	-Creating pure air	-Creating pure air in site -Creating pure indoor air -Requires human-powered transportation -Use human powered circulation	-Low emitting and fuel-efficient vehicles -Low emitting materials -Indoor chemical and pollutant source control	-Plants existence -Façade greening -Air purity -Geology and landscape preservation	-Urban agriculture -Healthy air -Offset the embodied carbon footprint of the construction, -Car free living -Red list materials
	Clean Soil	-Creating rich soil	-Creates rich soil	- No equivalent	- No equivalent	- No equivalent
	Clean Water	-creates clean water	-creates clean water	- Water use reduction 20% - Water efficient landscape - Innovative wastewater technologies - Storm water design- quality control	-Water as an environmental feature	-Net zero water -The ecological water flow
Mimics Natural Systems In The Way They Act For Surviving	Store, and Re-Use Rainwater	-Stores rainwater	-Stores rainwater	-Water efficient landscape	-Mimicking organic function "Biomimicry"	-Net zero water -The ecological water flow
	Use and store Renewable, Clean Energies	-Use solar energy -Stores solar energy	-Using passive cooling -Using passive heating -Use daylight -Export energy	-On-site renewable energy -Green power	-Sunlight -Natural light -Mimicking organic function "Biomimicry"	-Net zero energy use
	Recycling Everything or Consuming Its Own Waste	-Consumes its own waste -Matches nature's cycles	-Consumes wastes -Built of recycled materials -Can be recycled	-Construction waste management -Material reuse -Recycled content -Rapidly renewable materials	-Mimicking organic function "Biomimicry"	-Conservation and reuse of materials



Table 2: Continued.

Imperative	Elements	The Wilderness Checklist	The Regen. based Checklist	LEED	Biophilic design Checklist	LBC
Mimics Natural Systems In The Way They Act For Surviving	Produces Food	-Produces Its Own Food	-Produces food	- No equivalent	- No equivalent	- No equivalent
	Maintains Itself	-Maintains Itself	-Maintains Itself	- No equivalent	-Mimicking organic function "Biomimicry"	- No equivalent
	Minimize Material Use	-No equivalent	- No equivalent	- No equivalent	-Mimicking organic function "Biomimicry"	- No equivalent
	Use Local Materials	-No equivalent	- No equivalent	-Regional materials	-Mimicking organic function "Biomimicry"	-Using appropriate materials
Protect Wildlife Habitat	Habitat Exchange	-Provides wildlife habitats	-Provides wildlife habitats	-Protect or restore habitat	-Landscape ecology	-Providing habitat exchange
	Limits of Growth	-No equivalent	-Serves as an icon for regeneration	-Brownfield development	- No equivalent	-Limits to growth
Protect Human Habitat	Occupant Satisfaction and Comfort	-Provides human habitats	-Provides human comfort	-Increased vent. - Controllability of systems -Thermal comfort-design -Daylight and views-daylight -Daylight and views- views -Indoor chemical and pollutant source control	- No equivalent	-Human scale + human places -Democracy + Social Justice



Table 2: Continued.

Imperative	Elements	The Wilderness Checklist	The Regen. based Checklist	LEED	Biophilic design Checklist	LBC
Be A Good Neighbor	Sense of Place	-Moderates local weather	-A good neighbor -Serves as an icon for regeneration -Moderate local weather	-Innovation and design process -Regional priority	-Geographical connection place -Historical connection place -Cultural connection place -Ecological connection place -Indigenous materials -Landscape orientation -Landscape ecology -Integrating culture and ecology -Sense or spirit of place -Avoiding placelessness -Landscape feature that define building form	-Rights to nature
	Creates Silence	-Creates silence	-A good neighbor	-Innovation and design process -Regional priority	- No equivalent	-Urban agriculture
	Be Beautiful And Have A Nature Inspiration	-Is beautiful	-Is beautiful	-Innovation and design process	-Natural shapes and forms -Natural patterns and process -Evolved relation to nature	-Beauty + spirit -Inspiration + education

A building to be listed as a bio-eco regenerative should first maintain itself, this could be achieved by mimicking natural organisms function (Biomimicry), this credit is found in the original checklist by wells but unfortunately hasn't be developed in the most known applicable sustainable rating system, it could



indirectly fall under the credit of innovation. Creating silence is also a very important credit for a building to be listed as a bio-eco regenerative design but it couldn't be defined without the post occupancy evaluation as well it is not listed in the set of credits available in the most known sustainable rating systems.

Recently, human priorities have changed so that sustainability and regenerative design must take a high priority through all sectors of society as well as the governmental sectors. A quantitative rating systems and check lists could be applied to a technological worldview and are inappropriate for living system understanding and adaptation. Principle based understanding is essential for living systems because each place and being is unique and requires a level of understanding that acknowledges and identifies this uniqueness or essence. A qualitative assessment tool in form of a checklist as a guideline to encourage regenerative design could be applied in living building strategies by providing a post occupancy evaluation samples to measure and evaluate the degree of comfort and the applicability of regenerative strategies in each building.

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