Regenerative Design and Development for a Sustainable Future: Definitions and Tool Evaluation

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Dedication

Bismillahirrahmanirrahim: In the name of Allah, most gracious, most merciful.

To my dear husband, Ismail Akturk.

Abstract

This thesis investigates the emerging field of regenerative design and development, its current theory and practice, and design support tools. The purpose is 1) to define 'regenerative design' and 'regenerative development' and clarify the distinction between them, 2) to propose an overall framework that offers a new understanding of success with both quantitative and qualitative patterns, and 3) to evaluate the emerging regenerative design support tools— REGEN, Eco-Balance, Perkins+Will Framework, Living Building Challenge, and LENSES.

Regenerative design is an approach to shape and form a system that seeks to reverse environmental degradation by creating positive impacts, rather than merely causing less damage, to increase the health and wellbeing of humans, other living beings, and ecosystems as a co-evolutionary whole. Moreover, *regenerative development* is an approach for enabling human communities to co-evolve with natural living systems and building the field of caring for ongoing stewardship and self-renewing. *Regenerative design and development*, together, implies that these two approaches are interrelated and need to be discussed together.

The proposed framework, Holistic Regenerative Design Framework, is an effort to visually represent the key attributes and principles of regenerative design and development. The framework has four Essences: Philosophy, Design Process, Indicators, and Emergence of Regeneration. Each Essence includes four main categories to identify the focal points.

The Holistic Regenerative Design Framework can be used in design processes and evaluation of tools or case studies. This thesis aims to use the Framework to evaluate the regenerative design support tools listed above. The goal is to explore how the tools apply the concepts of regenerative design into design processes, what kind of methods and techniques they offer, and what their gaps and limitations are. This thesis concludes by providing recommendations for using the tools together instead of picking one and claiming it is the best.

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List of Abbreviations

ANSI: American National Standards Institute

BNIM: Berkebile Nelson Immenschuh McDowell

BREEAM: Building Research Establishment Environmental Assessment Method

CEO: Chief Executive Officer

CLEAR: Center for Living Environments and Regeneration

GB Tool: Green Building Tool

GIS: Geographic Information Systems

HRDF: Holistic Regenerative Design Framework

HVAC: Heating, Ventilation and Air Conditioning

ILFI: International Living Future Institute

LBC: Living Building Challenge

LCA: Life Cycle Assessment

LEED: Leadership in Energy and Environmental Design

LENSES: Living Environments in Natural, Social, and Economic Systems)

MTS: Institute for Market Transformation to Sustainability

SBTool: Sustainable Building Tool

SBAT: South African Sustainable Building Assessment Tool

SpeAR: Arup's Sustainable Project Assessment Routine

USGBC: United States Green Building Council

WSIP: Whole System Integration Process

CHAPTER I: INTRODUCTION

The emerging field of regenerative design and development redefines the goal of built environments, the process of design, and the role of designers. It extends the concept and application of sustainability. With green and sustainable design, designers and practitioners have become increasingly engaged in thinking about how their works impact the world and the environment. Although the current practices of green design exhibit many improvements on conventional design for conserving resources and reducing the damage to the environment and humans, they only slow down the degradation of earth's natural systems. Regenerative design and development aims to reverse the degradation and negative environmental impacts instead of merely slowing them down. It advocates for the interconnectedness of human and nature and whole systems thinking to create living systems that are mutually beneficial and co-evolving for nature and humans. Regenerative design and development is not just about architecture; it is also about people and their activities. It searches for a better way to live on this planet.

The problem is that the theory and concept of regenerative design and development is complex. It is not easy to set measurable performance goals like green design approach. However, a number of new regenerative design support tools are emerging to guide the transition. They strive to depict the key characteristics and attributes of regenerative approaches and assist practitioners, designers, and stakeholders. These tools serve a significant role in bridging the theory and the current building practice.

Although the concept of regenerative design and development is gaining prominence and the tools are entering the medium, there is still a big need for future studies to create adequate metrics and methods in order to comprise whole systems thinking.

CHAPTER II: CHRONOLOGY

It is necessary to provide a bigger picture for the evolutionary journey of the regenerative paradigm, although giving detailed historical information about regenerative approaches is not the purpose of this thesis. A timeline was developed to exhibit key names, concepts and books published in the last two centuries as a visual summary of chronology (Figure 1). This timeline aims to serve as a starting point for someone who would like to search and explore the underlying thinking process of regenerative approaches more deeply.

Two sources were examined and the key events were determined to develop the timeline. The graph of tree rings is used in the background as a metaphor to express the time process. It is inspired by the Perkins+Will Regenerative Design Framework's cover page. The first source for the timeline is the chronology part of Mang and Reed's paper in the *Encyclopedia of Sustainability Science & Technology* (2012b, p. 3-8). The second one is the Regenesis Group's annotated bibliography, *Introduction to the Thinking behind Regenerative Development*. The timeline uses the first source as a main source and examines the second source for additional key books and concepts. Mang and Reed do not include the studies done after 1995 in their chronology. The timeline was extended until 2015 in this thesis by including current studies.

Mang and Reed lay out the chronology of regenerative thinking under six main themes: Early roots; Development of the ecosystem concept and ecological perspective; New foundations for systems theory and systems thinking; Ecological sustainability —foundations of regenerative development and design; Ecological design systems proliferate; and Emergence of regenerative development and design as distinct disciplines. The authors start the chronology in the 1880s as early roots introducing Ebenezer Howard and continue with Lewis Mumford in 1902 and Patrick Geddes in 1915. These scholars influence the origins of ecological thinking by calling attention to the unsustainable growth of cities. In the second theme, Mang and Reed (2012b) address Arthur Tansley's works. In 1935, he introduces the concept of ecosystem and posits that living organisms and their environment are not separable. Tansley's concept was developed over time and has become a framework for sustainable urban planning. Mang and Reed argue that complexity science provides a new foundation for system thinking. According to them, the discoveries in complexity science lead to the idea of not being able to understand complex systems in a simple way. This helped the emergence of 'systems thinking.' In the 1960s-70s, Charles Krone, a system theorist, developed 'living systems thinking' as a continuation of his system thinking studies. Mang and Reed point out the influential importance of Krone's work for

the Regenesis Group to develop the concept of 'regenerative development and design.' After that, Mang and Reed note that the studies about 'ecological sustainability' and 'permaculture' in the timeframe between 1969- the 1990s introduced the concept of 'regeneration' as a new perspective for ecological performance for the built environment. In 1969, Ian McHarg, landscape architect, published *Design with Nature,* which represents a method for ecological land-use planning based on understanding natural systems. His book has become a foundational source and its concept was used to develop the Geographic Information Systems (GIS)[1]. Bill Mollison and David Holmgren introduced the term permaculture as an ecological design system that integrates human and natural systems and develops a technology for self-sufficient human communities and food production systems. In the 1990s, several scholars like David Orr, Nancy and John Todd, Frijtof Capra, Sim van der Ryn and Stuart Cowan studied 'ecological design' and its principles. Their studies and books are ground breaking and foundational in the literature. According to Mang and Reed, "emergence of regenerative development and design as a distinct discipline" starts with John Tillman Lyle and his book named *Regenerative Design for Sustainable Development* in 1994 (2012b, p.7). The book is the first handbook that outlines regenerative design and its principals and strategies. After 1995, Regenesis Group, where Reed and Mang are also the principles, studies to develop a theoretical and technological foundation for regenerative development and design.

The second source, Regenesis Group's annotated bibliography, covers a broader list of authors, thinkers and books. It notes that it is not a complete list but introduces the thinking behind the concept of regenerative approaches. The bibliography has three main categories: living systems worldview, key thinkers, and applying the living systems worldview. In the applying the living system worldview section, Regenesis lists the books that are from different fields such as design, architecture and planning; role and potential of humans; economics and business; and education to express "how it extends across conventional boundaries" (p.4).

The two sources both consider John Tillman Lyle's book to be the first key work that extends the concept into the built environment and the field of architecture. His work strives for applying regenerative methodologies to all of the life supporting systems.

[1] GIS is an essential tool for ecological development, and it links data with geography by using multilayered maps.

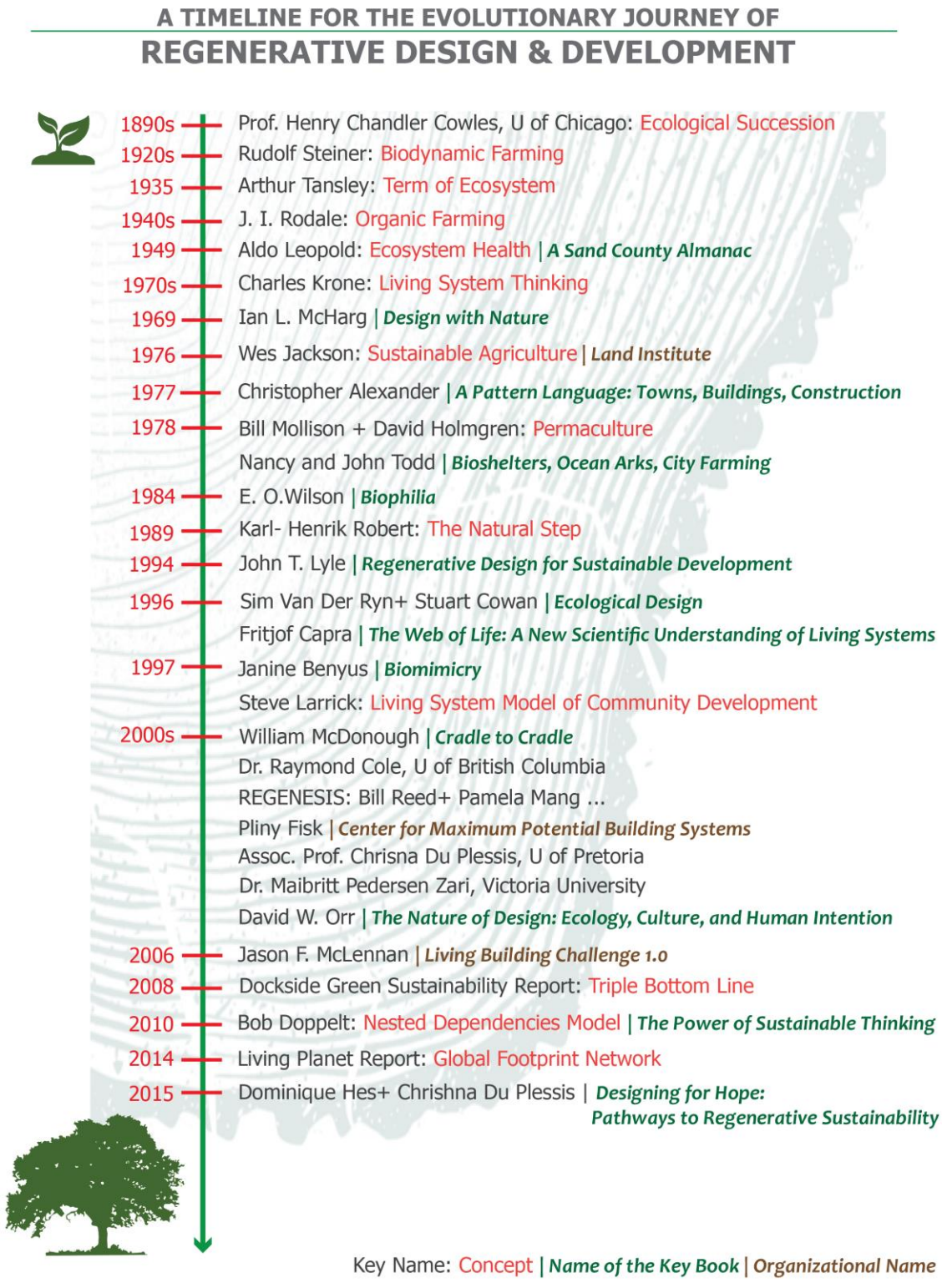

Figure 1: Timeline for Regenerative Design and Development

CHAPTER III: LITERATURE REVIEW

As a first step in this investigation, the current literature on regenerative design and development is reviewed. Key topics of the literature are organized in six sections: foundations of regenerative paradigm; the concepts of green, sustainable and regenerative; the importance and impact of regenerative design and development; key characteristics of regenerative approaches; a framework and methodology from the Regenesis Group; and a metric: ecosystem services.

Four different types of sources were used to examine the literature. These are theoretical, contextual, original and methodological sources. The theoretical sources are used to examine the roots of regenerative paradigm and the underlying theory. They can be categorized around two main areas: the theory of mechanistic and ecological worldview (Capra, 1997; Van der Ryn and Cowan, 1996; McHarg, 1969; Elgin and Le Drew, 1997) and the theory regarding 'paradigm,' 'paradigm shift' and 'social ecology' (Kuhn, 1962; Popper, 2004; Wilber, 2001; Bookchin, 1987). The second type, contextual sources, covers the existing studies regarding regenerative design and development. Contextual information is mainly gathered from the eight papers (Table 1) in the special issue of *Building Research &Information: Regenerative Design and Development* published in 2012; Hes and Du Plessis's recent book titled Designing for Hope: Pathways to Regenerative Sustainability (2015); and sources shared in Regenesis Group's website. Thirdly, the final versions of the regenerative design support tools (REGEN, Eco-Balance, Perkins+Will Framework, LENSES, LBC) are obtained as original sources and used for evaluation. Lastly, the article written by Mang and Reed in the special issue, *Designing from Place: a Regenerative Framework and Methodology*, is the only methodological source which is examined in this thesis.

R.J. Cole	Editorial: Regenerative design and development: current theory and practice
C. du Plessis	Towards a regenerative paradigm for the built environment
P. Mang and B. Reed	Designing from place: a regenerative framework and methodology
R.J. Cole	Transitioning from green to regenerative design
M. Pedersen Zari	Ecosystem services analysis for the deisgn of regenerative built environments
C. Hoxie, R. Berkebile and J.A. Todd	Stimulating regenerative development through community dialogue
P. Svec, R. Berkebile and J.A. Todd	REGEN: toward a tool for regenerative thinking
R.J. Cole, P. Busby, R. Guenther, L. Briney, A. Blaviesciunaite and T. Alencar	A regenerative design framework: setting new aspirations and initiating new discussions
J.M. Plaut, B. Dunbar, A. Wackerman and S. Hodgin	Regenerative design: the LENSES Framework for buildings and communities

Table 1: Authors and Titles of Articles in the Special Issue of Building Research & Information (2012)

Although four types of sources are used, the contextual and original sources cover the main topics and scholars of regenerative design and development. They are mapped in Figure 2.

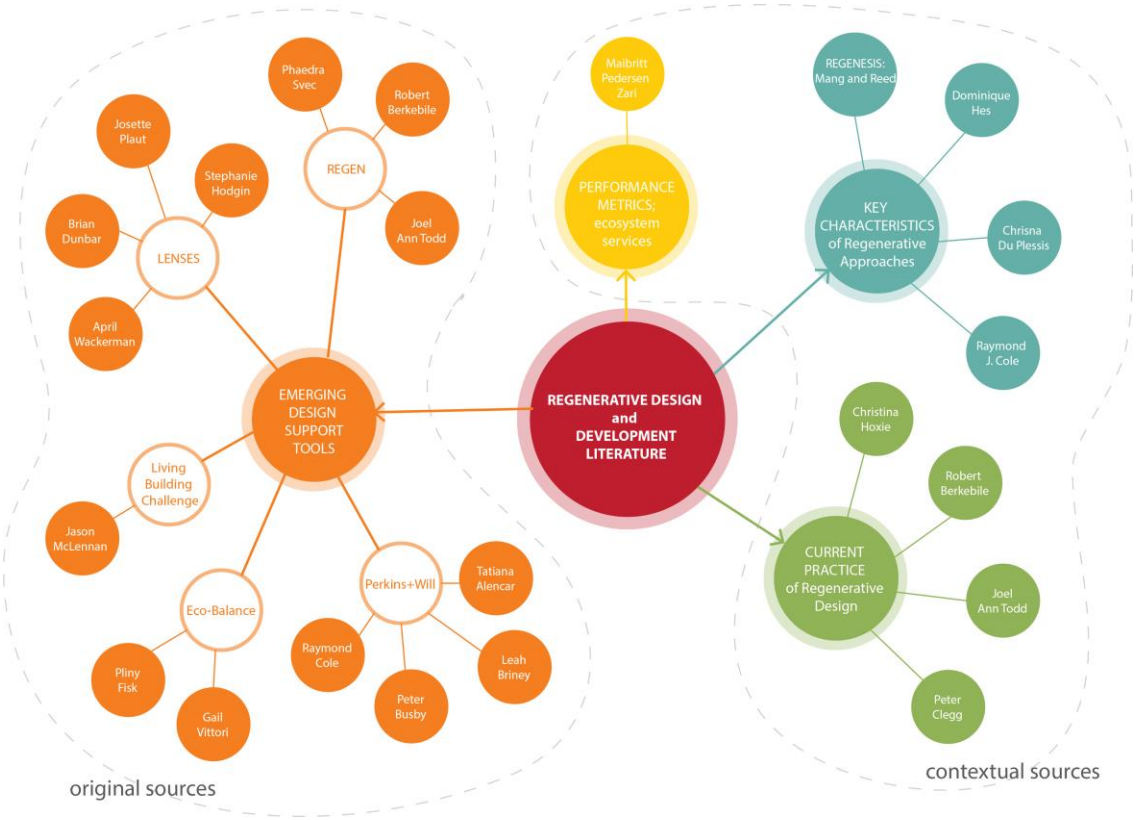

Figure 2: Literature Mapping of Regenerative Design and Development

a. Foundations of Regenerative Paradigm

There is a recognizable progress in the field from a narrow focus on using resources more efficiently to a broader vision embracing the ideas of systems thinking, understanding the whole and interconnectedness of strategies. This represents the much needed emerging transition that can be thought of as a continuum that moves from degenerative to sustainable to regenerative development.

Regenerative design and development as a 'distinct' field emerged from an ecological worldview, and its foundation goes back to the 1890s (See Chapter II). It aims to extend a development from a 'net-zero' approach to one that creates 'net positive' outcomes for ecological, social, and economic development as a whole. Regenerative paradigm questions the role of humans, design and built environment. It requires a different type of thinking, whole

system understanding and participation in nature. The essential concepts about the foundations of regenerative approaches are investigated in three main subtitles: the notion of limits and environmental problems; the prevailing paradigms; and the notion of regeneration.

The Notion of Limits and Environmental Problems

The sustainability literature mainly discusses environmental problems and the 'notion of limits.' It recognizes the negative impacts of human development and strives to reduce these impacts by using resources efficiently. Regenerative design and development offers another perspective and strives to create positive impacts to reverse the degeneration. It advocates to change human behavior as well as the way we design and create built environments to 'heal,' 'regenerate' or 'flourish' the earth by participating in the living system. It advocates seeing these crises as opportunities to do something better.

Environmental concerns increased and gained significant momentum in the 1970s and were propelled by books like *Silent Spring* (1962) and the *Limits to Growth* (1972). *Limits to Growth*, written by Meadows, Randers, and Behrens, explores the consequences of growth in population, industrialization, pollution, food production, and resource depletion for the Earth's ecosystems. Existing research manifests findings regarding many problems such as the presence of ozone hole; anthropogenic climate change and acid rain; augmentation of greenhouse gases; fresh water scarcity; extinction of plant and animal species (biodiversity loss); peak production of nonrenewable resources such as oil, natural gas and coal and so on. The literature states that the world is coming close to an end because of human behaviors. Hes and Du Plessis support this notion in their book, stating "we are well aware that the tenancy of humans on Planet Earth is rapidly pushing the planet past certain limits" and "[t]he world has already exceeded a number of critical operating boundaries in the ecosystem services provided to humanity (and other living beings) and is falling short of meeting important quality of life indicators" (2015, p.12).

Du Plessis (2012) examines the notion of limits and argues that it has two disadvantages for the concept of sustainability: increased materialism and economic perspective. She mentions that defining limits might cause acceptance of the idea of 'living with-in these limits':

> [The notion of limits] resulted in the reframing of the sustainability debate as a matter of determining limits (e.g. ecological footprints, fair shares, sink and source capacities, efficiency factors) and then living within these limits- in other words, determining how much damage can feasible be inflicted (2012, p. 12).

In addition to that, she notes that the idea of being able to calculate (e.g. values or limits) speculates the probability of having certain accurate predictions or one correct value to evaluate and understand a built environment from an ecological impact standpoint (e.g. ecological footprint, LCA, and assessment systems such as LEED and BREEAM). However, "there are also qualitative and normative limits to current models of growth and development that are impossible to predict, let alone quantify or price in currency of any sort" (Du Plessis, 2012, p. 14).

In summary, the predominant atmosphere and narrative of sustainability emphasizes the themes of alarm, pessimism, and a depressing possible future because of the environmental problems. However, an increasing number of scholars see this discourse as demotivating. For instance, Du Plessis, Johnston and Plaut[2] mention that it spreads a depressing, hopeless, and powerless message and does not provide hope to solve the problems. Hes and Du Plessis emphasize the need for hope and state:

> There is a wonderful opportunity in this period of change to create an alternative model of development that will lead to a thriving future. However, to harness this opportunity we need to think differently about how we see the world, how we define the problems to be solved, and how we can contribute as designers (2015, p.12).

The Prevailing Paradigms

Currently, there are two fundamental prevailing paradigms in the literature: a mechanistic and an ecological worldview. Regenerative design and development has its own roots in the ecological worldview. Changing the current dominant paradigm and 'transforming the way we create the built environment' are central tasks for a regenerative approach. There is a concurrence in the field about the significance of paradigms to create a world in which humans and their ecosystems can flourish. Mang and Reed (2012a) note that understanding of how a design practitioner's worldview influences which methods are chosen and how they are applied is essential to achieve the approach. According to Raymond Cole, worldviews have the power to "mature and become manifest in the shaping of human endeavors, including human settlement patterns and building practices" (2012a, p. 2).

The terms 'paradigm' and 'worldview' are used frequently and interchangeably in the literature. The paradigm can "be viewed as a way of looking at the world that requires a specific set of tools to study the phenomena of this world from this particular perspective" (Du Plessis and

[2] This information is obtained from the *Regenerates Film* which was compiled from the interviews conducted by Chrisna Du Plessis and Dominque Hes for their book *Designing for Hope*.

Brandon, 2014, p.2). Du Plessis and Brandon describe paradigm by noting that "it not only engages with our scientific understanding of the world, but also with our value systems and ideologies, as well as our ideas about sense-making, problem-solving, decision-making and correct action based on how we evaluate reality and the possible futures to which these actions may lead" (2014, p.2). Scholars like Cole and Du Plessis use the phrase 'shifting the current paradigm' to explain the transition from a mechanistic to an ecological worldview.

Thomas Kuhn[3] is the father of the term 'paradigm shift.' According to Kuhn (1962), the paradigm shift requires replacing the old paradigm with a new one, and scientific paradigms are incommensurable. This means that the new theories were not, as the scientists had previously thought, just extensions of old theories, but were instead completely new worldviews. Mang and Reed (2012a) and Haggard (2002) support Kuhn's idea by noting that regenerative approaches require an entirely new mind, not just adopting a few new mental models. Although Kuhn's studies are widely accepted, there are some criticisms of him in the context of his understanding of growth of knowledge. His colleague Popper (1963; 2004) does not accept 'discontinuity' of paradigms and argues that new knowledge, new thinking, and new technology are built by developing successful ideas based on a set of values. According to him, the paradigm shift might happen and a new worldview could come, but the knowledge and the tools of the old paradigm can still be partially valid for relevant topics. Wilber supports Popper and mentions that "any new worldview builds on the knowledge and insight accumulated through numerous preceding worldviews, but adds its own insights to increase the scope and coherence of the picture being revealed by the accumulated knowledge and wisdom of all these worldviews" (as cited in Du Plessis and Brandon, 2014, p.3). Du Plessis and Brandon support Popper and Wilber by noting that "while referred to as a new worldview, it is in reality emerging from an amalgamation of ancient worldviews" (2014, p.2).

Mechanistic worldview

The mechanistic worldview covers the timeframe between mid-17th century and early 20th century. It is also known as the Cartesian- Newtonian mechanistic worldview (Cole, 2012a). It sees nature as a machine that humans can manage by understanding its parts. Van der Ryn and Cowan argue that "the metaphor of the machine allows us to see nature as a passive and malleable resource, ready to be refashioned into useful products" (1996, p. 28). The mechanistic

[3] Kuhn breaks up science into five distinct phases in his book *The Structure of Scientific Revolutions*: pre-paradigm; normal science; a crisis; scientific revolution; and post-revolution (1962). If crises are not resolved within the normal science, the paradigm fails and the science requires a new paradigm.

worldview accepts that humans are separate (independent), dominant, and the master of nature (Capra, 1997; Rees, 1999; Du Plessis, 2012). It is based on reductionism, determinism, materialism, and a reflection-correspondence view of knowledge (Heylighen, 2006).

Hes and Du Plessis (2015) highlight that the discovery of new fields in science —such as quantum physics, ecology and complexity science— established that the mechanistic worldview cannot well explain all of reality regarding living systems and the subatomic realm. The mechanistic approach "is failing because the linear, reductionist methodologies used to develop strategies, cannot foresee or address the unintended consequences inherent in the complex dynamic systems that constitutes life on Earth" (Hes and Du Plessis, 2015, p.24).

Ecological worldview

The literature emphasizes the need of replacing the mechanistic worldview with an ecological one in which regenerative approaches are rooted. Du Plessis and Brandon note that "in order to move development into a positive curve towards sustainability, society needs to change the worldview/paradigm within which it currently operates; and that such a shift from a mechanistic to an ecological/living systems worldview is already happening" (2014, p.1). In addition to them, Mang and Reed state that "the radical changes required for Earth to 'remain fit for human habitation' require a change in worldviews from 'mechanistic' to 'ecological'" (2012a, p.23). Hes and Du Plessis also highlight the need of a new paradigm: "we need to shift to a worldview that is more relevant to the complex and living systems of which we form part; a worldview that would open solutions to us that are simply not possible using the thinking of the worldview which created the challenges in the first place" (2015, p.24).

In the literature, this alternative new worldview has been called 'ecological,' 'evolutionary,' 'whole living system,' 'radical ecologism,' and 'integral' (McHarg, 1969; Capra, 1997; Elgin and Le Drew, 1997; Wilber, 2001; Dobson, 1990; Hes and Du Plessis, 2015). In this thesis, the term of 'ecological worldview' was used to identify it. Frijtof Capra's works are the most often cited source to describe the ecological worldview by contrasting it with a mechanistic paradigm. Capra (1997) notes that an ecological worldview strives to understand nature, its processes and relationships. The worldview supports the idea that humans are an integral part of nature and members of the web of life. It also represents "a shift from seeing the planet as a deterministic clockwork system in which humans are separate from nature to seeing it as a fundamentally interconnected, complex, living and adaptive social –ecological system that is constantly in flux" (Du Plessis, 2012, p.14).

According to Hes and Du Plessis's book (2015), there are two key themes of ecological worldview: wholeness and change. While the mechanistic worldview tries to understand the parts, the ecological worldview works for understanding the whole. According to the ecological worldview, "the world is a complex, adaptive and dynamic system governed by non-linear dynamics" (Hes and Du Plessis, 2015, p.31). 'Change' is one of its processes to get negative and positive feedback. They indicate the ten key values of the ecological worldview in their book: integrity, inclusivity, harmony, respect, mutuality, positive reciprocity, fellowship, responsibility, humility and non-attachment.

The Notion of Regeneration

The *American Heritage Dictionary of the English Language* describes the word 'regenerate':

- To give new life or energy to; revitalize; to bring or come into renewed existence; to impart new and more vigorous life;
- To form, construct, or create a new, especially in an improved state; to restore to a better, higher or more worthy state; refreshed or renewed;
- To reform spiritually or morally; to improve moral condition; to invest with a new and higher spiritual nature;
- To improve a place or system, especially by making it more active or successful.

As Mang (2001) summarizes, the word 'regenerate' carries three key ideas: a radical change for the better; creation of a new spirit; generating a new life or energy.

Lyle[4] works to apply the notion of regeneration into the built environment and argues that it is possible to regenerate lost ecosystems. According to him, the notion of regeneration can be summarized as 'self-renewing.' He notes that the current human developments replaced the system of nature that provides "endlessly complex network of unique place adapted to local conditions" and "infinite diversity" with a system that is "relatively simple," uniform and generic (1994, p.4). And most importantly, he states that humans have replaced nature's continual cycling system with one-way linear flows. He sees this as a "pattern of degeneration" which is "devouring its own sources of sustenance" (1994, p.4). Regenerative cyclic systems try to optimize instead of maximize and they are resilient, while one-way linear systems are brittle. According to Lyle (1994), the issue is not a matter of technology alone. The core is the human relationship with nature. So, he defines regenerative design as "replacing the present linear systems of throughput flows with cyclical flows at sources, consumption centers, and sinks" to

[4] He is the author of the first handbook of regenerative design: *Regenerative Design for Sustainable Development*.

change the behavior (Figure 3) (1994, p.10). Lastly, he thinks that the notion of regeneration is necessary for sustainability and argues that "in order to be sustainable, the supply systems for energy and materials must be continually self-renewing, or regenerative, in their operation. That is, sustainability requires on-going regeneration" (1994, p.10).

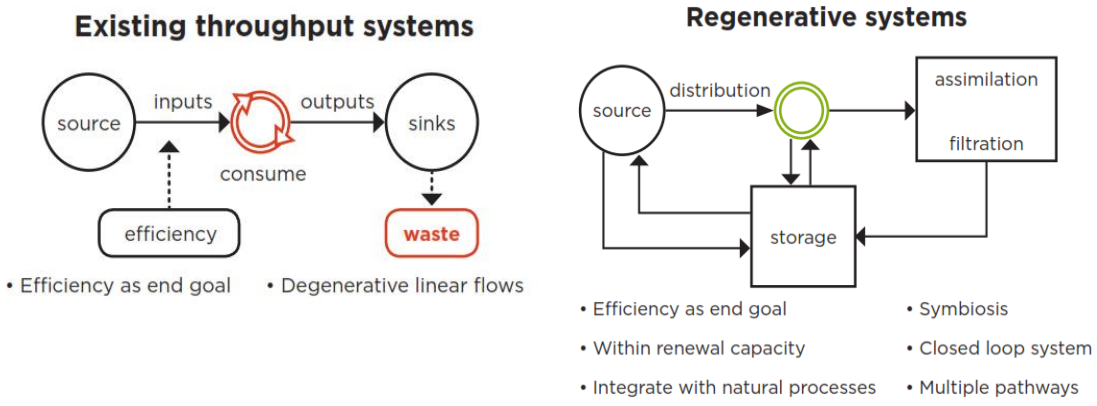

Figure 3: Lyle's Comparison between Flows in Degenerative and Regenerative Systems (http://akihan.hubpages.com/hub/Regenerative-Architecture)

On the other hand, Cole (2012a) mentions that the 'notion of regeneration' refers to the idea of 'rebirth' or 'renewal' and has been variously applied to the built environment. He gives the example of the inscription of Henry Hering's memorial sculpture and its message for the regeneration of the city after its demolition in the Great Chicago Fire of 1871. The inscription notes that"[f]rom its ashes the people of Chicago caused a new city to rise, imbued with that indomitable spirit and energy by which they have ever been guided" (Cole, 2012a, p. 1). According to Cole, although devastation and declining conditions are not ideal, they may provide a unique time to turn crisis into an opportunity for a better future and may create an atmosphere which is ripe for renewal and initiates rebuilding. The final condition (transformed) embodies some traces from the past but it brings new aspirations and possibilities. Cole bridges this idea and regenerative design by saying that "regeneration has been garnering increasing interest as a means of reframing green building practices and, carrying with it, qualitatively different and broader connotations than that used previously" (2012a, p. 1). So, the regenerative design paradigm carries some traces and knowledge from green and sustainable design but it also includes new aspirations and opportunities.

b. The Concepts of Green, Sustainable and Regenerative

The terms 'green,' 'sustainable,' and 'regenerative' design are widely used in the literature and practice and they are qualitatively very different terms. According to Cole, the prevailing paradigms shape design priorities and "environmental priorities in design are influenced by the types of tools and methods deployed in practice" (2012b, p.40). So, it is necessary to clarify green, sustainable and regenerative approaches to understand how they differ and what kind of tools they include.

Green design and assessment tools

While 'green design' emphasizes the environmental performance of buildings, 'green building' refers to a higher environmental performance building compared with a typical one. The term 'eco-efficiency' is used to describe green approaches. Green design primarily covers issues about resource use, emission/waste, health, and comfort. It strives to reduce the degenerative consequences of human activity on ecological systems and improve the health and comfort of occupants (Cole, 2012b). Several publications state that green design works for 'doing less harm' for the environment (McDonough and Braungart, 2002; Reed, 2007; Cole, 2012b). Reed defines green design as "a general term implying a direction of improvement in design, i.e. continual improvement towards a generalized ideal of doing no harm" (2007, p.676). He also notes that "the green building movement … has not been focused on … interrelated wholeness" (2007, p. 675).

1	Reduces damage to natural or sensitive sites
2	Reduces the need for new infrastructure
3	Reduces the impacts on natural features and site ecology during construction
4	Reduces the potential environmental damage from emissions and outflows
5	Reduces the contributions to global environmental damage
6	Reduces resource use – energy, water, materials
7	Minimizes the discomfort of building occupants
8	Minimizes harmful substances and irritants within building interiors

Table 2: Green Building Attributes (Cole, 2012b, p.40)

Cole (2012b) compiles the key attributes of green buildings (Table 2) in his paper. He characterizes green building assessment tools[5]: LEED, GB Tool, Green Globes, and BREEAM

[5] Cole (2012b) considers the LBC as a green design tool in his paper.

etc. Mostly, they 1) use a relative benchmark instead of absolute consequences to evaluate individual performance, 2) have criteria that are based on measurable metrics, 3) require clear and unambiguous assessment, 4) incorporate process-related criteria along with performance issues, 5) are based on the belief that long term performance can be predicted with some certainty, 6) are framed within a linear approach toward conserving resources, 7) are generic and struggle to accommodate regional priorities (Cole, 2012b).

According to Cole (2012b), green design does not close loops, encourage creative synergies, or respond to local ecological and social context. Despite his criticism, he notes that a shift occurs in the role and use of green building assessment tools through supporting some of the key attributes of regenerative design and development:

- It provides a base for emergence of integrated design which requires many different professionals in the team and blurs the boundaries of the traditional knowledge.
- Leading-edge practitioners achieve the highest level and are seeking to push further than the embedded performance aspirations in current assessment tools.
- Cross-scale performance issues are becoming essential to understanding buildings and their physical, social, and ecological context. (2012b)

Sustainable design and assessment tools

Sustainable society was first defined in 1981 by Lester Brown in *Building Sustainable Society* as "… one that is able to satisfy its needs without diminishing the chance of future generations." In 1987, the Bruntland Commission[6] explained sustainable development by adapting Brown's definition— as "…meeting the needs of the present without compromising the ability of future generations to meet their needs." A number of scholars in the regenerative literature criticize the definition of sustainability. For example, according to Pearce *et al*. (1989), this definition brings the term of "sustainable capitalism" — the idea of assuring the heritage left to next generations is not diminished. Secondly, Du Plessis (2012) argues that this idea causes an understanding that sustainability will be achieved if the capital of Earth— financial, human, social, manufacture, and natural— will either remain the same or not decline.

As David Orr (1992) labeled, sustainability falls into two streams: technological and ecological sustainability. While technological sustainability focuses on technical and engineering based solutions, ecological sustainability emphasizes an understanding of ecology and living systems principles. According to Mang and Reed (2012a), green design, or eco-efficient design,

[6] The report of the Bruntland Commission was published as a book: *Our Common Future (1987).*

emerged as a result of the first stream. Regenerative design and development and some other approaches like biophilia, biomimicry, permaculture, and resiliency (See Appendix A) emerged from the ecological sustainability stream.

The existing studies generally represent 'sustainable design' as an intermediate stage between green and regenerative— a 'neutral' state that provides the necessary base condition that permits regenerative capabilities to evolve (McDonough and Braungart, 2002; Pedersen Zari and Jenkin, 2008; Cole, 2012b). However, Cole points out that "this positioning of sustainability would seem to apply only to what Orr describes as 'technological sustainability' and, therefore, relate to green building practices and other strategies to manage progress" (2012b, p.45). Additionally, Mang and Reed (2012b) discuss that the emerging field of regenerative design and development creates an essential change and evolution in the concept of sustainability. They note that, primarily, the field of green design defines a sustainable environment as an environment that uses resources efficiently and creates neutral environmental impact, but this definition is changing rapidly. Pedersen Zari and Jenkin (2009) support this point by noting that a sustainable built environment should go beyond 'net-zero' impact and must have 'net-positive' benefits.

In the literature, the triple bottom line of sustainability —ecology, social, and economy— has been expressed in two different ways (Figure 4). First, the Venn diagram conveys the triple bottom line with three intersecting circles. Second, the nested dependencies model[7] uses overlaid circles sharing a common center, one inside the next. According to the nested model, ecosystems sustain societies that create economies (Doppelt, 2008).

Figure 4: Venn Diagram and Nested Model for Three Pillars of Sustainability (Doppelt, 2008)

Du Plessis (2012) criticizes the tendency of looking at sustainability from three separate lenses (the Venn diagram) and having economy as one of these lenses. She notes that making the

[7] Bob Doppelt discusses the nested dependencies model of sustainability in *The Power of Sustainable Thinking (2008)*.

economy one of the pillars of sustainability "meant a shift in emphasis from design innovation to performance measurement, monitoring and evaluation. It also created the idea of green building as a competitive business advantage" (Du Plessis, 2012, p.12). It led to businesses and building industries to involve the medium. She lists the flaws in the business driven variant of sustainability in her paper. Although Du Plessis (2012) mainly talks about the flaws in sustainability, Cole notes that "sustainability promotes a bio-centric view that places the human presence within a larger natural context, and focuses on constraints and on fundamental value and behavioural change" (2012b, p.43). Sustainability embraces the ideas that "humankind lives within the carrying capacity of the Earth" and that there is an "ongoing relationship [dynamic] between human and natural systems" (Cole, 2012b, p.44).

While typical 'green building' assessment tools cover environmental performance and human comfort and health issues, 'sustainability' assessment tools expand beyond these factors to include resource use, emissions and indoor environmental quality by organizing performance criteria through social, economic and environmental domains. Cole (2012b) characterizes sustainability assessment tools, and the tools mentioned in his paper are[8]: SpeAR, SBTool, SBAT, and German Sustainable Building Council's Certificate Programme. Their characteristics are:

- The criteria are represented in a circular framework as different from the list format of many green assessment tools.
- Frameworks have segmentation into titles of environmental, social and economic within equal proportions.
- The range of performance criteria is bigger than green building tools' and requires more time and effort to reach them.
- Having social, cultural and economic considerations cause greater difficulty and less consensus on performance metrics. (Cole, 2012b, p.44)

Regenerative design and assessment tools

Since regenerative design and development is an emerging field, the literature does not have a consensus on the definitions and each paper tends to represent its own definition. This creates a confusion in the literature and a clarification is needed to identify the distinction between 'regenerative design,' 'regenerative development,' and 'regenerative design and development' (See Chapter IV). The emerging design support tools of regenerative practice were examined in

[8] Cole (2012b) mentions these four sustainability tools in his paper. See page v for abbreviations.

detail (See Chapter V). In this literature review chapter, a number of definitions and descriptions will be addressed. They are mainly aligned around accepting two key points: the net positive goals for built environment and integrating human systems with natural living systems.

As mentioned before, the term 'regenerative design' was introduced by Lyle[9] (1994) and evolved during the last decade. In the *Encyclopedia of Sustainability Science & Technology*, Mang and Reed define 'regenerative design' as "a system of technologies and strategies, based on an understanding of the inner working of ecosystems that generates designs to regenerate rather than deplete underlying life support systems and resources within socio-ecological wholes" (2012b, Chapter 303, p.2). Further they define 'regenerative development' as:

> a system of technologies and strategies for generating the patterned whole system understanding of a place, and developing the strategic systemic thinking capacities, and the stakeholder engagement/commitment required to ensure regenerative design processes to achieve maximum systemic leverage and support, that is self-organizing and self-evolving (p.2).

Mang and Reed use 'regenerative development and design' together to emphasize their relationship with each other and state that "regenerative approaches view development and design as two distinct yet synergistic processes, both of which play an essential role in ensuring that greater scope, neither of which is sufficient without the other" (2012b, p.15). As ecological worldview offers, understanding relationships between systems is essential to strengthen them to regenerate. Mang and Reed highlight this key concept by noting that regenerative thinking:

> redefines the built environment —from the old, building-centric definition to one that includes the relationships between and among buildings, infrastructure and natural systems, as well as the culture, economy and politics of communities…It sets goals accordingly based on the perceived need to re-weave human and natural communities into a co-evolutionary whole, where humans exist in symbiotic relationship with the living lands they inhabit. (Mang and Reed, 2012a, p.36)

According to Pedersen Zari and Jenkin, regenerative development:

> investigates how humans can participate in ecosystems through development, to create optimum health for both human communities (physically, psychologically, socially, culturally, and economically) and other living organisms and systems… aims to restore or

[9] He defines regenerative design as replacing the present one way linear systems with nature's cyclical flows (1994).

> create the capacity of eco-systems and biogeochemical cycles (carbon, hydrological, nitrogen etc) to function optimally without constant human intervention (2010, p.3).

They define regenerative design as the means of achieving desired outcomes of regenerative development and note that it "seeks to create or restore the capacity of ecosystems and bio-geological cycles to function without human management" (2010, p.3).

On the other hand, Cole describes that regenerative design:

> relates to approaches that support the co-evolution of human and natural systems in partnered relationship. It is not the building that is 'regenerated' in the same sense as the self-healing and self-organizing attributes of a living system, but by the ways that the act of building can be a catalyst for positive change within the unique 'place' in which it is situated (2012a, p.1).

According to Cole, "within regenerative development, built projects, stakeholder processes and inhabitation are collectively focused on enhancing life in all its manifestations— human, other species, ecological systems— through an enduring responsibility of stewardship" (2012a, p.1).

Additionally, Du Plessis writes that "the concept of regenerative design and development needs to be considered within the broader theoretical context of sustainability" and uses the term of 'regenerative sustainability' (2012, p.7). She emphasizes the need of a regenerative sustainability paradigm that:

> attempts to address the dysfunctional human–nature relationship by entering into a co-creative partnership with nature. It aims to restore and regenerate the global social – ecological system through a set of localized ecological design and engineering practices rooted in the context and its social – ecological narratives (2012, p.19).

Further Du Plessis highlights three insights listed below to explain the basis of regenerative approaches:

- Understanding how nature works instead of how humans would like the world to work
- Seeing the world as ever-changing, impermanent and inherently unpredictable
- Accepting that humans and nature are not two separate interacting systems. (Du Plessis, 2012, p.15)

<u>Relationship between 'green,' 'sustainable,' and 'regenerative'</u>

The literature has a tendency to place the concepts of green, sustainable, and regenerative in a hierarchy. Larrick (1997), Reed (2007) and Pierce (2015) explain regenerative design by positioning it in the context of green or sustainable design. Conversely, Cole (2012b) supports the

idea of eliminating this alignment by embracing sustainability as an evolving overarching concept.

The earliest graphic characterizations of degenerative and regenerative processes was done by Larrick in 1997 (Figure 5). Larrick's framework became a foundation to clarify and position green, sustainable and regenerative approaches. The upper half of the graphic represents a sustainable condition with a recognition of ecological and social regeneration as necessary attributes. The lower half shows an unsustainable condition where human acts cause a decrease in natural resources. Therefore, green design is essential to slow this decrease and degeneration.

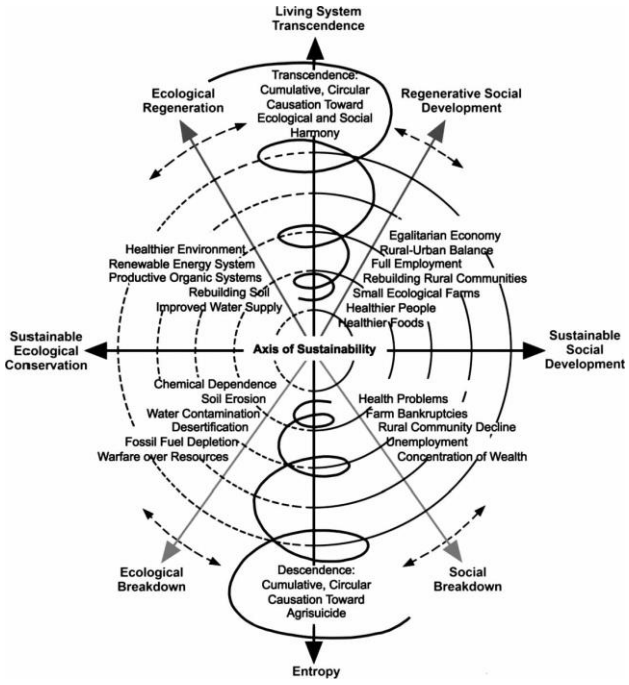

Figure 5: Living System Model of Community Development (Larrick, 1997)

Secondly, Reed has created a graphic to indicate a "Trajectory of Environmentally Responsible Design" (Figure 6). Reed suggests the following definitions to differentiate the transitions from 'sustainable' to 'restorative' and ultimately to 'regenerative design':

1. Sustainable Design – Green Design with an emphasis on reaching a point of being able to sustain the health of the planet's organisms and systems over time.
2. Restorative Design – Approaching design in terms of using the activities of design and building to restore the capability of local natural systems to a healthy state of self-organization.

3. Reconciliation design – Acknowledging that humans are an integral part of nature and that human and natural systems are one.
4. Regenerative Design – This is a design process that engages and focuses on the evolution of the whole of the system of which we are part. Logically, our place – community, watershed and bioregion – is the sphere in which we can participate. (2007, p.677)

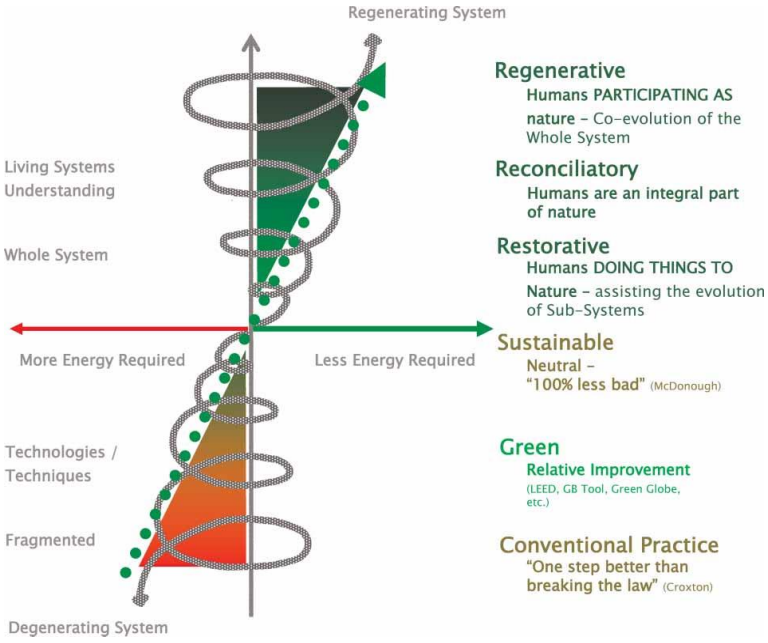

Figure 6: Trajectory of Environmentally Responsible Design (Reed, 2007, p.676)

After Reed, Cole (2012b) makes a simple distinction between 'green,' 'sustainable' and 'regenerative' by characterizing them as doing less harm, doing no harm and doing some good, respectively. However, Cole sees this relationship differently than Reed. According to him,

> Sustainability is an overarching globally scaled, evolving aspiration; green design and regenerative design and development are complementary approaches to the design of buildings and the built environment that aid in this process. Such an interpretation would seem to eliminate the need to reference a 'neutral' condition that represents the aspiration of green performance as the starting point for regenerative approaches (2012b, p.47).

Additionally, Pierce (2015) offers another perspective to look at the relationship. He sees regeneration as a pattern of living design. Pierce expands the trajectory by including the terms 'resiliency' and 'wellness.' He defines them as the five patterns of living design (Figure 7) and believes that 'each lens embodies the others (Figure 8). He also summarizes each term with a

specific word and explains its key purposes. For example, the term ‘regeneration’ is summarized as ‘replenish’ and its main purpose is being self-reconstructing and self-producing.

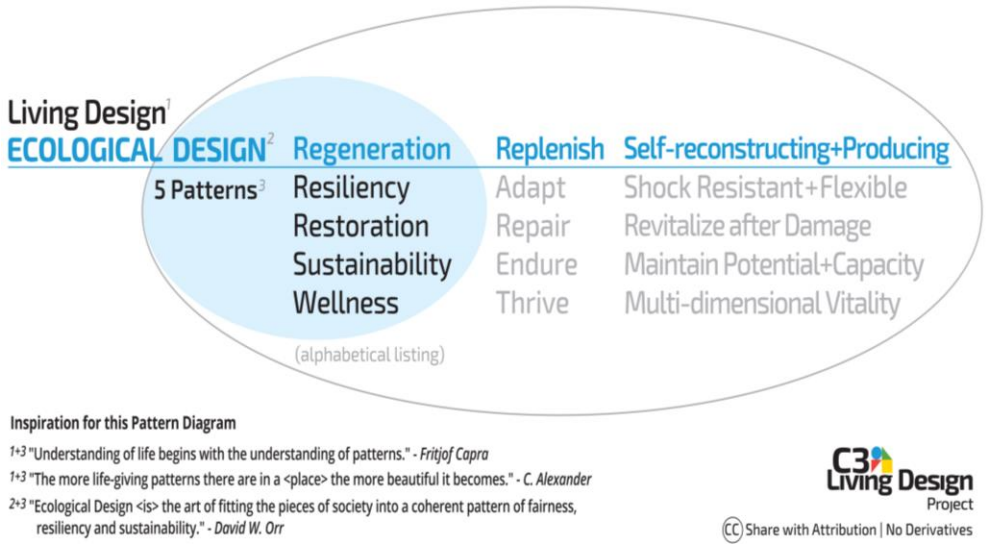

Figure 7: Living System Perspective for Design (Pierce, 2015)

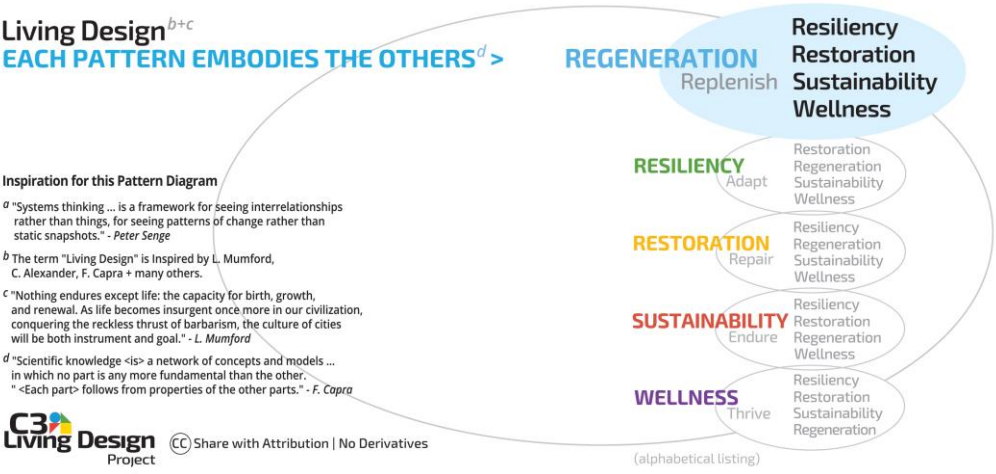

Figure 8: A Network of Patterns (Pierce, 2015)

c. The Importance and Impact of Regenerative Design and Development

While there exists a visible transition through regenerative approaches, it is essential to understand why we need them. Scholars mention four main reasons why regenerative approaches are gaining prominence. These can be listed as the need for moving beyond ‘doing less or no harm’ approaches, the push in the industry to achieve higher performance aspirations, the need

for a new paradigm due to the inappropriate thinking processes of the mechanistic worldview, and the call for a motivating positive discourse to address the problems.

The first reason is the need for moving beyond 'doing less or no harm' for health and vitality of socio-ecological systems. Design professionals are making advances in green building technology. However, the bigger problems like climate change and biodiversity loss have not been addressed yet (Haggard, 2002). Although the current practices of green and sustainable design exhibit improvements on conventional design in the area of energy and resource conservation, waste reduction, materials replacement, and quality of life, they "still result in negative environmental impact" (Pedersen Zari, 2010). They aim to do less damage to the environment and human health —less consumption of non-renewable energy and less pollution. It is a fact that reversing the degradation (adverse impacts) is needed, instead of just slowing it down. Regenerative design aims to go beyond eco-efficient design by extending development from a 'net-neutral' or 'net-zero' approach to one that creates 'net-positive' outcomes for ecological, social, and economic development. Regenerative design and development strives for a co-evolutionary relationship between humans and nature. This requires an awareness that the health of humans is dependent on the health of whole ecosystems and vice versa.

Secondly, there are an increased number of architectural practitioners that have gained experience in green design by producing buildings which achieve 'Platinum'– the highest level of performance within the Leadership in Energy and Environmental Design (LEED) program. "This maturing of green building practice has meant that leading-edge 'green' practitioners who have operated at this level are seeking to push much further than the performance aspirations embedded in current assessment methods" (Cole *et al*., 2012, p.96). Regenerative design and development offer a comprehensive and potent approach for framing future design practice.

Thirdly, Du Plessis argues that the current sustainability paradigms have been losing their "usefulness due to their conceptual foundation in an inappropriate mechanistic worldview" which prevents humans from developing an effective engagement with a complex, dynamic and living world (2012, p.7). In response to this, regenerative approaches suggest moving from a mechanistic worldview to an ecological worldview that explores the whole and provides living systems thinking. The regenerative paradigm emphasizes the significance of how we see the world, how we define the problems to be solved, and how we can contribute as designers. It argues that if we change the way we think, we can "improve the living and working conditions for both natural and human communities by healing the earth through development" (Haggard, 2002, p.24).

The next reason is the need for positive discourse in society for inspiring hope against fear. The predominant atmosphere and narrative of sustainability emphasizes scarcity, negative impacts and dystopic or doomed futures. This discourse causes people to lose their inner power and create resistance to change. To overcome the issues, it is necessary to manifest a positive narrative and move away from present fear-based narratives to flourish in the world.

d. Key Characteristics of Regenerative Design and Development

Regenerative design and development advocates that design and construction need to serve the well-being of people, the planet and all living things. Moreover, it provides an alternative that is explicitly designed to engage with a living world through its emphasis on a co-creative partnership with nature based on strategies of 'adaptation, resilience and regeneration' (Du Plessis, 2012).

The literature was scanned and the nine key characteristics (philosophical departure points) of regenerative design and development were determined[10]. The intent in this section is not listing and explaining all of the properties of regenerative design and development in detail; rather it aims to explore what key characteristics of regenerative approaches have been discovered in the literature.

1) Shifting the paradigm: bringing a new mind

Holistic design / Embracing systems thinking / Understanding of whole living systems

Shifting the prevailing paradigm from a mechanistic to an ecological worldview is central for regenerative design and development. It is necessary to embrace a new way of thinking about "how buildings are planned, designed, constructed and operated, as well as about the roles of designers and inhabitants" (Mang and Reed, 2012a, p.26). For example, seeing a site as a web of interconnected dynamic processes instead of a collection of things such as slopes, roads, etc. (Haggard, 2002). In addition to that, embracing whole living system thinking is one of the key ideas of an ecological worldview which requires changes in behavior to understand the whole system instead of its parts.

2) Seeing humans as a part of nature: co-evolution

Being a part of nested, dynamic, complex, interdependent and evolving living systems

Regenerative design "address the dysfunctional human- nature relationship by entering into a co-creative partnership with nature" (Du Plessis, 2012, p.19). Regenerative approaches require the

[10] Some main terms and concepts that are relevant to the topic were noted in italics.

reconnection of human aspirations and activities with the evolution of natural systems (co-evolution). Regenerative design and development acknowledges that humans are an integral part of nature and have a positive role in the systems. It argues that humans must evolve with nature in a mutually beneficial and partnered way. This co-evolution covers all domains of sustainability: ecological, cultural (social) and economic. Mang and Reed explains this by noting that "this is not preservation of an ecosystem, nor is it restoration. Instead, it is the continual evolution of culture in relationship to the evolution of life [and] defines the work of regeneration" (2012a, p.26).

3) Seeking for positive outcomes and improving health and vitality of the co-evolutionary whole

Regenerative development offers up the idea of seeing a built environment as a catalyst for positive change. It aims to heal and improve the health and vitality of both human communities —physically, psychologically, socially, and economically— and other living organisms and systems through development. It requires "producing and reinvesting surplus resources and energy to build the capacity of the underlying relationships and support systems of a place needed for resilience and continuing evolution of those communities" (Mang and Reed, 2012b, p.14). The regenerative approach does "not only protect and preserve; it restores a lost plenitude" (Van Der Ryn and Cowan, 2007, p.37).

4) Offering a hope and positive direction for turning crisis into an opportunity

Inspiring hope against fear / Psychological motivation / Positive discourse

As discussed before, the predominant atmosphere and narrative of sustainability emphasizes the terms of 'alarm, pessimism and a depressing possible future' because of mounting environmental problems. This alarming atmosphere impacts people psychologically in a negative way. They may show little interest in maintaining tolerance and engagement. Regenerative approaches offer a positive discourse to move people from fear to hope and encourage collective action to solve problems. Crisis can be an opportunity for renewal and bringing new ideas to the surface. Regenerative design and development offers "a wonderful opportunity in this period of change to create an alternative model of development that will lead to a thriving future" (Hes and Du Plessis, 2015, p.12).

5) Re-defining 'design' and the role of designer

Collaborative interdisciplinary process / Conscious design of whole ecosystems

Enhancing life in all its manifestations, human, other species, ecological systems, is a challenging design goal and requires a different kind of design process and team. A regenerative practitioner should design an ecosystem that integrates natural and human living systems. This requires an integrated design process and interdisciplinary team. Integrated design and ecological design are

the two supporting and underlying design ways for regenerative design. *Ecological design* is defined by Van der Ryn and Cowan as "any form of design that minimizes environmentally destructive impacts by integrating itself with living processes" (2007, p.33). In addition to that, *integrated design* process is defined as "a discovery process optimizing the elements that comprise all building projects and their inter-relationships across increasingly larger fields in the service of efficient and effective use of resources" (ANSI/MTS WSIP Guide, 2007, p.2).

6) Establishing place as a core and unique entity

Specificity and uniqueness of a place / Build to place, not formula

Regenerative approaches accept and promote place as the primary starting point for design. They emphasizes seeing place as:

> the unique, multilayered network of living systems within a geographic region that results from the complex interactions, through time, of the natural ecology (climate, mineral and other deposits, soil, vegetation, water and wildlife, etc.) and culture (distinctive customs, expressions of values, economic activities, forms of association, ideas for education, traditions, etc.) (Mang and Reed, 2012a, p.28).

Every place has its own unique historical, cultural, ecological and economic patterns. Thus, to achieve regeneration, it is necessary to understand these patterns, design for a specific place and avoid using template designs.

7) Recognizing values to engage all stakeholders and evoke deep caring for their place

Designing for harmony with place / Optimizing the presence of people / Stakeholder engagement

It is essential to "clarify aspirations and values and which enables the community to recognize and feel its connections to the natural systems of which they are a part" (Hoxie *et al*., 2012, p.65). A number of articles offer using 'Story of Place' as a method which may serve as a way to create a field of caring, commitment, and deep connection to place (Mang and Reed, 2012b; Hoxie *et al*., 2012). They argue that stories are fundamental for human memory and how people learn and organize what they know. The unique story of each place can provide an area that all stakeholders can come together. Recognizing values or stories of place to generate a dialogue is very essential and plays multiple roles. First, it enables people to grasp, share, grow and evolve in harmony with place. Second, stories can be used as powerful agents of change. Third, discovering the story of a place provides greater intelligence about how humans can then align themselves with living systems to the benefit of all. This provides ongoing learning process that aids co-evolution. Finally, sharing the same story (in a unique place) brings all stakeholders together and reminds

them of the need for symbiotic relationships. This increases social-ecological engagement for further regeneration.

8) Exploring patterns, new boundaries and scale

Larger ecological and social systems / Nested systems / Scale jumping (up-down) / Dissolving boundaries / Understanding and generating patterns

Du Plessis and Brandon explain that "a building is a system situated in larger ecological and social systems that it influences in some way, but is also influenced by" (2014, p.5). As many scholars argue, understanding and exploring the broader region in which the project is situated offers potential value (Mang and Reed, 2012a; Pedersen Zari, 2012; Du Plessis and Brandon, 2014). Pedersen Zari notes that regenerative development "cannot exist in isolation from their larger surrounding contexts" and requires "understanding ecosystem services at a larger scale (city, region, ecosystem boundary)" (2012, p.62). Mang and Reed (2012a) use watershed boundaries to explore place and note that regenerative process works from the macro-scale (the watershed or bioregion) to the local. They see the pattern literacy is a way to understand boundaries and "read the landscape thus provides the relational understanding required to design a built environment that harmonizes with and contributes to the flows of nature" (2012a, p.9).

9) Acknowledging a new time frame

Ongoing participatory and reflective process

Regenerative design and development is about an ongoing process of learning and getting feedback in this process (Mang and Reed, Du Plessis, Haggard, etc.). Pedersen Zari notes that "it is critical that the development of system complexity, and ongoing feedback and dialogue processes are allowed for, so that the development evolves over long time periods" (2010, p.3). Uncertainty of time needed for regeneration emergence is one of the challenges the literature has. Regenerative design and development does not end with the delivery of final drawings and approvals and construction. If creating culture of co-evolution succeeds, regenerative capacity of a project may sustain through time by integration of people who inhabit and manage it (Mang and Reed, 2012a). Most quantitatively, Pedersen Zari and Jenkin (2008) argue that regenerative design implementation and benefits may be seen in short: 5 years, medium: 40 years and long: 80 years for a study in New Zealand.

e. A Framework and Methodology from the Regenesis Group

In the *Designing from Place: A Regenerative Framework and Methodology* paper, Pamela Mang and Bill Reed (2012a) delineate an actual regenerative framework and methodology which was created by Regenesis Group and evolved over 16 years.

The methodology is adapted from scientific/academic research protocols which guide researchers in choosing specific methods, tools and strategies. The framework is used to "a lens for differentiating the key elements and levels of this methodology, and seeing how they work together in a practice as an integrated system" (Mang and Reed, 2012a, p.24). The Regenerative Development and Design Methodology has three levels or tiers (Figure 9):

- Tier 1: Guiding premises, principles and semantics: philosophical assumptions and principles and the underlying rationale for choosing methods,
- Tier 2: System of processes and sub-processes: the overall system methods and processes,
- Tier 3: Technologies and methods: specific methods, techniques and tools.

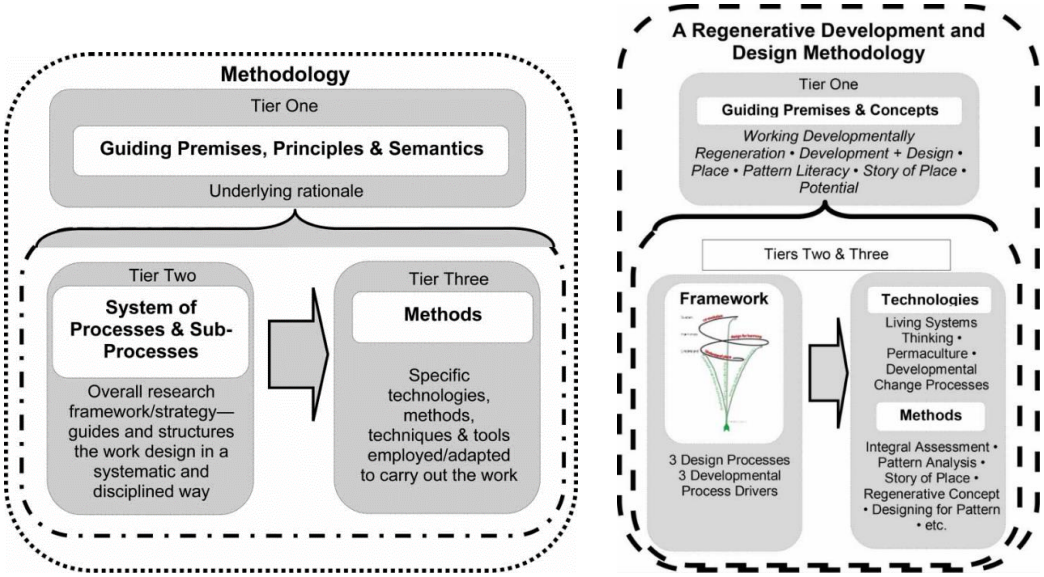

Figure 9: Regenerative Design and Development Methodology (Mang and Reed, 2012a, p.25)

Tier 1 (Guiding premises, principles and semantics): is essential because it reflects the role of worldviews in regenerative design and development. Tier 1 has four underlying premises (role of humans, a new mind, a new role, working developmentally) and six core organizing concepts (regeneration, development and design, place, pattern literacy, story of place, potential). These premises and concepts are explained in Table 3.

TIER 1: GUIDING PREMISES & CONCEPTS

PREMISES of REGENERATIVE METHODOLOGY	ORGANIZING and ORDERING CONCEPTS
• **Role of Humans:** People as a part of nature; Co-evolution. • **A New Mind:** Bringing an entirely new mind; A new way of thinking about how buildings are planned, designed, constructed, and operated as well as about the roles of designers and inhabitants | exp: seeing the site as web of interconnected dynamic processes. • **A New Role:** Changing the role of a designer and the process and definition of design | exp: a regenerative practitioner designs an ecosystem that integrates natural and human living systems to create and sustain greater health for both psychological and cultural literacy • **Working Developmentally:** A developmental process that improves the values of the whole and capacities.	• **Regeneration:** Shift from mechanistic (close loop system) to ecological worldview (living -nested, dynamic, complex, interdependent, and evolving- and open system); Regeneration as a level of work: operate, maintain, improve, regenerate • **Development + Design:** Seeing different professional disciplines as parts of an integrated system that includes community engagement and stewardship; Realizing the greatest potential for evolving a system. • **Place:** Place as the unique, multilayered network of living systems within a geographic region that results from the complex interactions, through time, of the natural ecology and culture; Understanding how a living place works becomes the touchstone for organizing how the project needs to work as a living system nested in its place to achieve the connectedness required for increasing the mutuality of relationships. • **Pattern Literacy:** Understanding and generating patterns; Exploring the complex adaptive living systems and patterns of relationships. • **Story of Place:** (Human memory is story based, not data based) Helps deep-ening connection to and growing harmony with place; Leads understanding how living systems work in that place; Provides a framework for an ongoing learning process that enables humans to co-evolve with their environment. • **Potential:** Looking for potential in relation to the larger systems in which an entity is nested; Working to develop patterns of relationships between the entity and the larger system that generates a cascade of capacity development up and down system scales.

Table 3: Underlying Premises and Organizing Concepts of the Regenesis Methodology (Summarized from Mang and Reed, 2012a, p.26-30)

Tier 2 (System of processes and sub-processes): consists of a theoretical systemic framework developed by Regenesis as a system of processes. Figure 10 shows the overall framework that guides and structures the Regenesis approach to regenerative design and development. It has three phases and three processes. The phases are: understanding and conceptualizing right relationship to place, designing for harmony with place, and co-evolution. The three developmental processes are:

1. Growing Stakeholder Partnerships,
2. Living Systems Thinking,
3. Integrative Developmental Processes.

The three phases and the three developmental processes work together to create and sustain the consciousness and commitment required to realize the regeneration potential. The phases and the processes of the framework are summarized in Table 4 to show the overall concept clearly.

Tier 3 (Technologies and Methods): focuses on technologies and methods that can be used for regenerative approaches. Mang and Reed offer some methods to use in specific phases. For example, the Integral Assessment can be used in the phase 'understanding and conceptualizing right relationship to place.' The offered methods are also summarized in Table 4.

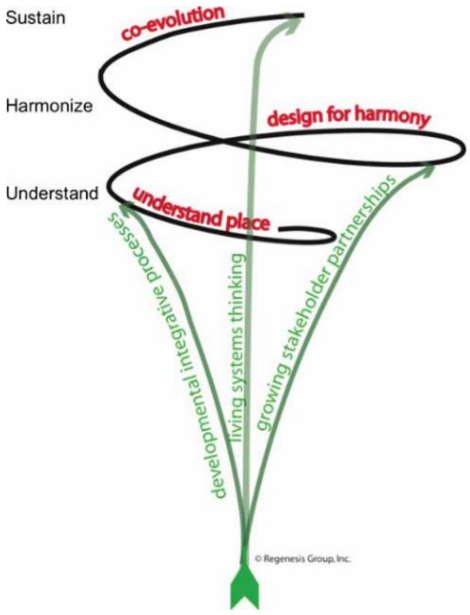

Figure 10: The Theoretical Systemic Framework of Regenesis (Mang and Reed, 2012a, p.31)

TIER 2 & 3 : System of processes & Methods : FRAMEWORK

PHASES of the FRAMEWORK	DEVELOPMENTAL PROCESSES
• **P1. Understanding and conceptualizing right relationship to place:** Regenerative development begins with the recognition that each place is a dynamic entity with its own unique history and future – growing and evolving, forming and decomposing, continuously influenced by the larger system in which it is embedded. P1- Methods: - Defining Place - Integral Assessment - Core Patterns/Story of Place - Stakeholder Dialogue to Create Guidelines - Concept for Systemic Regenerative Role • **P2. Designing for harmony with place:** Pattern harmony means buildings and infrastructure improve land and ecosystems, and the unique attributes of the land improve the built environment and those who inhabit it. Synergy with the land and ecosystems leverages the effectiveness of green design features and technologies, and lowers costs while improving ecosystem health and productivity. P2- Methods: - Permaculture - Place Potential/Vocation - Project Aims and Aspirations - Regenerative Concept • **P3. Co-evolution:** A regenerative project seeks to catalyse a process of 'co-evolving mutualism' – the increasing and mutually beneficial integration of human and natural systems that supports their coevolution. The implication is that harmony is not some steady-state, but rather a process of progressive harmonization of dynamic systems, one that cannot be predicted but can be continually planned and managed.	• **Growing Stakeholder Partnership:** Stakeholder engagement. - Discovering shared identity - Redefining what is at stake - Shifting roles • **Living Systems Thinking:** Living Systems Thinking is a means for consciously improving the capacity to apply systems thinking in a way that responds to the uniqueness of a given place – enabling design teams and local stakeholders to come to each project with a fresh mind, and to avoid the automatic, conventional or 'template' approaches that are antithetical to regeneration. In addition to being place-specific, regenerative processes are evolutionary, going beyond improving current systemic performance (what is often called restorative) to embedding into the system the capacity to continue to improve its own performance through time and through varying environmental conditions. • **Integrative Developmental Processes:** Managing processes needs to be designed to embed developmental processes into the 'day-to-day' work of the project in order to support the transformation of thinking necessary for communities to make any real and lasting changes to the way they relate to their living environment. Inviting and assisting people to think outside of the paradigms they are accustomed to can be challenging, but without it old habits and patterns will inevitably reassert themselves.

Table 4: The Regenesis Framework Phases, Processes and Methods
(Summarized from Mang and Reed, 2012a, p.30-36)

f. A Metric: Ecosystem Services

The term of ecosystem is first articulated by Tansley in 1935 and is defined as "the interactive system of living things and their non-living habitat" (p.299). Tansley's studies strive to understand how life ordered and organized itself in a specific landscape. He asserts that living organisms and their physical environment cannot be thought of as separate entities. He offers the idea that all species are ecologically integrated with each other, as well as with the abiotic constituents of their biotope or habitat. Howard Odum (1971) sees ecosystems as the fundamental ordering structure of nature. He researches how the ecological systems interact with one another. Lyle defines human ecosystems as "places in which human beings and nature might be brought together again" for mutual benefits (as cited in Mang and Reed, 2012b, p.6). Lyle also emphasizes the importance of the ecosystem concept for regenerative design and notes that:

> [the] relationship between humanity and nature is likely to be the ecosystem…Since all ecosystems include human influence and most include human presence, we might well think of human ecosystems as the ordering systems of life on earth. In nature, ecosystems are continuously changing through the processes of evolution and succession, generally in a trajectory of increasing complexity and efficiency. Where humans dominate the ecosystem, the natural processes of change are, more often than not, severally altered. Nevertheless, ecosystematic order remains operational at some level (1994, p.22).

He argues that "ecosystem and its modes of order[11] provide a conceptual model of the world that serves well as a basis for regenerative design" (1994, p.23). Mang and Reed note that "the ecosystem offered a valuable framework for analyzing the effect of human activities on natural systems and resources" (2012b, p.4).

The regenerative design literature offers the idea of using ecosystem services as a metric. "The Millennium Assessment Programme defines ecosystem services as the benefits people obtain from ecosystems, and identified four categories of service: provisioning, regulating and cultural services that directly affect people; and supporting services needed to maintain the other services" (Figure 11) (as cited in Hes and Du Plessis, 2015, p.95). Provisioning services are what products we obtain from ecosystems such as food and fresh water. Regulation services are benefits we obtain as a result of ecosystem regulation such as water purification and air quality maintenance. Cultural services refer to the non-material benefits obtained from ecosystems such as recreation and inspirational benefits. Supporting services include the essential processes of life

[11] Lyle (1994) discusses three modes of order in his book: structural, functional, locational order.

such as oxygen production and nutrient recycling. Additionally, Kathleen L. Wolf explains 'ecosystem services' as a concept for "understanding and strategically generating nature based functions and benefits" (2010, p.1).

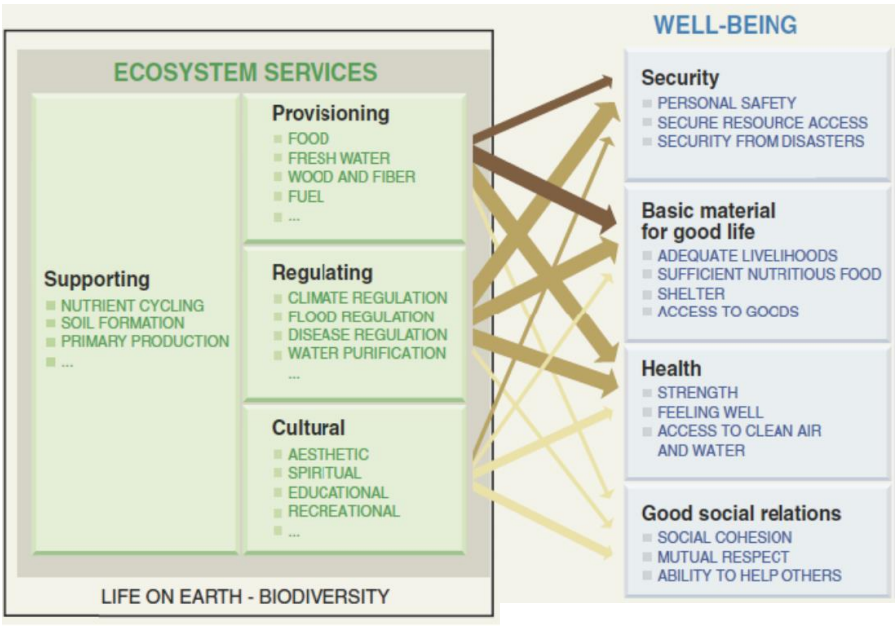

Figure 11: Ecosystem Services (the Millennium Ecosystem Assessment, 2005)

In the *Ecosystem Services Analysis for the Design of Regenerative Built Environments* article, Pedersen Zari (2012) suggests that understanding and 'mimicking' ecosystem services can be a way to set goals for regenerative developments. She offers 'ecosystem service analysis' as a potential starting point for regenerative design. Rather than having human-defined goals (related economic, political or convenience factors), she suggests ecosystem service-based targets. She claims that ecosystems show designers an example to understand how life can behave effectively in a given site and climate. Pedersen Zari argues that having ecosystem services as a performance target makes ecological regeneration interventions easier to measure. To explain this, she discusses "identifying potential key ecosystem services," "examining how ecosystem services analysis might be applied to urban settings," and "what benefits and difficulties are inherent in such an approach to design" (2012, p.55).

In her paper, Pedersen Zari assesses the ecosystem services (in Figure 11) with three criteria —physically being able to be mimicked, having the greatest impact on the maintenance of ecosystem health, and the relative negative impact— to determine which were the most appropriate for the built environment. She summarizes the results in a table (Table 5). According to her, not all of the ecosystem services are easy to mimic in the built environment. Four services

are considered as highly applicable to the built environment: provision of fuel/energy, provision of fresh water, purification, and climate regulation. In addition to that, two services have medium applicability: nutrient cycling and provision of habitat.

Ecosystem service	Ranking criteria			Examples of existing design methods that could be potentially be used	Positive environmental implications
	Applicability to the built environment	Ecological significance	Negative environmental impact caused by the built environment		
Supporting services					
1. Habitat provision (including: provision of genetic information; biological; fixation of solar energy; and species maintenance)	Medium	High	High at a local scale	Revegetation; preservation of existing flora and fauna; urban wildlife sanctuaries; living walls; urban forests; green roofs and facades; wildlife corridors; green belts	Increased biodiversity; reduction of the urban heat island effect; sequestration of carbon; increased air, water and soil quality; remediation of some forms of water, air and soil pollution; possible protection from wind or wave surges; more adaptable ecosystems as the climate changes; reduction of storm water peak flows
2. Nutrient cycling (including: decomposition; soil building; and the provision of raw materials)	Medium	High	High at a regional/ global scale	Recycling and reuse techniques; cradle-to-cradle design; composting techniques; design for deconstruction; landfill mining; industrial ecology	Reduction of waste; reduced need for mining/ growing/production/transportation of materials and energy leading to reduction in greenhouse gas (GHG) emissions, waste and ecosystem disturbance; decreased use of energy; increased health of ecosystems and humans
Regulation services					
3. Purification	High	High	High at a local/ regional scale	Living machines; phyto-remediation and bio-remediation; filtration techniques; green roofs and facades; urban forests; constructed wetlands; composting techniques	Increased health of living organisms; increased terrestrial and marine productivity; reduction of air and water pollution; eutrophication reduction; remediation of polluted sites; reduced ozone damaging gas and GHG emissions
4. Climate regulation	High	High	High at a global scale	Storage of carbon in building structure; revegetation; design to enable behaviour change in energy use; renewable energy generation; passive solar design; non-high thermal mass infrastructure and landscaping; design to reduce reliance on fossil fuels	Mitigation of the causes of climate change; more adaptable communities; mitigation of the urban heat island effect; improved health of living organisms
Provisioning services					
5. Provision of fuel/energy for human consumption	High	Medium	High at a global scale	Design for renewable energy generation; cogeneration methods; design to enable behaviour change to reduce energy use; industrial/construction ecology	Reduced transport and energy generation-related GHG emissions; more self-reliant and therefore robust urban environments; reduction of air, water and soil pollution; reduction of mining and drilling impacts
6. Provision of fresh water	High	High	High at a regional scale	Rain water harvesting and storage; grey/black water recycling; design incorporating water saving equipment; porous paving surfaces; water efficient landscaping	Reduction of water pollution; increased health of riparian systems; reduction of the urban heat island effect; increased quality of water; increased health of living organisms

Table 5: Ecosystem Services for the Built Environment (Pedersen Zari, 2012, p.59)

Pedersen Zari (2010) notes that regenerative design develops the built environment in ways where ecosystem health is increased rather than diminished. She argues that a built environment should be a part of a system that:

> deliberately provides habitat for species other than humans; contributes to soil formation and fertility through careful cycling of biodegradable wastes and recycling of non-biodegradable wastes; purifies air, water and soil; regulates the climate through mitigating greenhouse gas emissions or possibly sequestering carbon; produces renewable energy; collects water (2012, p.60).

She highlights the importance of applying ecosystem services analysis— studying whether there is an adequately healthy existing ecosystem in the locality— to achieve regeneration. However, she also points out that "it may be difficult in some cases to determine with accuracy certain rates or figures related to ecosystem services" (2012, p.61). She adds that this methodology requires wider disciplines on design teams and inputs than a traditional design job.

CHAPTER IV: DISCUSSION

The literature on regenerative design and development exemplifies that people are tired of hearing depressing and hopeless messages in regard to environmental problems. Regenerative design and development is a hope to change this situation and searches for a better way to live on this planet. It is not just about architecture; it is about people and human activity. The core issue is about changing humans' mindsets and worldviews instead of developing new technologies. In that sense, if a building is an object, it is about exploring what we want to do with this object.

Overall, there are five main topics that represent conflicts in the literature and require this investigation to take a position. These are 1) the distinction between regenerative design and development, 2) the need of placing green, sustainable and regenerative in a hierarchy, 3) the difference between embracing the nested model or Venn diagram of triple bottom line of sustainability, 4) the impact of being able to calculate limits and having a metric, and 5) the process and practice of regenerative approaches.

First, there is a confusion in the literature regarding the definition of 'regenerative design' and 'regenerative development' and the distinction between them (See Chapter III. b). Scholars have different perspectives in terms of exploring regenerative approaches. Because of this, they use different terms to explain the topic, making the approach very complicated to comprehend. For example, Lyle (1994) discusses it as 'regenerative design for sustainable development,' while Mang and Reed (2012a; 2012b) use the term of 'regenerative development and design' and see these concepts together. Du Plessis (2012) focuses on emphasizing the need for a new paradigm to support the concept and notes this as a 'regenerative sustainability paradigm.' Pedersen Zari and Jenkin (2010) define 'regenerative development' by defining the desired outcomes and see 'regenerative design' as the means of achieving those. Additionally, in Cole's article (2012a), it is difficult to recognize the distinction. Thus, this thesis aims to clarify the distinction between 'regenerative design,' 'regenerative development,' and 'regenerative design and development':

Regenerative design is an approach to shape and form a system (i.e. human ecosystems, communities, buildings, built environments, cities etc.) that seeks to reverse environmental degradation by creating positive impacts, rather than merely causing less damage, to increase the health and wellbeing of humans, other living beings, and ecosystems as a co-evolutionary whole.

Regenerative design requires an understanding of the fundamental principles of ecosystems to explore how nature designs to regenerate rather than deplete life support systems. It supports that human and natural systems are not separate and should have a partnered relationship. It aims to

provide a basis for self-renewing aspects of natural ecosystems. It sees place as a core for design and works for understanding patterns of place and ecosystems in different scales from planetary to local in order to find a way to positively participate. The overall objectives of regenerative design are understanding how nature and ecosystems work and participating in nature as a socio-ecological partner to provide positive impacts.

Regenerative development is an approach for enabling human communities to co-evolve with natural living systems and building the field of caring for ongoing stewardship and self-renewing.

The regenerative development approach represents inspirations from the self-healing and self-organizing capacity of natural living systems. It suggests engaging all stakeholders into the processes to ensure the emergence of regeneration, continual evolutionary transformation, and self-evolving process.

Regenerative design and development, together, refers to the fact that these two approaches are interrelated and need to be thought of as together. Both of them are essential to apply to the notion of regeneration into the built environment. For example, while regenerative design requires a radical shift in thinking and understanding how humans see their relationship and role regarding the planet, regenerative development creates conditions and capacities to achieve this shift. Regenerative development is a continuous active process which arises from design. It is the phase in which design decisions become actions by transforming and reshaping the ecosystems of a unique place.

As Lyle describes, *design* involves "conceiving and shaping complex systems" (1994, p.ix). Although *development* implies "change —specifically modifying and adapting the landscape for human purposes" (Lyle, 1994, p.3), it "means designing a new ecosystem in nature" (1994, p.23). In short, if a design strives to reverse negative environmental impact and provides a basis for self-renewing (regenerative design) while a development supports designing the new ecosystem by ensuring the whole system's health (co-evolution) and caring for ongoing stewardship (regenerative development), a sustainable future might be achievable. In that point, as Reed mentions, the role of an architect or a designer or a planner in the future might be a facilitator between stakeholders and these stakeholders include nature, future generations, community, and so on[12].

Secondly, as discussed in Chapter III. b., Larrick (1997), Reed (2007) and Pierce (2015) place green, sustainable, and regenerative in a hierarchy. On the other hand, Cole (2012b) disagrees

[12] This information is obtained from the *Regenerates Film* which was compiled from the interviews conducted by Chrisna Du Plessis and Dominque Hes for their book *Designing for Hope*.

with them to position regenerative above sustainable design. He sees sustainability as an evolving overarching concept. In addition to him, Lyle also mentions that sustainability requires regeneration and that they are not very different concepts. The literature review shows that it is reasonable to support both Cole and Lyle in that point due to one main reason. The reason is in regard to the presence of two different streams of sustainability[13]. Considering technological sustainability as sustainable design or 'sustainability' is wrong and deficient. It is necessary to look from both perspectives. In contrast to green design and the 'current version of sustainable design', regenerative design emerged from ecological sustainability. It is logical to see sustainability as an evolving broad concept and eliminate the need to place them in an order.

Thirdly, in the literature it is not very easy to understand who discusses the topic by considering the differences between the nested model and the Venn diagram of the triple bottom line of sustainability. It is essential to identify this notion. The research demonstrates that the nested model depicts a more accurate relationship between the three systems: social, environmental and economic. Economic systems are created by human social systems which exist and rely on environmental systems. This idea brings the three systems together. As the term 'nested' implies, this model corroborates the key concept of regenerative design that is seeing nature and humanity as one.

Fourthly, the impact of being able to calculate limits and having a metric is one of the most discussed issues in the literature. Du Plessis (2012) argues that calculating limits speculates the idea of accepting these limits and living within these limits without thinking of a better solution. However, this is not a well-supported argument. Having a correct worldview or thinking process might prevent this idea. It is essential to recognize the role of measurement and its contribution to regenerative approaches instead of discrediting calculations. In addition to Du Plessis's point, Cole (2012a) and Mang and Reed (2012a) argue that the success of regenerative design and development cannot be clearly understood and is not measurable like green and sustainable design because of its qualitative difference and timeframe. On the other hand, Pedersen Zari (2012) and Clegg (2012) highlight the need for having a metric and applicable goals. Although qualitative concepts exist in the process of regenerative design and development, it is necessary to have metrics or indicators. Instead of rejecting the idea of using metrics, the possible new format of metrics should be studied.

[13] David Orr notes that sustainability falls into two streams: technological and ecological (See Chapter III. b).

This topic is also related the discussion about holism vs. reductionism. The scholars in the literature endorse whole systems thinking and reject element-based approaches in reductionism. They question reductionism in favor of a holistic view. For instance, Mang and Reed (2012a) note that shifting from a mechanistic to an ecological worldview is central and this requires an entirely new mind, not just the adaptation of a few new mental models. However, there are some advantages of reductionism such as its ability to assist with uncertainties (Tainter, 2012). Du Plessis mentions that "nature is simply too complex to allow prediction" and the human mind cannot comprehend this (2012, p.14). On that note, reductionist science can be helpful. It is necessary to recognize the weaknesses or faults of reductionism but this does not require rejecting the entire approach. There is a debate regarding the multiplicity of worldviews and how these two (holism and reductionism) might interact with each other (See Chapter III. a). The existing research reveals three potential future to explain how this process might happen: merging, holding multiple views (hybrid), and creating an entirely new one (See Figure 12).

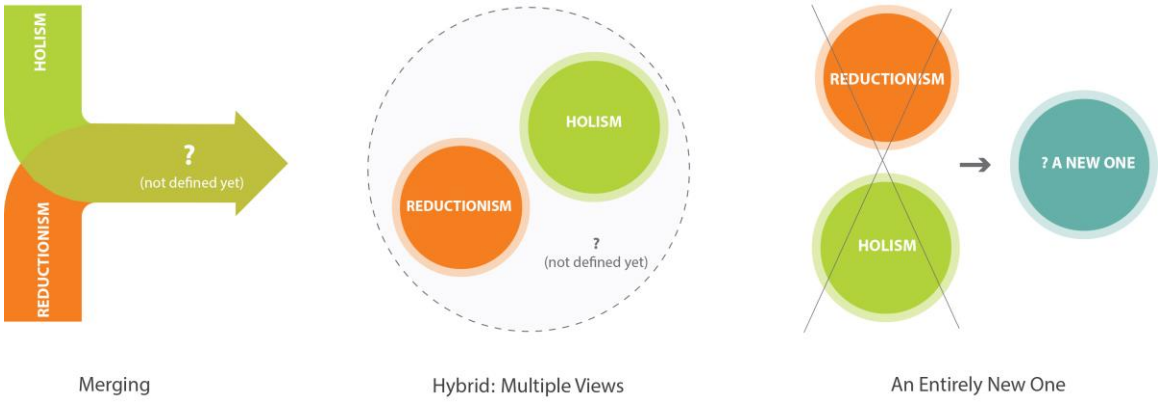

Figure 12: Three Potential Ways for Evolution of Worldviews

In this process of paradigm change, it is crucial to be cautious about the humanistic aspects of the ecological worldview. Bookchin (1987), a social ecologist, argues that 'deep ecology' or ecological worldview carries a risk of falling into "misanthropy," being hateful toward humanity. He notes that as a principle of an ecological worldview, decreasing human population for any purpose sounds like an anti-humanist discourse and prevents freedom. Bookchin (1987) also mentions that environmental problems are firmly rooted in the manner of human social interaction, and points out the potential for human beings to solve environmental issues through a change of cultural attitudes. This thesis absolutely does not support the idea of anthropocentric environmentalism, which is only concerned with the conservation of the environment for

exploitation for human purposes. However, it intends to draw attention to the importance of not pushing society into the misanthropy and to emphasize the significance of humanist discourses and social attitudes for future paradigms. In order to change situations, the role of people's creative intelligence should not be forgotten.

Lastly, although the concept of regenerative design and development is gaining an increasing interest, its operation and practice are less clear. As Peter Clegg notes, papers regarding regenerative design and development "are long on theory and short on practical exemplars" (2012, p.366). The literature does not describe the physical characteristics of a regenerative design and development which is essential in order to transform the practice. Mainly, there are three concerns related to the practice: dealing with the complexity of systems thinking, the client response to longer timeframe to understand success, and defining and working with broader boundaries.

Clegg represents the first concern by questioning "how the complexity of systems thinking can be translated into the decision-making processes without adding undue complication" (2012, p.365). According to him, there are some challenges that practice might face:

> increasing complexity, in already complex decision-making process that accompanies most architectural and urban design projects, could reduce the capacity for change… The unexpected negative outcome is to impede the flow of design ideas that eventually produce a building. Added complexity in the design process does not ensure a better building… Some of the systems that are beginning to develop around the idea of regenerative design hold the potential to stultify innovation and cause stagnation in decision-making (2012, p.367).

After this, Cole (2012a) points out the difficulty of convincing clients that regenerative design requires a longer timeframe to explore the success of a project. Thirdly, Cole (2012a) and Clegg (2012) note that current practice primarily focuses on individual buildings without acknowledging the larger system context. Cole questions that "while boundaries are indeed beginning to blur, will regenerative design and development accelerate the development of the necessary systems-thinking, shared vision, shared ownership and shared responsibility?" (2012, p.5).

This thesis acknowledges the concerns regarding the practice of regenerative design and development. It contributes to current literature by presenting information on regenerative design support tools and evaluating them to determine gaps for further study.

CHAPTER V: EMERGING REGENERATIVE DESIGN SUPPORT TOOLS

New tools such as REGEN, Eco-Balance, LENSES, Perkins+Will Framework, and Living Building Challenge[14] are emerging to depict the key characteristics and attributes of regenerative approaches and assist practitioners, designers, and stakeholders. These emerging design support tools carry a significant role in bridging the theory of regenerative design and development and current building practice. They aim to simplify the theoretical underpinnings and thinking process of regenerative design and to provide guidance and approachable goals for practitioners. Because of their important role in shaping literature and practice, these five tools were explored, examined and will be evaluated (Chapter VI) in detail.

The necessary change in current practice cannot be easily and quickly internalized within the design and production of buildings. Although the technical performance of buildings is still essential, "contribution to the ongoing health and evolution of the whole system" is the most important intention for a regenerative approach (Hes and Du Plessis, 2015, p.135). However, as Clegg (2012) mentions, the theories, emphases, and strategies behind the regenerative approaches are complex, blurry and not very clear from practitioners' standpoint. Its assimilation might vary due to differences in a firm's or designer's capability. Therefore, it is necessary to have a tool or guide and metrics/indicators to understand and apply regenerative approaches.

With the emergence of regenerative design, the role and scope of the tools are changing and being expanded. Although Cole states that "drawing on this literature, it is possible to argue that even attempting to reduce the range of complex systems into design tools is a questionable exercise, and any resulting products will diminish the overall holistic aspiration of regenerative design and development" (2012b, p.48), there is a need and demand for support tools to assist practitioners who wish to engage and work for achieving regenerative design.

Regenerative design would seem to require different kinds of tools to comprise systems thinking. Although the regenerative design support tools are in their infancy, it is frequently argued that they should be substantially different from checklist-based reductive green and sustainable design assessment tools. Performance assessment and rating systems such as LEED have been dominating the mainstream of green building practice. Their methods are checklist-based and depend on a list of indicators. Reed (2007) characterizes green design tools as

[14] LBC was accepted as regenerative design tool in this investigation. It might look like an indicator-based green design tool, but the indicators are broad enough to involve systems thinking. This notion is stated as "the program has always been a bit of a Trojan horse—a philosophical worldview cloaked within the frame of a certification program." (ILFI, 2014, p.6).

indicative of current reductive and fragmented thinking. This checklist-based 'reductive' method has been criticized for three main reasons in the literature. The first reason is the lack of overall framework to understand the concept and the interconnectedness of strategies. The green design tools "identify discrete performance requirements often translates into design as a series of isolated design gestures to meet them rather than encouraging creative synergies, closing loops, and responding appropriately to the local ecological and social contexts" (Cole, 2012b, p.41). The second reason is that "the indicators reflect the specific interest of their authors" (Du Plessis, 2012, p.13). The last reason is that "a reliance on aggregation methods for the assessment of different interventions in such as complex dynamic system does not easily lend itself to a systemic understanding" (Du Plessis, 2012, p.13).

The emerging regenerative design support tools were developed as a response to these criticisms. Scholars emphasize the importance of providing process-based tools which are 'for thinking and making connections' to transform the practice. Hes and Du Plessis summarize the goals of these tools in three main points:

- Develop an understanding of how the proposed project fits into and contributes to the wider system within which it is situated.
- Make visible the connections, relationships and flows between the different elements of the system across scales.
- Enable meaningful and inclusive dialogue that will build ownership, ongoing commitment and personal transformation. (2015, p.135-136)

a. REGEN

The US Green Building Council (USGBC) appointed the Berkebile Nelson Immenschuh McDowell (BNIM) firm, the Kansas City-based design company and was instrumental in the establishment of the USGBC and the development of LEED and the LBC, to "develop a tool that will go beyond LEED Platinum and stimulate market transformation toward regenerative thinking" (Hes and Du Plessis, 2015, p.141). USGBC sponsored the project as a part of its mission and its goal to "participate most effectively in transformation of practice toward regenerative design and development, complimenting the LEED tool with other approaches" (Svec *et al*., 2012, p.82).

The team has considered the REGEN as a data-rich, web-based tool to guide dialogue and help professionals engage with regenerative approaches. Svec *et al.* explains the tool:

> It is not intended to 'teach' regenerative thinking to those new to the concept, but it is designed to be accessible to them, including new professionals and community members, to introduce them to regenerative concepts and examples, to inspire them to participate in regenerative processes, and to provide information to enable them to develop a fuller understanding of their community and project (2012, p.83).

Before developing the tool, the team scanned the literature. According to the team, although some of the existing frameworks such as the One Planet Living, the LBC and Biomimicry Laws of Nature are not sufficiently comprehensive to address all aspects of regenerative design, they can help reveal the 'whole' when they come together. These existing frameworks acted as an inspiring starting point for the process of developing REGEN. According to the team, the frameworks in the literature do not show the connections between important issues and make connections and relationships visible to guide dialogue. So, REGEN aims to fill this gap. To do so, REGEN includes three components:

- a framework that encourages systems thinking, the establishment of positive goals, and collaborative dialogue: links specific strategies to the whole and shows the interconnectedness of individual strategies
- place-based resources: provides data and other information for project teams
- examples of projects: incorporates the elements of regenerative thinking. (Svec *et al*., 2012, p.85)

The REGEN framework consists of nested systems which have two different levels. At the broadest level, there are four quadrants of life: robust and resilient natural systems, high-performing constructed systems, prosperous economic systems and whole social systems. The next level provides 40 components of life including water, flora, fauna, energy systems, transportation systems, capital, employment, food, social justice, public health etc. (Figure 13).

The concept idea is that the project team can input basic information regarding the project data such as project type, scale and location, and the tool will populate with all existing information (within the tool's database) that is known about the place and its current state of health. The health of each component is represented by a change in the size of the colored circle. A larger circle shows a robust health and a smaller circle indicates "imperiled health" (Svec *et al.*, 2012, p.88) (Figure 14).

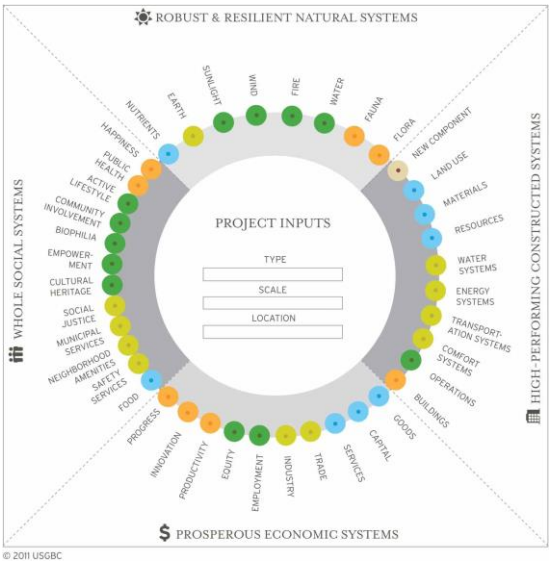

Figure 13: REGEN Concept Framework (Svec et al., 2012, p.87)

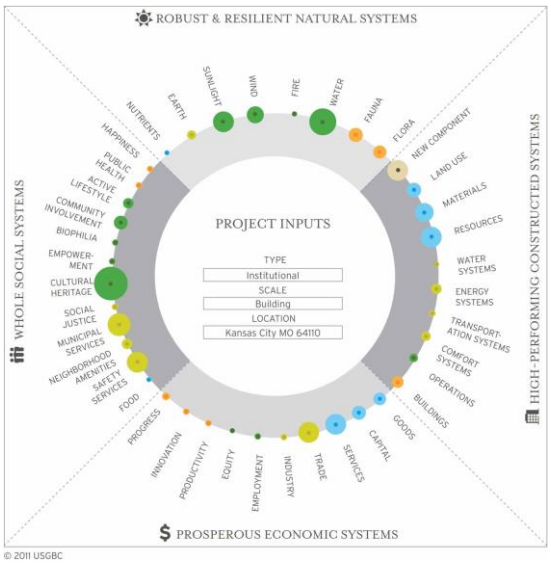

Figure 14: The Framework Shows Place-based Information (Svec et al., 2012, p.88)

The next step for the tool is to input and understand specific strategies and map their relationships (Figure 15). The relationships may have an impact on different components. This helps design teams realize multiple benefits and interactions and understand the complex web of connections. In addition to that, the tool links place-based information from open source databases. These databases can populate the available data, case studies and project examples demonstrated in practice for users.

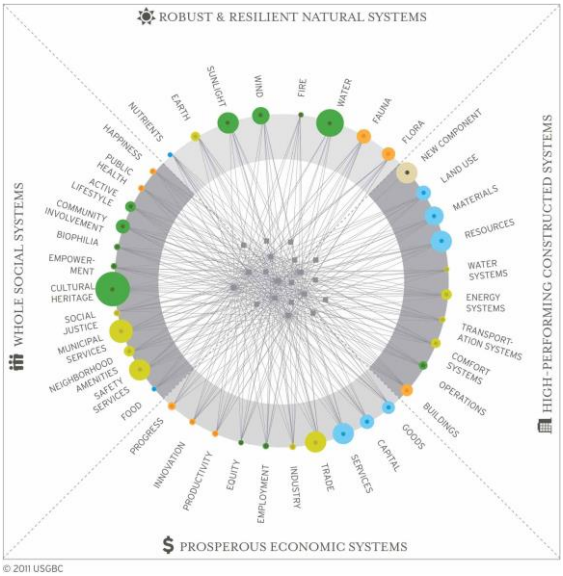

Figure 15: The Interconnected Web of Strategies Connected to Components (Svec et al., 2012, p.89)

According to Hes and Du Plessis (2015), although the tool is still under development, its emphasis on understanding the impact of a set of strategies for the different components shows the power of the tool for informed dialogue and learning. On the other hand, the presence of a list of strategies like a checklist is a danger for the tool that can prevent design innovations (Hes and Du Plessis, 2015).

b. Eco-Balance Planning and Design

The Center for Maximum Potential Building Systems, a non-profit education, research, and demonstration organization that was established in 1975 and specializes in life cycle planning and design, developed the Lenses for a Maximum Potential Future that are protocols for creating a more sustainable present and future. There are twelve lenses in the framework (Figure 16). The third lens of the framework, Eco-Balance, is a design and planning tool for regenerative design. Before exploring Eco-Balance, the other lenses will be summarized.

First Lens: Visible Green is a visualization protocol to share information that is key to creating a green world. Protoscope (second lens) means organizing how prototypes are conceived and is a worldwide scoping procedure that provides essential perspective related to the unique significance of any place on Earth by organizing from a global ("protoMetric") scale. Lens 3 is Eco-Balance which is the main tool for regenerative design. Lens 4 is Supports & Connections and covers the Center's whole building system approach that is based on eight low-impact methods: design with Climate, Building System Typologies, Design for Manufacturing, Design with Nature, Design with Reuse, Design for Open Building, Embodied Carbon Balance, and Evidence-Based Economics. Gamification, the next lens, is a protocol for gaming environments of varying scales for educating for a green world. Lens 6: Area Point Network is a planning protocol. 'Area' means resources that are organized with suitability maps, 'Point' refers to resources that target regional human experience, and 'Network' explains resources that are measured through four flows: information, currency, energy, and material. The name of the next lens is Green Health. This lens demonstrates four principles across the health spectrum: precautionary principle, cycle of life, design for healthy body and strategic planning. Lens 8: Baseline Green/GreenBalance is a protocol for using national data sets. While Lens 9 is Feedback City and helps to recognize feedback loops within the structure of a city, Minimax is the other lens and engages efficiency and integration between human power and nature power to support basic needs. Meta Max (Lens 11) provides global-scale systems thinking. Finally, the last lens is

Conceptual Space Race, which tries to help people to develop an understanding about the carrying capacity of Earth (Martin, 2013, p.239-265).

Pliny Fisk notes that "[the lenses] may be used independently or combined for different conceptual views. They may reflect cultural and regional distinctions and serve as a framework on which other lenses should be added as the field of sustainable design continues to advance" (Martin, 2013, p.240).

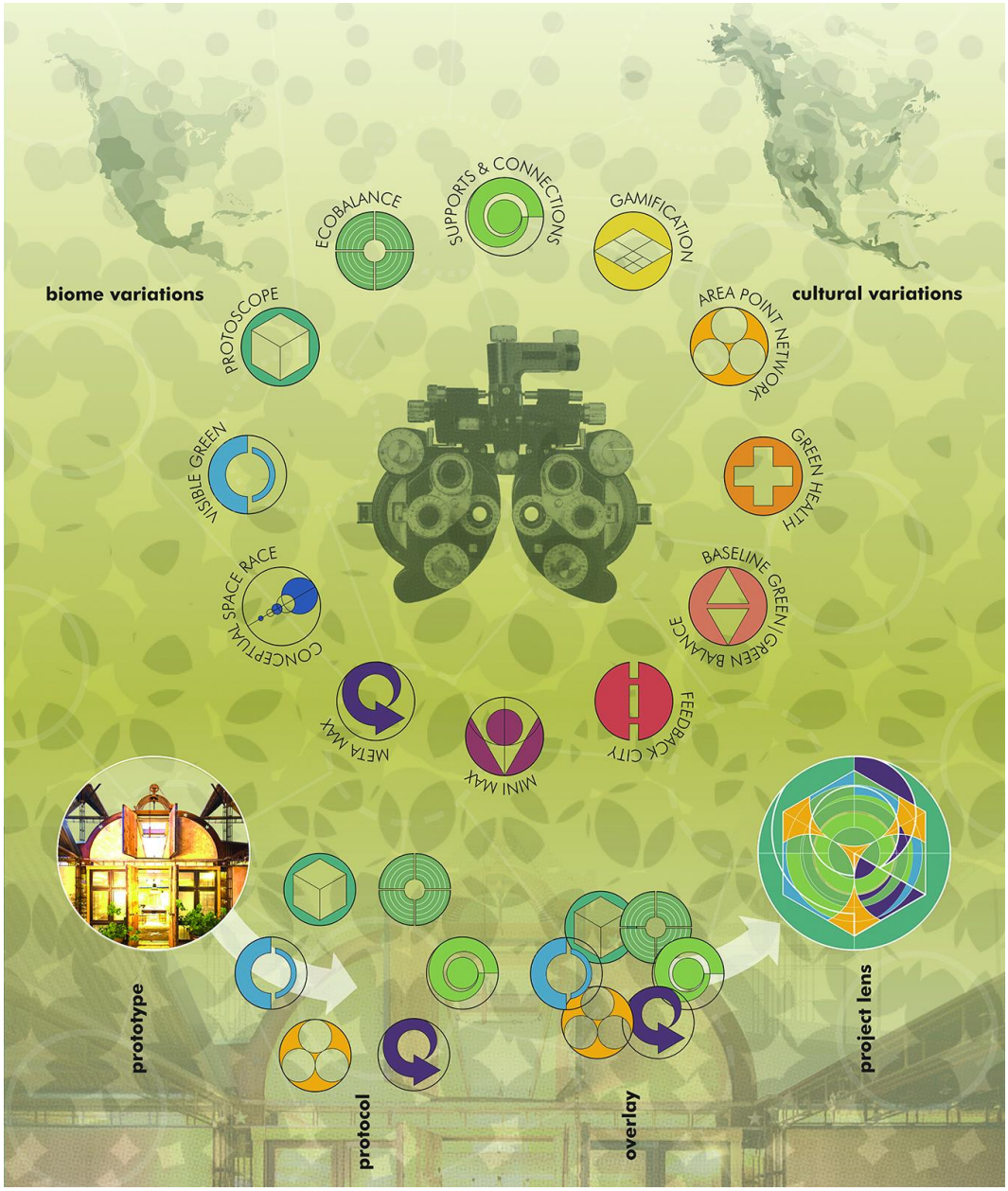

Figure 16: Lenses for a Maximum Potential Future (http://www.cmpbs.org)

Eco-Balance was developed by Pliny Fisk and Gail Vittori, co-directors of the Center for Maximum Potential Building Systems, as the third lens (Figure 17). As mentioned above, it is a design and planning tool for "balancing of resource flows by adroitly managing nature in ways that continually supply our basic needs in a regenerative manner" (Fisk, 2009, p.2). Fisk describes the Eco-Balance planning and design as "the principle of balancing life support systems (air, water, food, energy, and materials) across life cycle phases (source, process, use and resource)" (2009, p.2).

Cole summarizes the key characteristics of Eco-Balance planning and design:

- managing natural systems to continually balance resource flows
- sourcing and re-sourcing within a spatial context that is manageable either by the individual or the community
- industrial processes considered inextricable from holistic performance assessments
- life support cycles occur at many scales and as part of almost all life
- nature-based but managed and augmented through green technology and engaging of user/participant as part of resource cycles. (2012b, p.49)

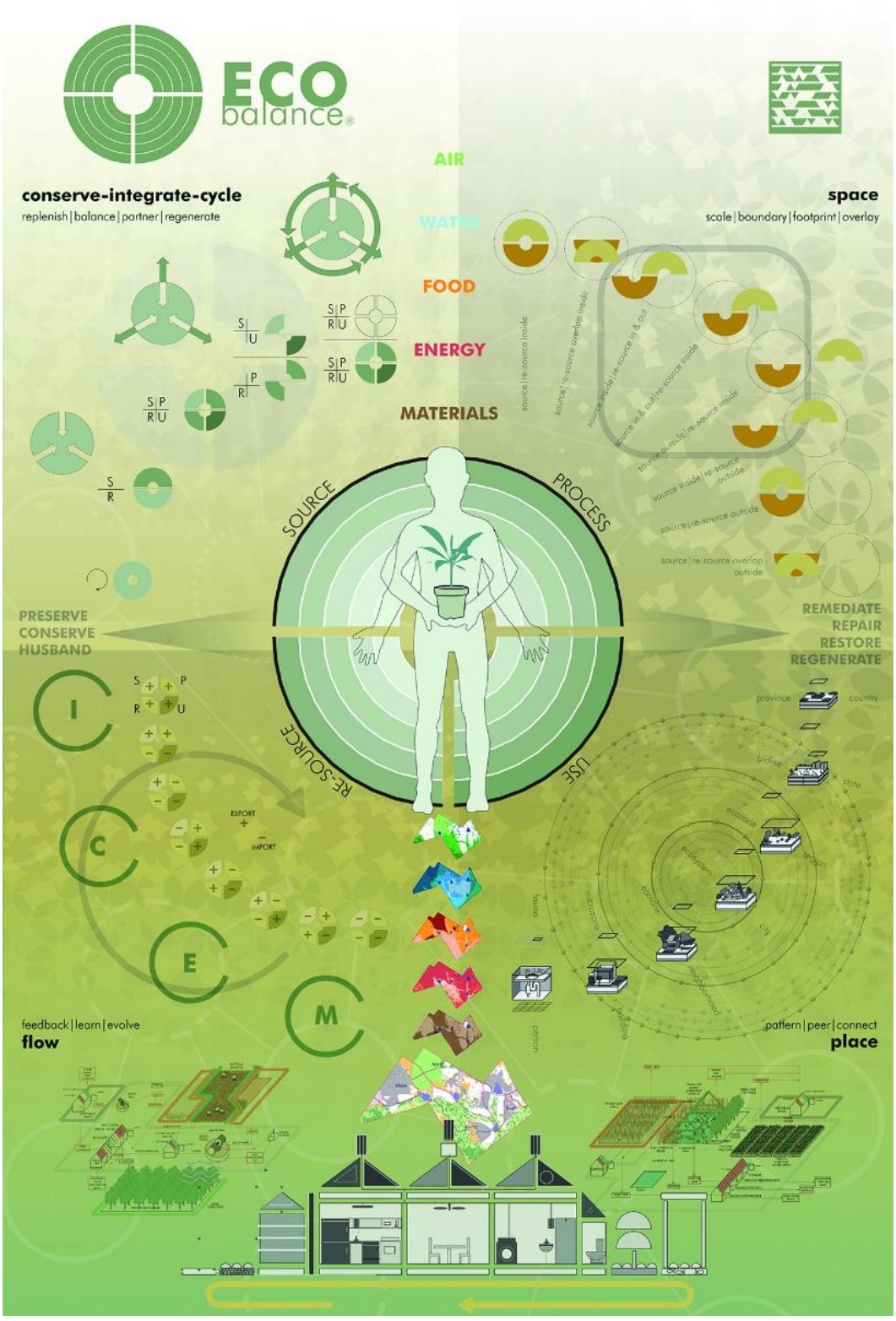

Figure 17: Eco-Balance Planning and Design (http://www.cmpbs.org)

c. Perkins+Will Regenerative Design Framework

Perkins+Will, the North American architectural practice, is developing a regenerative design framework "to offer constructive direction to design teams and to generate dialogue —both internally and with clients— that expands performance issues and strategies beyond those covered in green design and that identifies positive synergies" (Cole *et al*., 2012, p.96). This framework could be used for all market sectors such as healthcare, education, and retail in various scales from a single building to city.

The framework was created to guide Perkins+Will's design processes. Cole *et al*. summarize objectives of the framework:

- to initiate a different and expanded dialogue between the design team members and with the client and users, moving beyond the immediate building and site boundaries
- to emphasize the opportunities of developed sites and buildings to relate to, maintain, and enhance the health of the ecological and human systems in the place in which they are situated
- to highlight the ecological and human benefits that accrue from regenerative approaches
- to facilitate the broader integration of allied design professionals – urban planners, landscape architects and engineers, together with other disciplines (ecologists, botanists, hydrologists, etc.) typically not involved in buildings – in an interdisciplinary design process. (2012, p.96-98)

The Perkins+Will framework[15] has two main parts, an 'issue-based' framework and a 'process-based' framework. The first part introduces an 'issues-base framework' that consists of "two complementary graphics formed that basis of the framework: representation of place and representation of flows" (Perkins+Will, 2015, p.10). The issue-base framework represents the interaction between humans and natural systems by using place as a core and addresses human needs, resource flows, and ecosystem functions (Figure 18). Within the graphic, while human needs are organized in four categories: enhancing individual human health and wellbeing, enhancing social vibrancy, enhancing cultural vitality, enhancing healthy economy, ecosystem functions are categorized as habitat, regulation and production functions.

[15] The framework explained in here, is the final (2015) version of the Perkins+Will Framework. Cole *et al*. introduced the Perkins+Will framework in the special issue of Building Research & Information in 2012. However, this was the earlier version of the framework. The current version was obtained from Doug Pierce of Perkins+Will for deep exploration and the information gathered from this report is cited as Perkins+Will, 2015. Although it still uses 'questions' as an approach, the final version has a number of new diagrams and information in comparison with the earlier version.

In addition to that, the framework analyzes the resource flows —energy, water, material— separately in an additional graphic (Figure 19). Resource flows are located between human and ecological systems in Figure 18. This demonstrates that buildings have a critical role to contribute to developing social, cultural and natural benefits by engaging these flows (Cole *et al*., 2012). The framework tracks material, energy and water flows from nature and back into nature to replenish and provide multiple benefits with an emphasis on quality of resource flows (in addition to the quantities). It covers four quadrants of the cycles that are produce, use, recycle, and replenish.

Figure 18: Representation of Place

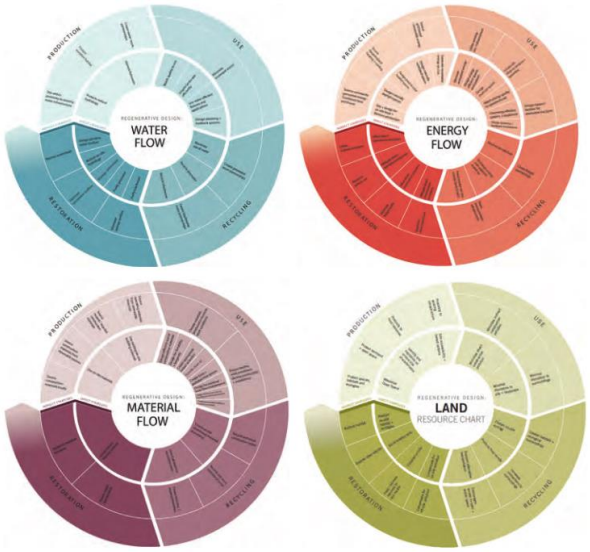

Figure 19: Representation of Flows

The second part of the Perkins+Will Framework discusses a 'process-based' framework. It "attempts to reorganize the same conceptual material into a process-based framework. While the process-based version is much more explicit about its embedded operations, the intent is to leave plenty of latitude for experimentation and customization" (Perkins+Will, 2015, p.18). Instead of listing strategies, the process-based framework uses a series of challenging questions to help the team establish norms and new aspirations. The framework explains why the use of 'questions' is a key approach:

> The process-based framework maintains the view that a checklist approach (commonly found in green building assessment tools) is ill-suited to guide the design process toward regenerative outcomes. Regenerative design is relative, meaning that each project is

unique and strongly place and program specific, possessing its own constraints, opportunities, priorities and notions of success (Perkins+Will, 2015, p.18).

The Perkins+Will framework is intended to be useful at all stages of the design of a project. Although the team acknowledges that the greatest value of the tool is in pre-design, "the regenerative principles and the more operative components of the framework are presented in a way that remains relevant to all stages of design—from formulating an initial concept to schematic design and design development" (Perkins+Will, 2015, p. 20).

The images below explain the overall framework (Figure 20) and its key principles (Figure 21). The framework graphically has two main parts: Foundation ring and 'Sandbox'. The Foundation ring tries to bridge mechanistic and ecological worldviews and emphasizes that regenerative design sits within the ecological worldview. The concepts of 'place' and 'program' within the framework try to provide a discussion regarding limits and boundaries and highlight the importance of 'scale adaptability'. In addition to that, due to the uniqueness of each project, the framework promotes the concept of Sandbox to guide a fluid, flexible, and less tight process of 'finding regenerative potential, assembling project inputs, and testing design propositions'.

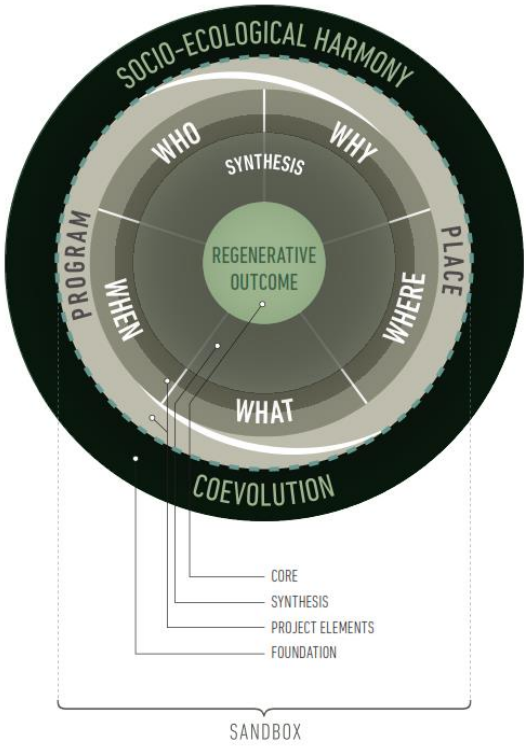

Figure 20: Perkins+Will Process-based Framework

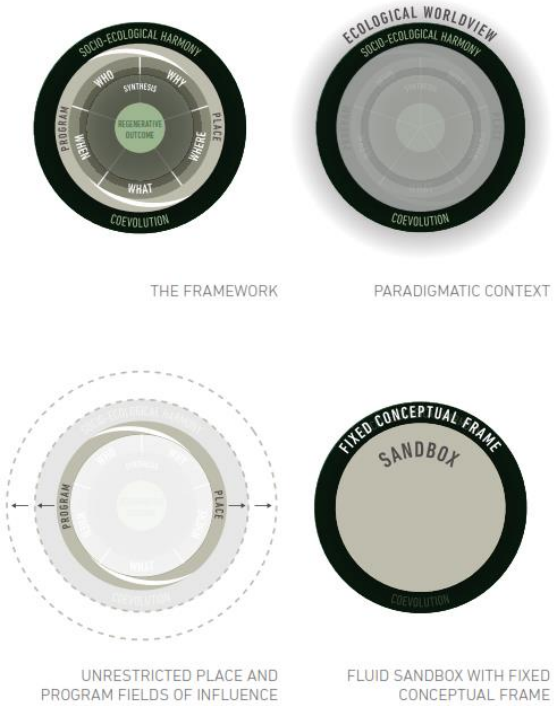

Figure 21: Key Principles of the Framework

There are three primary sections in the framework: Sandbox (the rings of the framework except foundation), a set of questions correlating to each of the rings of the Sandbox, and a 'Toolbox.'

First, the Sandbox consists of three main rings that are Project Elements, Synthesis, and the Core (Figure 22). Project Elements (place and program) represents existing and introduced conditions and conceptually frame the 'who', 'why', 'what', 'when', and 'where' of the project. Synthesis ring shows how the project elements are interconnected and comes together for a regenerative outcome. This part serves as a starting point for developing strategies that are specific to the given architectural project. Synthesis ring includes two main aspects that are characteristics (polyvalence, synergy, self-organization, and feedback loops) and assembly components (inputs and outputs, flows, and systems). The Core is the center and explains "a regenerative outcome in terms of its indicative qualities. These are what the design team will expect to strive for and in turn against which the success of the work would ultimately be judged" (Perkins+Will, 2015, p.28). The Core highlights mutualistic, generative, resilient, and tactful approaches for the notion of regeneration.

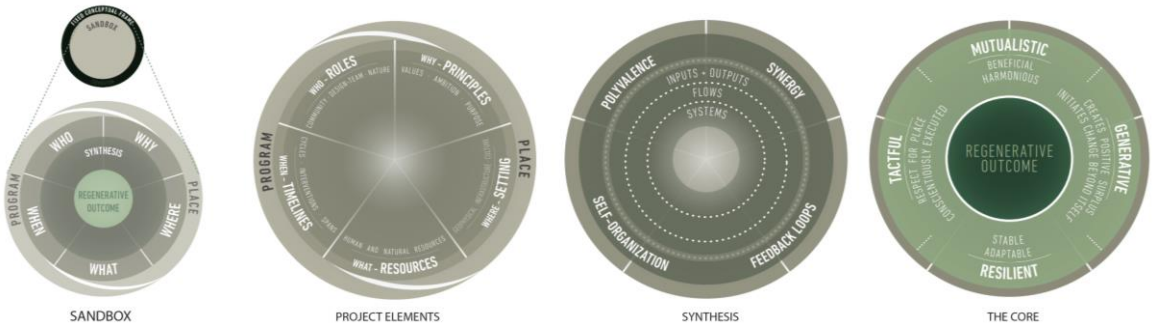

Figure 22: Exploded Version of the Sandbox Section of the Framework (Perkins+Will, 2015, p.33-42).

The second primary section of the framework provides some questions for each of the rings of the Sandbox. Questions for the Core rings are shown to provide an example (Figure 23).

The final section is the 'Toolbox' of the framework. The content of the Toolbox is meant to supplement the content organized within the Project Elements, Synthesis, and the Core. The Toolbox has three circular diagrams: Conditions, Dimensions and Additional Resources. They are self-explanatory and can be seen in the Figure 24.

QUESTIONS: CORE

ASSESSING THE OUTCOME

Questions belonging to the Core revolve around the speculative assessment of the proposal, whether it be a water retention strategy or the building as a whole. Such questions are meant to aid in the informal evaluation of the appropriateness of the project, for example:

At any point does an emphasis on efficiency of subsystems compromise effectiveness of the whole?

Is there a balance between (environmental, social, economic, etc) cost, functionality, and long-term investment?

How does a particular strategy enhance or bring value to aspects of Place? Does this in turn strengthen aspects of the project?

Does the functioning of a particular system interfere with other systems of Place and Program?

Does the project generate positive surplus (i.e. energy, water, cultural vitality, biodiversity)? How can this be best deployed?

Is the relationship between the project and its context mutually beneficial?

Is the impact of the project positive and self-reinforcing? Does it retain these qualities over time?

Does the project have the capacity to deal with climatic, economic, and political disturbances?

Figure 23: Questions for the Core Ring (Perkins+Will, 2015, p.60)

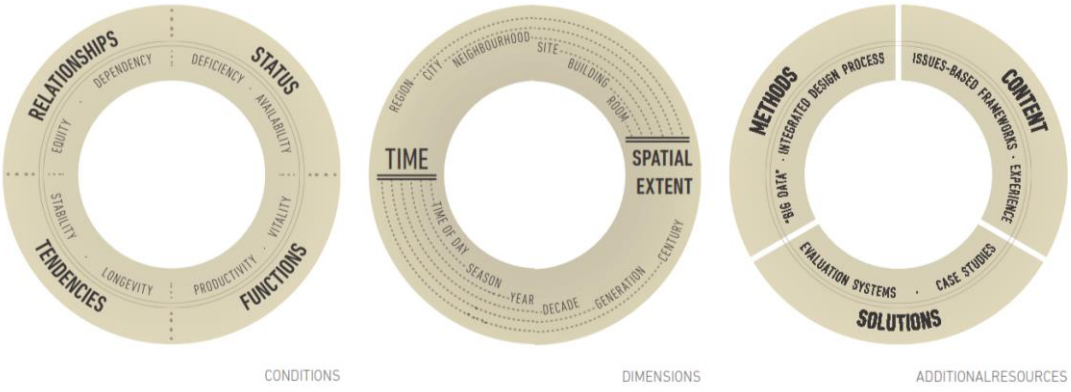

Figure 24: Toolbox Section of the Framework (Perkins+Will, 2015, p.49-50)

d. Living Building Challenge

The Living Building Challenge (LBC) is a philosophy, an advocacy and a certification tool for building projects to "move beyond merely being less bad and to become truly regenerative" in scale from single building to neighborhoods (ILFI, 2014, p.4). Currently, LBC is managed by the International Living Future Institute (ILFI). However, it was initially developed by Jason F. McLennan who is also the CEO of the ILFI.

The idea of LBC emerged in the EpiCenter in Bozeman, Montana while working on the most advanced sustainable design project[16] in the world in the 1990s (LBC website). McLennan was inspired by the studies of EpiCenter and worked with Berkebile and Williams at BNIM to conceive the concept of 'living buildings' (Hes and Du Plessis, 2015, p.169). After that, McLennan turned the theoretical idea into a 'codified standard,' developed the LBC programme, and launched the LBC version 1.0 in 2006. The current version of the tool is LBC 3.0[17] and was explored in this study.

The philosophy of LBC aligns with the ecological worldview. It sees the role of humans "as steward and co-creator of a true Living Future" (ILFI, 2014, p.6). The tool aims "to envision a future that is Socially Just, Culturally Rich and Ecologically Restorative" (ILFI, 2014, p.6). The LBC references natural systems by using a flower/petals metaphor:

> Imagine a building designed and constructed to function as elegantly and efficiently as a flower: a building informed by its bioregion's characteristics, that generates all of its own energy with renewable resources, captures and treats all of its water, and that operates efficiently and for maximum beauty (ILFI, 2014, p.2).

The LBC 3.0 consists of seven performance categories, or 'Petals': Place, Water, Energy, Health & Happiness, Materials, Equity, and Beauty. Petals are subdivided into twenty Imperatives and each of them focuses on a specific 'sphere of influence.' All Imperatives of the tool are mandatory and the certification is based on an actual performance rather than a modeled one. There are three options for the certification: Living Certification, Petal Certification, and Net Zero Energy Certification. The LBC can be applied to all types of projects in every climate zone.

LBC includes the Living Transects to encourage appropriate development in specific settings. The Living Transect[18] provides categorizations from rural to urban areas (Figure 25). The projects

[16] This study was led by Bob Berkebile and Kath William.
[17] Version 3.0 was launched in 2014. The tool was downloaded from the official website of the International Living Future Institute (http://living-future.org/lbc) for this investigation and cited as ILFI, 2014.
[18] It is adapted from the work of Duany Plater-Zyberk and Company, which created the New Urbanism Transect model.

need to be classified into three Typologies that are renovation, landscape or infrastructure, and buildings. The Scale Jumping Matrix (Figure 26) shows all Imperatives and which ones are allowed to incorporate "multiple buildings or projects to operate in a cooperative state—sharing green infrastructure as appropriate and allowing for Renovation or Building status to be achieved as elegantly and efficiently as possible" (ILFI, 2014, p.18).

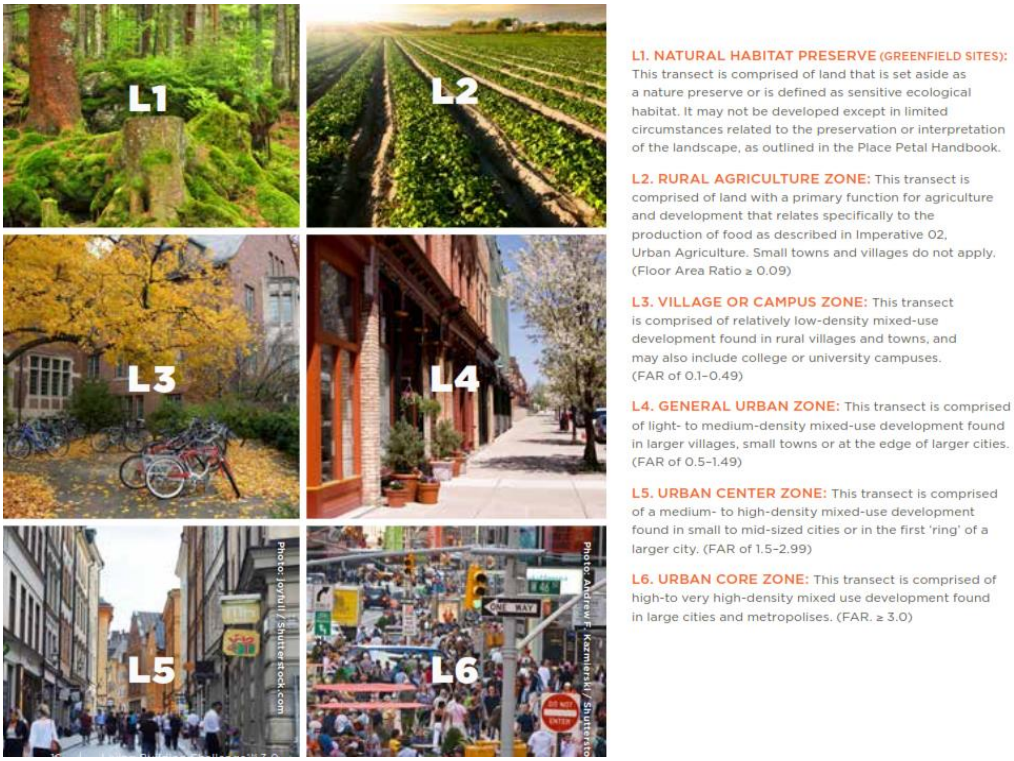

Figure 25: The Living Transects (ILFI, 2014, p.16)

The tool provides detailed information regarding the application of Petals and Imperatives. Place Petal is described as "restoring a healthy interrelationship with nature" in the actual framework and has four Imperatives: Limits to Growth, Urban Agriculture, Habitat Exchange, and Human Powered Living (ILFI, 2014, p.23). This Petal emphasizes 'story of place' and 'unique characteristics of a place' to support the notion of regeneration. The second Petal is Water and has only one Imperative which is Net Positive Water. Water Petal intends to

> realign how people use water and to redefine 'waste' in the built environment… [LBC] envisions a future whereby all developments are configured based on the carrying capacity of the site: harvesting sufficient water to meet the needs of a given population while respecting the natural hydrology of the land, the water needs of the ecosystem the site inhabits, and those of its neighbors (ILFI, 2014, p.29).

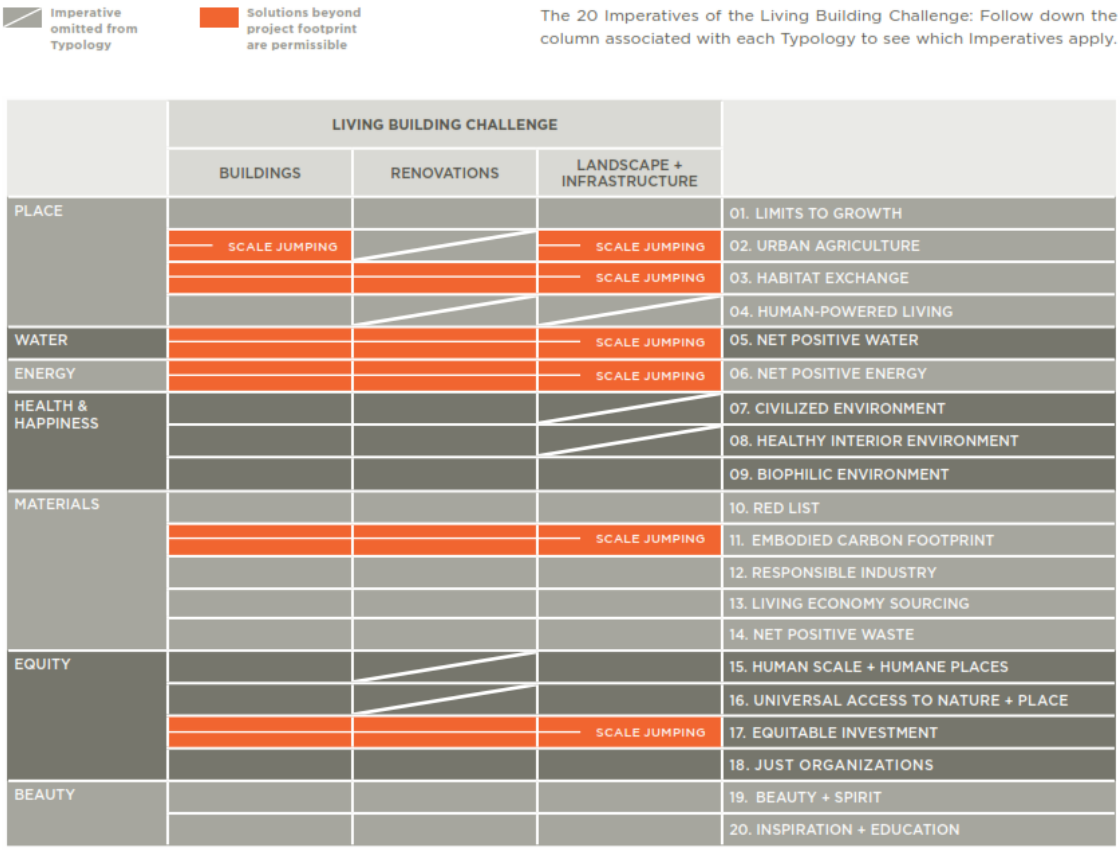

Figure 26: The Scale Jumping Matrix (ILFI, 2014, p.21)

Like Water, Energy Petal also has one Imperative that is called Net Positive Energy. It notes that "one hundred and five percent of the project's energy needs must be supplied by on-site renewable energy on a net annual basis, without the use of on-site combustion [and] projects must provide on-site energy storage for resiliency" (ILFI, 2014, p.34). The fourth Petal, Health & Happiness, aims to create environments that optimize physical and psychological health and well-being. Its Imperatives are Civilized Environment, Healthy Interior Environment and Biophilic Environment. The Materials Petal includes five Imperatives: Red List, Embodied Carbon Footprint, Responsible Industry, Living Economy Sourcing, and Net Positive Waste. It aims to push the industry to "create a materials economy that is non-toxic, ecologically regenerative, transparent and socially equitable" (ILFI, 2014, p.43). The Equity Petal, the sixth petal, strives to transform developments to create a true and inclusive community that is just and equitable regardless of an individual's background, age, class, race, gender or sexual orientation. Human Scale + Human Places, Universal Access to Place + Nature, Equitable Investment, and Just

Organizations are the Imperatives of the Equity Petal. The seventh and last Petal is Beauty and aims to "recognize the need for beauty as a precursor to caring enough to preserve, conserve and serve the greater good" (ILFI, 2014, p.59). Its Imperatives are Beauty + Spirit and Inspiration + Education.

The literature represents a variety of different perspectives in terms of placing LBC among design tools. For example, Cole (2012b) categorizes the LBC as green design tool[19]. However, Hes and Du Plessis (2015) consider it a regenerative design support tool. They point out the factors that differentiate the LBC from green design rating systems such as LEED and BREEAM. According to Hes and Du Plessis (2015), the first factor is measuring actual performance for certification. LBC requires measuring over a 12 month period before certification instead of a modeled performance. The second is that all of the Imperatives of the LBC are mandatory rather than selecting some points on the checklist. The next factor is the concept of providing broad and high goals such as Net Positive Water. Instead of listing descriptive strategies, the LBC introduces the goal and design teams need to solve how this goal could be achieved in their unique place and project. The last differentiator is the existence of Scale Jumping. Additionally, Hes and Du Plessis notes that:

> The Living Building Challenge provides an interesting bridge between the old and new worldviews, using the tools of the mechanistic worldview to pull clients and project teams into a deeper understanding of a project's relationships with its Place, helping them almost imperceptibly to shift towards an ecological worldview. In some ways it presents a much more rigid 'checklist' than any of the Green Building rating schemes, but it also allows much greater freedom in meeting the requirements of that checklist. The strength of the programme is that it provides both a vision and definite limits – but not by prescribing process (2015, p.188).

The LBC Framework also states its difference with the following sentences:

> The program has always been a bit of a Trojan horse—a philosophical worldview cloaked within the frame of a certification program. The Challenge is successful because it satisfies our left brain craving for order and thresholds and our right brain intuition that the focus needs to be on our relationship and understanding of the whole of life (ILFI, 2014, p.6).

[19] Cole may consider this because the structure of the LBC looks like a green design rating tool. However, it was intentionally designed that way to easily integrate practitioners. The LBC is a kind of bridge tool and acts like a Trojan horse to adapt regenerative design into the medium.

e. LENSES

The LENSES (Living Environments in Natural, Social, and Economic Systems) Framework was developed by the Institute for Built Environment at Colorado State University to "be a guidance tool that will lead users to appropriate, contextual, and regenerative decisions and actions" (Plaut *et al*., 2012, p.115). Currently, it is managed by CLEAR (Center for Living Environments and Regeneration).

The LENSES framework[20] (Figure 27) is both a process and a metrics tool. While it intends "to shift mindsets toward regenerative thinking and to inspire positive action throughout the life cycle of a project," the aim of it is "to facilitate tangible, actionable and contextually based solutions that support and create healthy, natural, social and economic systems" (Plaut *et al*., 2012, p.113). The framework strives to move practice toward the concept of a 'living environment' that represents a thriving, healthy, and resilient place. It focuses on 'descriptive metrics' instead of 'prescriptive metrics' and can be applied across project types on all scales.

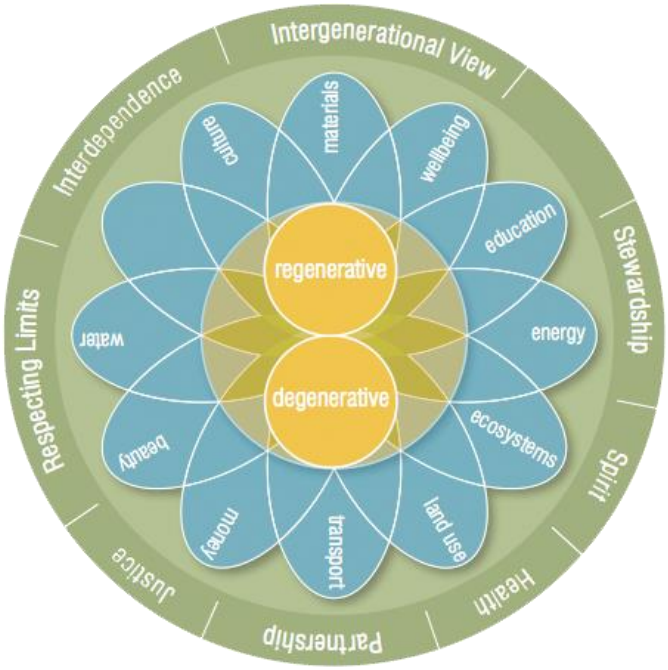

Figure 27: The LENSES framework (Clear, 2014, p.10)

[20] This thesis examines the final (launched in 2014) version of the LENSES. Plaut *et al*. explains the LENSES framework in the special issue of Building Research & Information in 2012. However, this was the earlier version of the framework. The current version of the LENSES was downloaded from the official website of CLEAR (http://clearabundance.org/about-lenses/) and analyzed in this thesis. The information gathered from the *LENSES Application Guide* (downloaded from the website) was cited as 'Clear, 2014'.

The framework[21] consists of three lenses: Foundation, Flows and Vitality (Figure 27). Each lens has a number of guiding principles and an open space. The open space has been left for user inputs or additions to provide flexibility for project-specific needs. In addition to that, it expresses the humility of the developers by "showing the users that the developers cannot and do not assume to have all the answers" (Plaut *et al*., 2012, p.116).

The goals of the Foundation Lens are: providing understanding of regeneration and systems thinking; representing the guiding principles; and engaging all stakeholder groups (Clear, 2014, p.13). The Foundation Lens includes eight guiding principles: Stewardship, Respecting Limits, Interdependence, Justice, Intergenerational View, Partnership, Health, and Spirit. The nested/integrated triple bottom line[22] —depicting natural, social, economic systems— is located in the center of the lens (Figure 28). The Foundation Lens strives to help the teams determine "who is given a voice in this project?" and who will be defined as stakeholders? (Plaut *et al*., 2012, p.117). It can be used in the discovery phase of design most intensively.

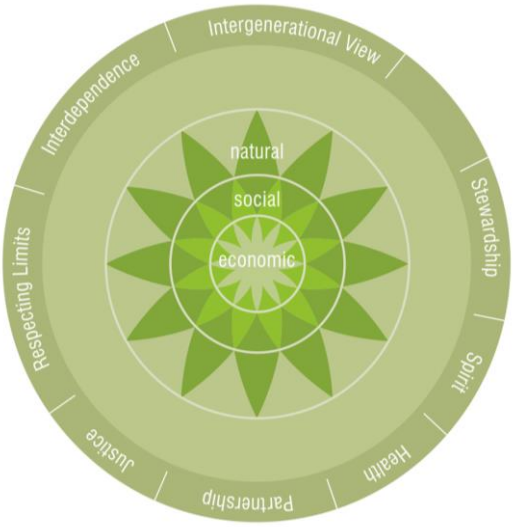

Figure 28: Foundation Lens of the Framework (Clear, 2014, p.13)

The Flows Lens addresses critical built environment issues and emphasizes the "inherent uniqueness" of projects (Clear, 2014, p.11). The lens consists of eleven categories and an open space that can flow into and through a project and define the project context (Figure 29). These categories are Culture, Materials, Wellbeing, Education, Energy, Ecosystems, Land use,

[21] There are some differences between the earlier version —explained in Plaut *et al*.'s paper in 2012— and the current version (2014) such as changes in the name of the lenses, visual improvements in the graphic images, and additions like Vitality Lens's Rubrics and their numeric values.

[22] The LENSES framework prefers to represent the integrated triple bottom line instead of the common Venn diagram.

Transport, Money, Beauty, and Water. The intent of the Flow Lens is to develop project context and discover relationships. Use of this lens requires assessing the past and current condition of flows and discovering intersections and relationships between the flows. The LENSES Framework acknowledges that living environment should have "healthy cycles of renewal and regeneration for the flows moving in and through it" (Clear, 2014, p.17).

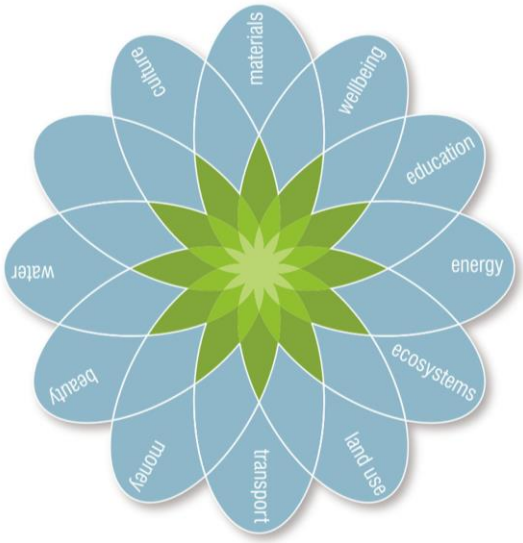

Figure 29: The Flows Lens (Clear, 2014, p.17)

The last lens of the framework is Vitality (Figure 30) and aims to support teams for establishing an understanding of "what characteristics and qualities comprise a regenerative state for each flow" (Clear, 2014, p.11). Its central sphere diagram illustrates a scale of impact from degenerative to regenerative. The Vitality Lens cannot stand alone and works in conjunction with the other lenses. While the Flows Lens works for understanding historic and current flows, the Vitality Lens guides teams in envisioning future or potential flows. The lenses of the tool overlap to display the interactions between the foundational attributes and the flows. For example, the "integrated bottom line of the Foundation Lens displays through each flow, representing that each has natural, social and economic implications" (Hes and Du Plessis, 2015, p.149).

The Vitality Lens helps teams to set regenerative goals and measure the impacts. It is associated with Rubrics to provide "qualitative metrics for identifying where a project or decisions falls on the scale from degenerative to regenerative" (Clear, 2014, p.11). The LENSES Framework includes twelve Rubrics, one for each flow, which are inspired by the *Whole Measures Guidelines* created by the Center for Whole Communities. Each Rubric comprises a set of Focal points that define subtopics of each flow. A 'five point scale' across the top represents

the classification range from degenerative to regenerative. Each classification is assigned a numeric value between -3 and 3. This provides an option to numerically measure how regenerative a project is. Each cell within a rubric includes a brief description defining the characteristics or qualities of a given Focal Point that align it with a particular classification. The Figure 31 illustrates one Focal Point (Production, Transmission & Storage) from the Energy Rubric.

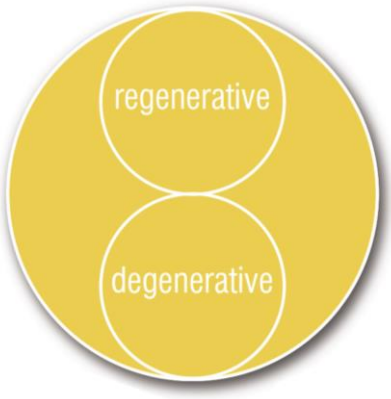

Figure 30: Vitality Lens (Clear, 2014, p.20)

focal point	degenerative (-3)	degenerative-sustain (-1)	sustain (0)	sustain-regenerative (+1)	regenerative (+3)
Production, Transmission & Storage The pollution created by energy use, the methods through which energy travels to the users, and the storage of produced energy.	Creates negative social and/or natural impacts including health problems, waste disposal issues and pollution; linear and centralized production; bases production on resources that cannot be easily replenished, thereby reduces total stored energy.	Reduces pollution, negative social impacts and/or transmission losses; may indirectly address energy production through purchase of Renewable Energy Credits (RECs).	Energy production is nearly free of toxins and health risks and does not create negative impact on environment; has a very low or no sum total carbon footprint; eliminates or greatly reduces transmission losses; helps to distribute power generation; begins to decentralize energy production.	Energy production is free of toxins and health risks; mitigates any negative impacts of production; energy production is direct (on-site or very nearby), has the ability to be stored and be used at a later time; storage options are free or nearly free of toxins.	Completely passive energy (e.g. solar or wind) and/or locally produced and used; nature serves as the primary model for energy production, transmission, and storage including being free of pollution and toxins; helps to collect and store energy to make energy denser and more organized; production and storage sequester more pollution than they generate.

Figure 31: Production, Transmission & Storage Focal Point from the Energy Rubric (Clear, 2014, p.23)

Additionally, the framework provides two worksheets associated with the Rubrics "to empower teams to evaluate the project's existing state, acknowledge areas for improvement, and continually assess the impact of project decisions" (Clear, 2014, p.24). The Vitality Planning

Worksheets help design teams solidify their intended strategies (Figure 32). After implementing the plan, the framework offers to use the Vitality Evaluation Worksheets to assess how effectively the project applied each strategy and whether or not the classification (on the degenerative to regenerative scale) of each flow has changed (Figure 33).

focal point	achievement strategies	responsible parties	timeline	resources
Production, Transmission & Storage The pollution created by energy use, the methods through which energy travels to the users, and the storage of produced energy. A regenerative state of being for energy production, transmission, and storage: • uses completely passive energy (e.g. solar or wind) and/or locally produced energy • mimics nature as the primary model for energy production, transmission and storage including being free of pollution and toxins • helps to collect and stores energy to make energy denser and more organized; production and storage sequester more pollution than they generate	1. Incorporate solar and geothermal onsite systems for project. 2. Draw inspiration from the elephant ear plant, oriental hornet, and wallaby for efficient energy storage techniques. 3. Apply partnership program with energy provider.	1. Mechanical Engineer 2. Sustainability Consultant § Architect 3. Mechanical Engineer § Architect	1. Solidift system types and specifications by mid-March 2. Conduct research by end of December. 3. Submit application by May 1st.	1. Energy feasibility report and site analysis 2. www.asknature.org, biomimicry blog 3. Energy provider website

Figure 32: Sample Completed Vitality Planning Worksheet (Clear, 2014, p.28)

focal point	degenerative (-3)	degenerative-sustain (-1)	sustain (0)	sustain-regenerative (+1)	regenerative (+3)	Score
Production, Transmission & Storage The pollution created by energy use, the methods through which energy travels to the users, and the storage of produced energy.	☐ why and/or how?	☐ why and/or how? Project was able to provide 80% of energy demand through a combination of increased wall thickness, onsite solar and geothermal installations, and pertnership program with energy provider. As of the latest quarterly meeting, the Owner would like to explore cost benefits of further reducing energy consumption and increasing onsite system capacities to reach net zero or possible net positive status.	☐ why and/or how?	☐ why and/or how?	☐ why and/or how?	☐

Figure 33: Sample Completed Vitality Evaluation Worksheet (Clear, 2014, p.28)

f. Summary

The information regarding the regenerative design support tools is summarized in a table to compare and contrast the tools (Table 6). The summary was done with following ten factors:

- Name of the developer
- Type of the developer (e.g. non-profit organization or architectural firm)
- Background of the tool (e.g. practice, research center or university)
- What? How does the developer team define the tool? (e.g. process-based, planning, web-based, metrics tool etc.)
- Audience
- Mission statement of the tool
- Goal
- Structure of the tool (e.g. series of graphics, list of indicators, etc.)
- Main categories of the tool
- Verification (Does the tool verify the results?)

In addition to these factors, it is necessary to discuss the general tendencies of the tools. Instead of narrowly prescribed strategies, descriptive strategies and broader goals are preferred in the regenerative design support tools to not limit possibilities. Generally, they emphasize changing the process in order to achieve the desired design outcomes. They note that the building performance metrics (such as energy or water consumption) are well established in green design assessment tools and can be combined with the regenerative design tools. The regenerative design support tools strive to provide a broader framework to integrate the knowledge that comes from previous approaches such as green design.

The regenerative design support tools aim to guide design teams for:

- thinking about whole systems
- encouraging users to consider the interconnectedness of the different elements
- designing for a unique place
- enabling conversations and meaningful dialogue between the stakeholders
- assuring positive impacts for the socio-ecological whole.

	REGEN	Eco-Balance	Perkins+Will	LBC	LENSES
Developer	BNIM	Pliny Fisk and Gail Vittori	Perkins+Will	International Living Future Institute	CLEAR
Type of Developer	architectural firm	non- profit organization	architectural firm	non- profit organization	non- profit organization
Background	practice + USGBC	the Center for Maximum Potential Building Systems	practice + University of British Columbia	research in EPICenter + BNIM	Institute for Built Environment at Colorado State U.
What?	a data-rich, web-based tool	a design and planning tool	issues and process-based frameworks	a philosophy, an advocacy and a certification tool	a process and a metrics tool
Audience	professionals and community members	professionals and businesses	practitioners of Perkins+Will	all of humanity i.e.: design professionals, contractors, building owners, politicians, government officials	professionals, businesses, government, students and nonprofit teams
Mission	to guide dialogue and help professionals to engage with regenerative approaches	to provide principles for balancing life support systems across life cycle phases	to offer constructive direction to design teams and to generate dialogue for regenerative approaches	to lead the transformation to a world that is Socially just, Culturally rich and Ecologically restorative	to cultivate, empower, and equip change makers to create a regenerative future
Goal	transforming practice toward regenerative approaches	supplying our needs in a regenerative manner	expanding design for positive synergies	a living regenerative future	a thriving living environment
Structure	linking specific strategies to the whole	series of graphics	challenging questions	list of imperatives	overlaid three lenses
Main Categories	Robust and Resilient Natural Systems, High-performing Constructed Systems, Prosperous Economic Systems and Whole Social Systems	Air, Water, Food, Energy, and Materials	Foundation, Sandbox, and Toolbox	Place, Water, Energy, Health & Happiness, Materials, and Equity, Beauty	Foundation Lens, Flows Lens, and Vitality Lens
Verification	no	no	no	yes	no

Table 6: Summary of Regenerative Design Support Tools

CHAPTER VI: EVALUATION OF REGENERATIVE DESIGN SUPPORT TOOLS

Regenerative design and development requires considering a number of new concepts during the design processes such as whole system thinking, interconnectedness, co-evolution, place-related design, and stakeholder engagement (See Chapter III. d). These concepts come from theory and they are intangible. However, it is necessary to have some operational methods and indicators for practitioners to engage with the approach. Even if practitioners might agree on the necessity of embracing these concepts, the issue is how they could apply these emerging concepts into a design. On that point, the regenerative design support tools might bridge theory and current building practice.

This study aims to examine and evaluate the tools[23] (explored in the Chapter V) to answer the following questions:

- There is a clear pattern that regenerative design support tools are complex compared with to green design tools. Is it possible to find a clarity on these tools?
- Are there any shared patterns in the tools? What do they have in common? Where do they overlap?
- Are there any specific methods or techniques that have been offered in these tools for intangible concepts[24] of regenerative design and development? If yes, what are they?
- Are they individually comprehensive enough? or Is it better to use them together in a meaningful way?
- Are there any missing points or areas that need further exploration?

In the first section of this chapter, the proposed overall framework to evaluate the tools, Holistic Regenerative Design Framework, will be explained. Next, the methodology and results of the evaluation will be reported. In the final section of the chapter, the findings and recommendations will be discussed to contribute to the future studies in the field.

Before moving to the methodology section, it is important to acknowledge that the tools can be used in a variety of different ways and their success "is dependent on the experience and skill of [their] users" (Cole *et al.*, p.104).

[23] They are REGEN, Eco-Balance, Perkins+Will Framework, LBC and LENSES.
[24] The key characteristics of regenerative design and development includes a number of philosophical departure points (See Chapter III. d.). They are called intangible concepts in this section to emphasize the demand for practicable methods and techniques.

a. The Holistic Regenerative Design Framework

This thesis proposes an overall framework called Holistic Regenerative Design Framework (HRDF) to evaluate the regenerative design support tools. The intention is to visually represent regenerative design and its key attributes (Figure 34). The HRDF highlights the importance of a new kind of understanding of success with both quantitative and qualitative indicators.

As a first step to develop the HRDF, the following four key principles of regenerative design and development were determined:

- embracing the philosophy behind regenerative design and development
- understanding the master patterns of a unique place beyond site boundaries and translating these into design
- working towards creating maximum positive outcomes for capacity of ecosystem and bioregional cycles in order to regenerate
- engaging all stakeholders to evolve over time for self-renewing and on-going feedback by providing a story of place and a dialogue.

The HRDF was created by using the principles as a framing structure to gather all attributes together. The principles were each labeled as 'Essence' respectively: Philosophy, Design Process, Indicators, and Emergence of Regeneration (Figure 34). Each Essence consists of four Categories, and there are sixteen Categories in total. The first Essence, Philosophy, comprises the Categories of: a New Mind; Whole System Thinking; Interconnectedness; and Co-evolution. The Design Process, the second Essence, includes the four Categories called: New Structure of Team; Place Exploration; Place Specific Design; and Process-based Tools. The third Essence is called Indicators and depicts the physical characteristics of regenerative design. Like others, it has four main Categories: Ecosystem Services; Health and Well-being of Socio-ecological Whole; Social; and Economics. Each Category of this Essence has a number of Focal Points to represent the overall picture. These Focal Points can be seen in Figure 35. The last Essence of the HRDF is Emergence of Regeneration and includes: Net-Positive Impacts; Cyclic Closed Loops; Stakeholder Engagement; and Ongoing Participation. Figure 36 represents the cyclic and continual properties of the process embedded in the HRDF.

The HRDF can be used to both design a project and to evaluate the existing design tools or case studies. In this thesis, the HRDF was used to evaluate the regenerative design support tools. Its sixteen Categories were transformed into a table format to compare the tools (Table 7).

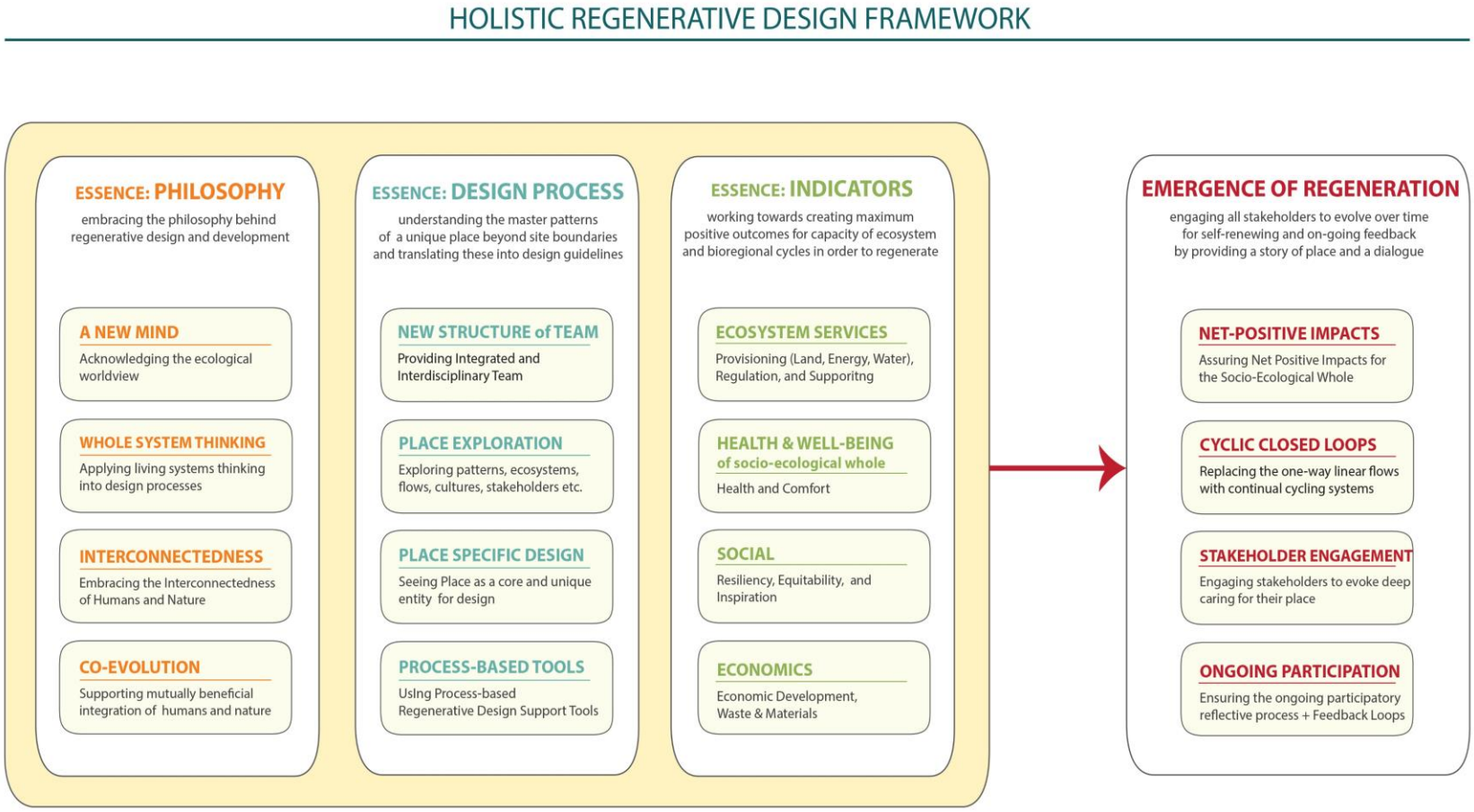

Figure 34: Holistic Regenerative Design Framework

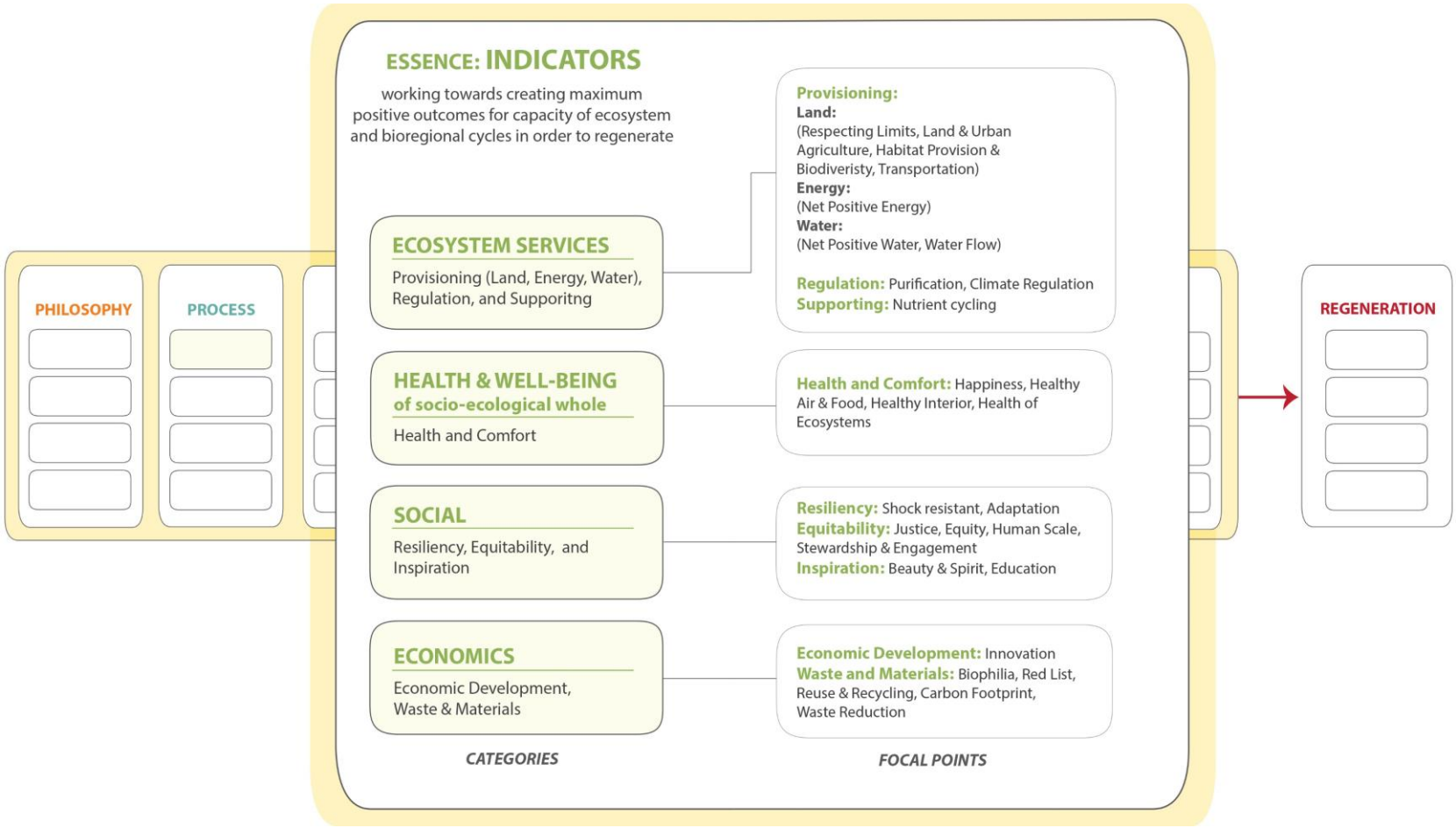

Figure 35: Indicator Categories and Focal Points of Holistic Regenerative Design Framework

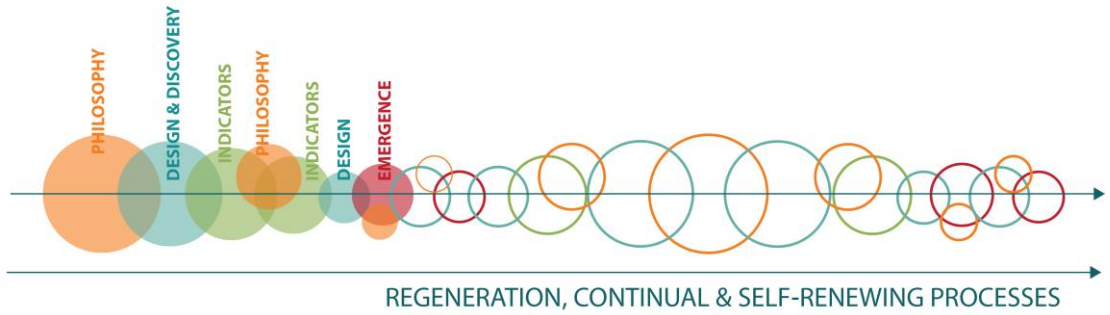

Figure 36: Cyclic and Ongoing Process of the Holistic Regenerative Design Framework

b. The Methodology for the Tool Evaluation

The goal of the tool evaluation is to explore how the tools apply the concepts of regenerative design into design processes, what kind of methods and techniques they offer, and what their gaps and limitations are.

The HRDF, the proposed framework to provide a comprehensive understanding of regenerative design, was used as a foundation for the evaluation. The sixteen Categories of the HRDF were adapted as an outline to assess and compare the regenerative design support tools[25] during the evaluation (See Table 7).

The broader questions of why the tool evaluation was chosen (stated at the beginning of Chapter VI) were narrowed and gathered into three main questions to do the evaluation:

- Do the regenerative design support tools address all of the topics mentioned in the HRDF?
- Do they set goals or provide a method for each topic which they addressed?
- If they provide any method or strategy for the emerging (intangible) concepts, what are these specific methods?

The tool evaluation consists of two parts. The first part is the 'Comparison of the Regenerative Design Tools: Support.' This part aims to answer the first two questions listed above and to represent the results visually. The second part of the evaluation is the 'Comparison of the Regenerative Design Tools: Theory + Practice Methods.' The goal of the second part is to answer the last question for each tool separately and compare the information in order to show

[25] The five regenerative design support tools were selected for this study: REGEN, Eco-Balance, Perkins+Will, LBC, and LENSES (See Chapter V).

common methods or shared patterns. The results of the tool evaluation will be interpreted (Chapter VI. c); and the findings and recommendations will be stated (Chapter VI. d).

In order to provide a credible evaluation, the Tool Evaluation Worksheet was created (Table 8) and completed for each tool by carefully examining the original source of the tools for each Category listed in the worksheet. The worksheets were used to compare the tools for the two parts of the evaluation (See Appendix B for the completed worksheets for each tool).

The Tool Evaluation Worksheet includes the same Categories as the HRDF to provide consistency. However, the worksheet combines the four Categories of Indicators Essence into one Category called 'Indicators and Focal Points (Structure of the Tools).' The choice was made because the Categories and Focal Points of the Indicators Essence of the HRDF (Figure 35) focuses on the building performance criteria and this area is well established in green design assessment tools (except the concepts of ecosystem services and resiliency). Thus, instead of looking at these criteria individually, it is preferred to explore the structure of the tools.

	Categories	REGEN	Eco-Balance	Perkins+Will	LBC	LENSES
PHILOSOPHY	A New Mind					
	Whole System Thinking					
	Interconnectedness					
	Co-evolution					
PPROCESS	New Structure of Design Team					
	Place Exploration					
	Place Specific Design					
	Process-based Tools					
INDICATORS and Focal Points	Ecosystem Services: *Provisioning*					
	Regulation					
	Supporting					
	Health and Well-being:					
	Social: *Resiliency*					
	Equitability					
	Inspiration					
	Economics: *Econo. development*					
	Waste and Materials					
REGENERATION	Net Positive Impacts					
	Cyclic Closed Loops					
	Stakeholder Engagement					
	Ongoing Participation					

Table 7: The Table Format of the Holistic Regenerative Design Framework

Name of the Tool

	Categories	HOW TO: COMMON TECHNIQUES	EXAMPLE INDICATORS
PHILOSOPHY	A New Mind		
	Whole System Thinking		
	Interconnectedness		
	Co-evolution		
PPROCESS	New Structure of Design Team		
	Place Exploration (Patterns, Boundaries, Scale)		
	Place Specific Design		
	Process-based Tools		
INDICATORS	Indicators and Focal Points Structure of the Tools)		
REGENERATION	Net Positive Impacts		
	Cyclic Closed Loops		
	Stakeholder Engagement		
	Ongoing Participation		

THEORY → PRACTICE

Table 8: The Tool Evaluation Worksheet

The Comparison of the Regenerative Design Tools: Support

The five regenerative design support tools, REGEN, Eco-Balance, Perkins+Will, LBC, and LENSES, will be compared by using the HRDF. The overall comparison (See Table 9) will be represented in two main layers: Addressing and Goal Setting.

The Addressing layer is represented by yellow circles and has three options. 1) If a tool addresses one of the Categories, it is noted with a full solid yellow circle. 2) If a tool indirectly addresses one of the Categories, it is noted with a yellow donut circle. For example, a tool might not address or use the term ‘whole system thinking.’ However, if it mentions accepting an

‘ecological worldview,’ the tool indirectly addresses the whole system thinking that is a part of an ecological worldview. 3) If a tool does not address one of the Categories, it is noted with a hollow, white circle.

The Goal Setting layer is represented by dark pink circles and has three options. 1) If a tool sets a specific goal or offers a technique to achieve one of the Categories, it is noted with a full solid dark pink circle. 2) If a tool sets goals but misses 1 to 3 Focal Points of the HRDF, it is noted with a half colored pink circle. 3) If a tool does not set an operational goal for one of the Categories, it is noted with a hollow white circle.

The Comparison of the Regenerative Design Tools: Theory + Practice Methods

The first part of the tool evaluation, the Comparison of the Regenerative Design Tools: Support, demonstrates which tool addresses and set goals for which topics. In the second part of the evaluation, the comparison shows the common methods offered in the tools that strive to apply theoretical concepts of regenerative design into practice (See Table 10).

In order to do the Comparison of the Regenerative Design Tools: Theory + Practice Methods, the methods and techniques offered in each tool were determined by using the Tool Evaluation Worksheet, separately. After that, the completed Tool Evaluation Worksheets were metaphorically overlaid to determine common methods for each Category. The comparison has two columns. These are How to: Common Techniques and Example Indicators. The techniques that are explored in more than two tools were highlighted with green. In addition to that, a number of selected indicators were listed as examples.

c. The Results of the Tool Evaluation

The results of the tool evaluation were represented in two tables. Table 9 demonstrates the ‘Comparison of the Regenerative Design Tools: Support’ and Table 10 shows the ‘Comparison of the Regenerative Design Tools: Theory + Practice Methods.’ The limitations and gaps of the tools will be discussed in the next section. Although the tables are self-explanatory, it is essential to summarize the results for each specific tool before discussing the overall issues.

The REGEN is a web-based platform to support regenerative design. It does not address three Categories of the evaluation: Process-based tool; Regulation ecosystem services; and Supporting ecosystem services. The tool is not a process-based tool. It strives to provide a database to support teams with gathering information for a specific place. Moreover, the REGEN has four indirectly

addressed[26] Categories. These are New structure of design team; Resiliency; Cyclic closed loops; and Ongoing participation. Additionally, in the Indicators Essence, some of the focal points are missing. For example, the REGEN does not cover the focal points of Reuse and Recycling in the broader area of 'Waste and Materials.'

Although the Eco-balance is originally defined as a design and planning tool for regenerative design, it addresses only a few Categories. The tool focuses on some specific Categories such as Place exploration, Place specific design, Cyclic Closed Loop, and Ongoing Participation. The reason of its narrow scope is that the Eco-balance works in conjunction with the other eleven lenses in its bigger frame (the Lenses for a Maximum Potential Future). The issue is that the other lenses are not called regenerative design tools and thus have not been considered in this evaluation.

The Perkins+Will Framework is a comprehensive tool and addresses almost all of the Categories of the evaluation. However, although it introduces and provides written and diagrammatic explanations for the concepts, it does not set goals or offer practicable methods for a large number of Categories. It prefers to guide the design process with provocative questions instead of providing clear strategies or techniques.

The LBC is a certification tool and demonstrates a very clear approach. Mostly, if it addresses a Category, it offers a set of rules and goals for the Category. There are four exceptions that the LBC indirectly addressed and has not yet offered goals for. These are: Whole system thinking, New structure of design team, and Cyclic closed loops.

The LENSES is a process-based tool. It is the most comprehensive[27] regenerative design support tool for both the Addressing and Goal setting layers. It addresses almost all of the Categories. However, it addresses four Categories without offering a practical goal. These are Co-evolution, Regulation ecosystem services, and Supporting ecosystem services, and Ongoing Participation.

[26] In order to explain how a tool might indirectly address a topic, one example will be provided here. Although the REGEN does not provide any specific information about the structure of design teams, it highlights the need of a broader dialogue and integration of stakeholders into design processes. These require a new structure for a design team and indirectly introduces the topic.

[27] It is the most comprehensive one in comparison with the other four tools mentioned in the thesis.

Comparison of Regenerative Design Tools: Support

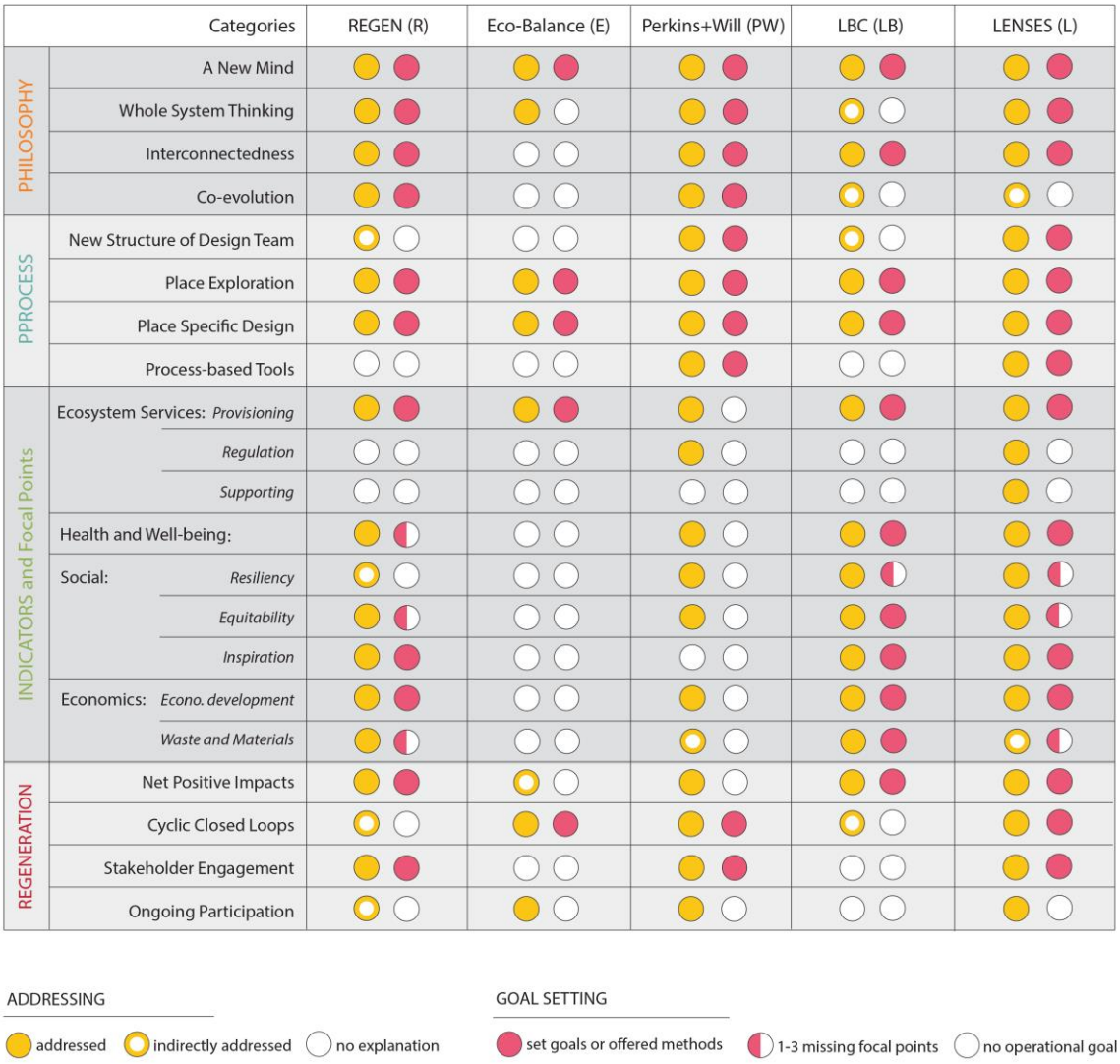

Table 9: The Comparison of the Regenerative Design Tools: Support

Comparison of Regenerative Design Tools: Theory + Practice Methods

	CATEGORIES	HOW TO: COMMON TECHNIQUES (Sources)	EXAMPLE INDICATORS
PHILOSOPHY	A New Mind	- Ecological worldview (All) - Place specific design (All) - Interconnectedness (R, PW, LB, L) - Flexible and descriptive strategies (E, PW, LB, L) - Process-based Framework (PW, L)	- Stewardship - Partnership - Intergenerational view - Education
	Whole System Thinking	- Link specific strategies to whole (R, L) - Make connections and relationships visible (R) - Outside in Thinking (L) - Holistic Performance Assessment (E) - Sandbox and Toolbox (PW)	
	Interconnectedness	- Ecosystem understanding (indirectly / All) - Nested model of the triple bottom line of sustainability (R, PW, L) - Story of Place (LB, L) - Link specific strategies to whole (R, L)	- Socio-ecological harmony - Co-evolution - Polyvalence - Synergy - Mutualism - Interdependence - Respecting limits
	Co-evolution	- Biophilia (R, LB) - Map multiple benefits of strategies (R) - Place diagram: representation of the interaction between human and natural systems (PW)	
PPROCESS	New Structure of Design Team	- Interdisciplinary and integrated team (PW, LB, L) - Use 'IDP roadmap' for design processes (PW)	
	Place Exploration (Patterns, Boundaries, Scale)	- Measuring the flows (historic, current, and future) (All) - Discover broader boundaries (All) - Scale Jumping concept (LB, PW) - Pattern Literacy (R, E) - The Living Transect (LB) - Using web-based data to gather information for place (R) - The Place and Flows diagram to explore a place (PW)	- Place - Water - Energy - Materials - Ecosystem services
	Place Specific Design	- Assessment of the Flows (All) - Define Unique Place (All) - Story of Place (LB, L) - Be uniquely connceted to the place, climate, and culture (LB) - Remediate, Repair, Restore and Regenerate a unique place (E) - Use place-based data (R) - Initial Stakeholder dialogue to discover place and create guidelines (PW) - Sandbox diagrams (PW)	- Geophysical - Infrastructure - Culture - Human and natural resources - Climate - Transportation - Flows - Land use
	Process-based Tools	- Guidance for design process (PW, L)	
INDICATORS	Indicators and Focal Points (Structure of the Tools)	- Series of graphics to explain the approach (All) - List of strategies / indicators /impreratives (R, E, LB) - Qualitative metrics: Scaled from degenerative to regenerative (L) - Rubrics and focal points for each rubrics (L) - Vitality Lens and its Planning and Evaluation Worksheet (numeric measurement option) (L) - Guiding Questions (PW)	N/A
REGENERATION	Net Positive Impacts	- Net positive goals (R, PW, LB, L) - Balance life support systems across life cycle phases (E)	- Net positive water, energy, waste - Positive surplus - Health and Happiness
	Cyclic Closed Loops	- Represent the importance of cyclic closed loops by creating circular (sphere) diagrams (R, E, PW, L)	
	Stakeholder Engagement (Evoking Deep Caring)	- Stakeholder involvement (R, L, PW) - Get feedback from stakeholders (PW, L) - Story of Place (LB, L) - Discover shared identity (PW, L) - Guided dialogue (R) - Ensure stakeholder participation in design processes; initial discussion, design charrettes and team meetings (PW, L)	- Stakeholder Engagement
	Ongoing Participation	- Ongoing participatory reflective process (E, PW, L) - Feedback processes (E, PW, L) - Whole life cycle (R, E)	

LEGEND R: REGEN, E: Eco-balance, PW: Perkins+Will, LB: Living Building Challenge, L: LENSES — Techniques explored in more than two tools

Table 10: The Comparison of the Regenerative Design Tools: Theory + Practice Methods

d. Findings and Recommendations

Findings:

Overall, there are three main findings about regenerative design tools. These are the shared patterns of the tools, the well explored concepts within the tools, and the gaps and limitations of the tools.

First, the regenerative design tools share three patterns. 1) The tools are complex and time intensive due to their attempt to deal with complexity. 2) Although the literature of regenerative design and development rejects the checklist format and element-based approaches in reductionism, the regenerative design tools also include a list of indicators with a different kind of representation. They provide a broader framework to engage with a holistic view and integrate this with a reductionist approach. 3) The tools provide a series of graphics to explain the issues. They emphasize the cyclic processes of regenerative design by using circular shaped visuals. Although this attitude is understandable, it carries the risk of making the diagrams more difficult to comprehend.

Second, by using the tool comparisons, the well explored concepts within the regenerative design tools were determined. They are listed below (Table 11):

- A new mind
- Interconnectedness
- Place exploration and Place specific design
- Building performance metrics such as energy and water[28].

Third, the gaps and limitations of the regenerative design tools were also determined to give a direction for future studies. The tools do not provide adequate information and practical methods for some of the key attributes of regenerative design. These gaps are listed below in the order of importance (See Table12):

- Ecosystem services
- Resiliency and social systems
- Stakeholder engagement
- Ongoing participation and Co-evolution.

[28] Reductive green building practice provides technical knowledge and strategies for provisioning ecosystem services.

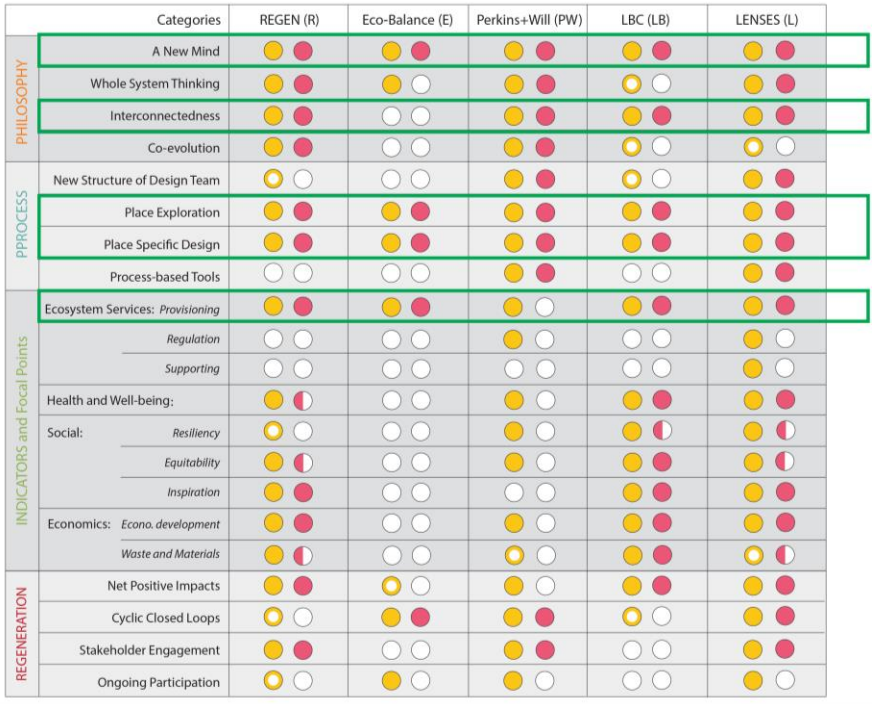

Table 11: The Well Explored Categories within the Regenerative Design Tools

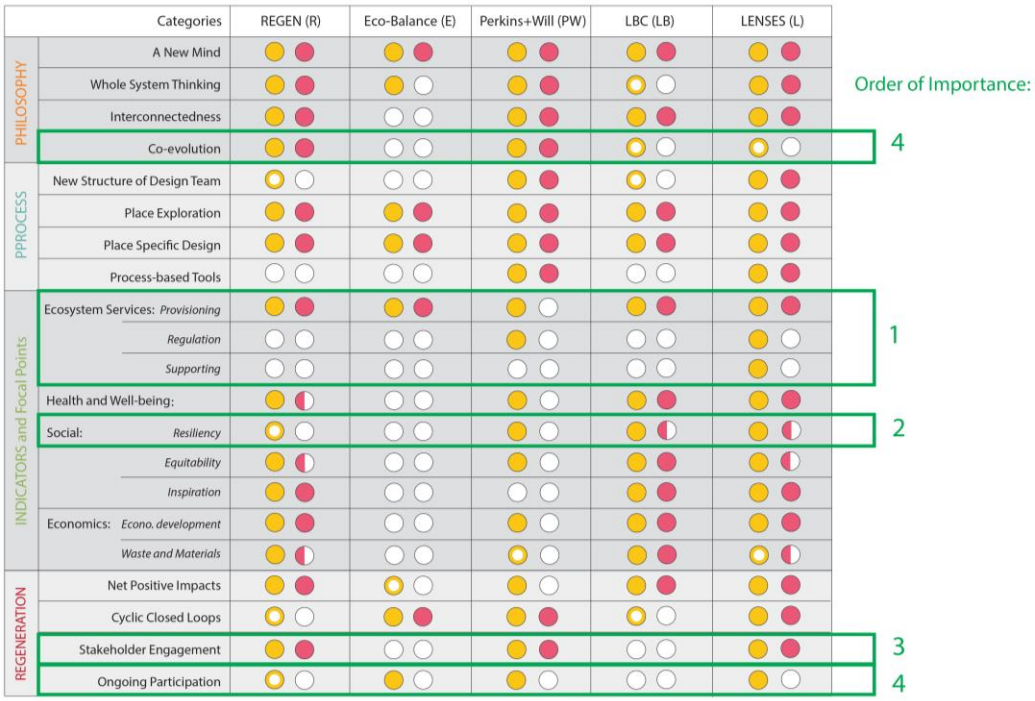

Table 12: The Gaps in the Regenerative Design Support Tools

Recommendations:

The transition from green to regenerative design requires theoretical and practical changes. In order to support these changes, it is necessary to define the roles of design tools. There is a general expectance and assumption in the field that one tool will address and solve all of the issues of regenerative design. However, it is very difficult to generate whole system thinking, which is one of the key characteristics of regenerative design, with one single tool. Thus, this thesis recommends using regenerative design support tools together instead of picking one and saying it is the best. This is because, each tool has different purposes, perspectives, and strengths. They can work in conjunction with others to create the most comprehensive view.

Having different purposes, each regenerative design tool can support specific phases of integrated design processes. While the Figure 37 shows the life cycle and phases of projects, the Figure 38 represents how the tools relates to integrated design processes. In order to suggest a way to use the regenerative design tools together, this thesis aims to characterize them to reveal their strength:

- REGEN: was characterized as an *analysis tool*. It can support regenerative design practice by providing place specific web-based data and representing the links between the strategies to express their interconnectedness at the beginning of design.
- Eco-Balance: was characterized as an *introductory education tool.* It can be used to introduce the philosophy of regenerative design to designers, architects and professionals. The tool itself displays very innovative/creative visual representation. It supports the idea of thinking differently and creatively to achieve regenerative design.
- Perkins+Will Framework: was characterized as an *ongoing education tool*. Education is a missing part in practice. Architectural firms need to educate their employees regarding emerging concepts and new technologies. The Perkins+Will Framework is a good fit for this purpose.
- LBC: was characterized as an *assessment and advocacy tool*. It sets clear practicable goals and develops the most advanced measures for sustainable design. The LBC can be used along with a process-based design tool to apply regenerative design concepts into a real project.
- LENSES: was characterized as a *process tool*. The LENSES provides an approach to guide design processes in shifting mindsets toward regenerative thinking. It is the most comprehensive regenerative design tool in comparison with the others. In addition to that, numeric values in its Vitality Lens show a potential for the possibility of integrating assessment function in the future.

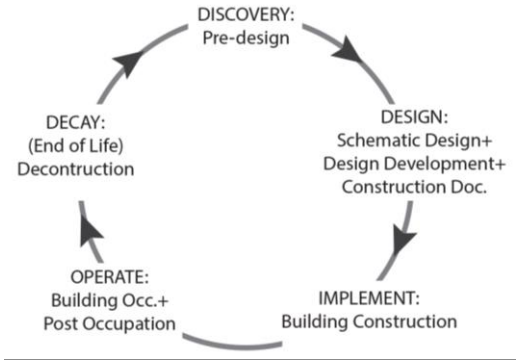

Figure 37: Life Cycle and Phases of Projects

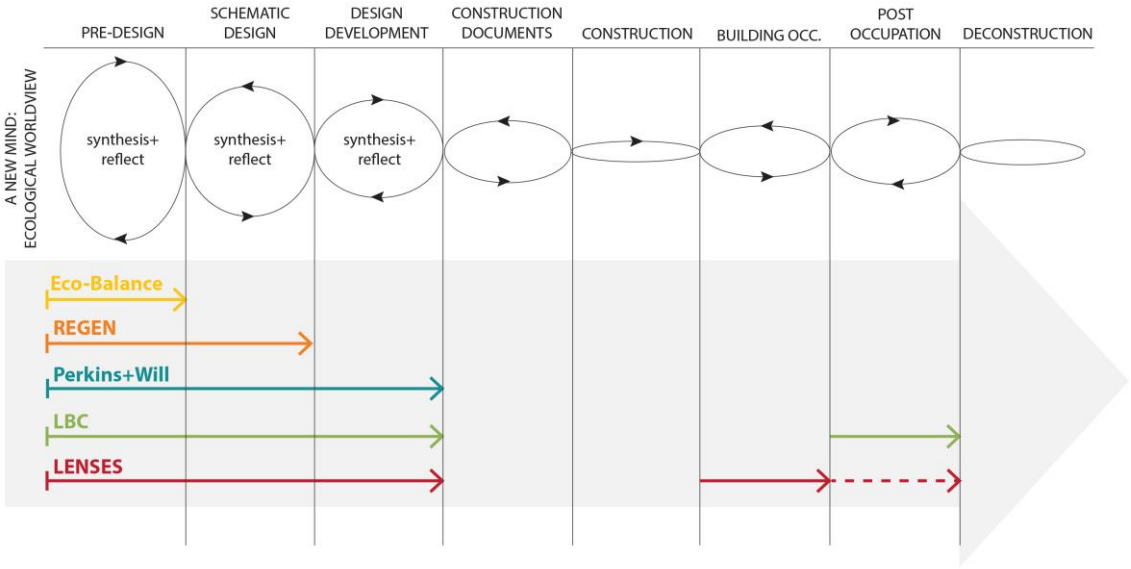

Figure 38: How the Regenerative Design Tools Relates to Integrated Design Processes

This thesis recommends using the regenerative design tools together while it offers a specific area for each. The purpose is to provide particular areas to move forward in order to support regenerative design. This approach is an attempt to apply whole system thinking into the tool evaluation process. However, from a designer standpoint, it might be difficult to use the five tools together. For this case, this thesis recommends using the combination of the LENSES and LBC. The LENSES might guide the design processes while the LBC provides strategies and assessments. It is crucial to call attention to the gaps in the tools to acknowledge that none of the tools are sufficient to include all aspects of regenerative design.

CHAPTER VII: CONCLUSION

Regenerative design and development represents an expansion of the design process, a shift in the scope and responsibilities of design professionals, and a change in the roles of design tools. As the concept of regenerative design and development gains prominence, it is anticipated that there will be an increasing demand for more comprehensive and approachable design support tools to guide practitioners aspiring to engage with it. Observing the development and testing of regenerative design tools will certainly lead to shifts in thinking and understanding.

The proposed framework, Holistic Regenerative Design Framework, is an effort to visually represent the key attributes and principles of regenerative design and development. Although this thesis utilizes the HRDF to evaluate the regenerative design tools, the higher goal is to use it to guide design processes. Further explorations such as creating rubrics, technical goals, and metrics are needed to move HRDF forward to become a regenerative design tool.

Although it is predictable that using the regenerative design support tools requires many more skills and personal transformation, the new skills required to engage regenerative design and development are still unclear. The second issue is considering how holism and reductionism work together? Which information and skills are valid in the new approach? While providing more holistic solutions is essential, we must also consider how the boundaries of a project might be defined. Moreover, it is anticipated that the concept of ecosystem services will be discussed more in the future due to its significance and lack of exploration. To better explore the concept, the design and development disciplines must coordinate research with the fields of biology and ecology on the application of ecosystem services to the built environment. The question is how will the future studies regarding ecosystem services shape and transform the practice and the tools?

In conclusion, the built environment has an increasing responsibility for global environmental and socio-ecological problems. It is becoming clear that we must substantially change how the built environment is created. The concept of regenerative design and development aims to renew and heal the earth through development to improve conditions for the wellbeing of humans, other living beings and ecosystems as a co-evolutionary whole. Only time can show how successful design professionals and builders will adapt to this approach and how the existing buildings and urban areas will participate in this transition.

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APPENDIX A
Alternative approaches that have emerged from the ecological sustainability stream

Regenerative design and development and some other approaches like Biophilia, Biomimicry, Permaculture, Resiliency, and Positive Development emerged from the ecological sustainability stream. They were developed in the timeframe of the 1980s and 1990s. They share a common set of philosophical and theoretical concepts which is an ecological worldview. Although they have different 'systemic scopes' and levels of comprehensiveness, all of them acknowledge the net positive goals and interconnectedness of human and nature (Mang and Reed, 2012b). These strategies can be used as supporting approaches for regenerative design.

Biophilia

The Biophilia Hypothesis explains why reconnecting with nature is essential and biophilic design provides some design guidelines for supporting our connection to nature. It argues that the built environment can be designed to foster a greater connection with nature.

Edward O. Wilson (1984), Harvard biologist, proposed that "humans have an evolutionarily based affinity for nature and an innate need to affiliate with life and lifelike processes – a concept he termed biophilia" (as cited in Hes and Du Plessis, 2015, p.45). After that, the Biophilia Hypothesis was developed by Stephen Kellert in collaboration with Wilson and suggests that "over millennia of evolution our species has internalized certain 'learning rules' that helped us negotiate relationships with our environment to our advantage, which created a deep need for intimate association with the natural environment and other living beings" (as cited in Hes and Du Plessis, 2015, p.46).

For Wilson (1984), biophilia is a feeling of 'rejuvenation,' 'connection,' and 'wellness.' According to Wilson's medical and psychological research, it is found that the physical and psychological effects from connection to nature go back to our primeval brain. He suggests that "because much of our brain developed before buildings and cities existed, the evolutionary traits that allowed our species to thrive are still present and influence our well-being" (as cited in Hes and Du Plessis, 2015, p.46). Wilson's research shows that connection to nature supports the following:

- Enhanced healing and well-being
- Fewer social problems when living near open space
- Improved productivity
- Improved concentration and memory

- Healthy maturation and development
- Improved intuition and connectedness
- Greater 'quality of life'– connection to community, neighbours, sense of place, environmental awareness. (Kellert, 2005; Hes and Du Plessis, 2015)

After the Biophilia Hypothesis, Kellert has studied biophilic design that connects people to nature through the built environment. Kellert (2008) notes that "biophilic design is an approach to sustainable development that incorporates the needs of humans to affiliate with natural systems and processes into the design of the built environment." Moreover, Kellert has developed 'six dimensions of biophilic design encompassing seventy principles' (Table 13).

Environmental features	Natural shapes and forms	Natural patterns and processes
Colour	Botanical motifs	Sensory variability
Water	Tree and columnar supports	Information richness
Air	Animal (mainly vertebrate) motifs	Age, change, and the patina of time
Sunlight	Shells and spirals	Growth and efflorescence
Plants	Egg, oval, and tubular forms	Central focal point
Animals	Arches, vaults, domes	Patterned wholes
Natural materials	Shapes resisting straight lines and right angles	Bounded spaces
Views and vistas	Simulation of natural features	Transitional spaces
Façade greening	Biomorphy	Linked series and chains
Geology and landscape	Geomorphology	Integration of parts to wholes
Habitats and ecosystems	Biomimicry	Complementary contrasts
Fire		Dynamic balance and tension
		Fractals
		Hierarchically organized ratios and scales
Light and space	**Place-based relationships**	**Evolved human–nature relationships**
Natural light	Geographic connection to place	Prospect and refuge
Filtered and diffused light	Historic connection to place	Order and complexity
Light and shadow	Ecological connection to place	Curiosity and enticement
Reflected light	Cultural connection to place	Change and metamorphosis
Light pools	Indigenous materials	Security and protection
Warm light	Landscape orientation	Mastery and control
Light as shape and form	Landscape features that define building form	Affection and attachment
Spaciousness	Landscape ecology	Attraction and beauty
Spatial variability	Integration of culture and ecology	Exploration and discovery
Space as shape and form	Spirit of place	Information and cognition
Spatial harmony	Avoiding placelessness	Fear and awe
Inside-outside spaces		Reverence and spirituality

Table 13: Six Dimensions and Seventy Elements of Biophilic Design
(Kellert's Principles as cited in Hes and Du Plessis, 2015, p.52)

Biomimicry

Biomimicry advocates that if we accept being a part of nature (essential principle of ecological worldview), we should "follow the laws of nature, and cooperate with and participate in its processes, in both our daily life and in how we shape our habitats" (Hes and Du Plessis, 2015, p.73). Janine Benyus (2002) suggests seeing nature as a mentor and terms this approach as biomimicry. She mentions that we can learn from nature, be inspired by nature, and test ourselves

to understand the 'rightness of our innovations.' Benyus describes biomimicry as "the conscious emulation of life's genius" (2002, p.2) and proposes following "the laws of natural systems" for a biomimetic world:

- Nature runs on sunlight.
- Nature uses only the energy it needs.
- Nature fits form to function.
- Nature recycles everything.
- Nature rewards cooperation.
- Nature banks on diversity.
- Nature demands local expertise.
- Nature curbs excesses from within.
- Nature taps the power of limits. (Benyus, 2002, p.7)

Benyus (2002) highlights three ways to find design solutions in nature provided by biomimicry. The first way is using nature as a model such as looking for precedents in nature to inspire technology and so on. The second is using nature as a measure which helps us to check the 'rightness' of our innovation or design (*e.g*. resilient thinking). The last one is seeing nature as a mentor that requests exploring the wisdom of nature to improve human life and social systems.

In addition to that, Hes and Du Plessis note that "biomimicry helps us to learn from the wisdom of nature and the processes and patterns that it has developed over aeons of evolution, so that we can channel our human creativity into directions that can contribute to the regeneration of both our ecosystem and ourselves" (2015, p.74).

Permaculture

The permaculture concept was developed by Bill Mollison and David Holmgren in the 1970s. The term permaculture is a combination of the two words 'permanent' and 'agriculture' to denote a system of permanent, self-sustaining agriculture and human culture.

Holmgren conceived permaculture as "consciously designed landscapes which mimic the patterns and relationships found in nature, while yielding an abundance of food, fibre and energy for provision of local needs" (2011, p. xvi). "Permaculture has its roots in the sciences of systems thinking and ecology, combined with landscape geography and ethno-botany" (Hes and Du Plessis, 2015, p.80).

At the core of permaculture is a set of three ethical principles: care for earth; care for people; and fair share —setting limits to consumption and reproduction while redistributing surplus.

Permaculture provides some universal design principles that can be used to guide the 'development of locally appropriate methods and solutions in agricultural and other social-ecological systems' (Holmgren, 2011; Hes and Du Plessis, 2015). These design principles lead the designer to understand how nature solves problems (Table 14).

Permaculture Design Principles
Principle 1 – Observe and interact
Principle 2 – Catch and store solar energy and other resources
Principle 3 – Obtain and yield
Principle 4 – Apply self-regulation and accept feedback
Principle 5 – Use and value renewable resources and services
Principle 6 – Produce no waste
Principle 7 – Design from patterns to details
Principle 8 – Integrate rather than segregate
Principle 9 – Use small and slow solutions
Principle 10 – Use and value diversity
Principle 11 – Use edges and value the marginal
Principle 12 – Creatively use and respond to change

Table 14: Permaculture Design Principles (Hes and Du Plessis, 2015, p.81)

The twelve permaculture design principles listed above can foster transformation across the seven key domains shown in the permaculture flower that is generated by Holmgren (2011) (Figure 39).

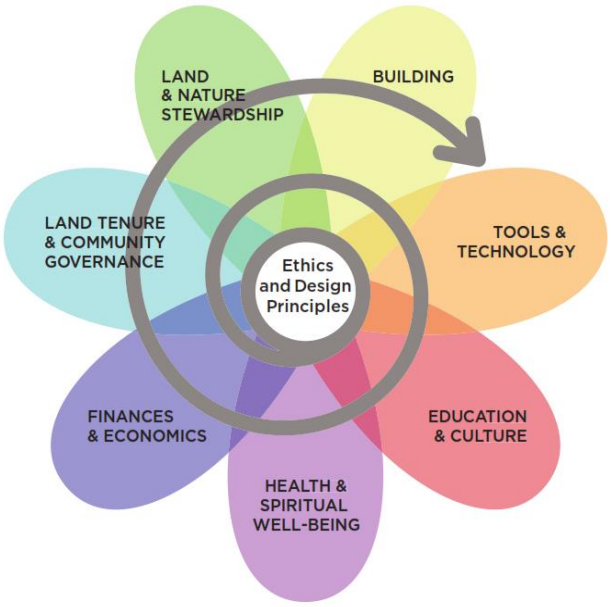

Figure 39: Permaculture Flower (http://permacultureprinciples.com/principles/)

Resiliency

Yanarella and Levine describes resilience as "the capacity of a social-ecological system to continually change and adapt yet remain within critical thresholds" (2014, p.197). In other words, Holling and Gunderson state that resilience is the capacity of a system "to experience disturbance and still maintain its ongoing functions" (2002, p.25). This can be achieved by 'bouncing back,' 'adapting' or 'transforming.'

The resilience theory uses the Adaptive Cycle (Figure 40) to describe the recurring cycles of rapid growth, conservation, release, and reorganization found in nature. It helps us "understand that change is necessary, and that the occasional collapse of a system may be beneficial to the overall health of the system, as it allows for different, possibly better conditions to emerge" (Hes and Du Plessis, 2015, p.30). The Adaptive Cycle consists of four phases: exploitation, conservation, release, and reorganization. Later, Holling creates a simpler image to represent the adaptive cycle with the four phases organized in a fore loop and a back loop (Figure 41).

The earth is experiencing many more extreme climate conditions and disasters and our cities and buildings should be able to adapt to these conditions. On that point, Pierce explains that resilient design "pursues Buildings + Communities that are: shock resistant, healthy, adaptable and regenerative through a combination of diversity, foresight, and capacity for self-organization and learning" (2015, p.5). He differentiates between sustainability and resiliency by saying that "sustainability sees our future at risk and we should 'mitigate and adapt' to improve the future but resiliency accepts that future is arriving and we should 'adapt and mitigate' the worst impacts" (2015, p.6).

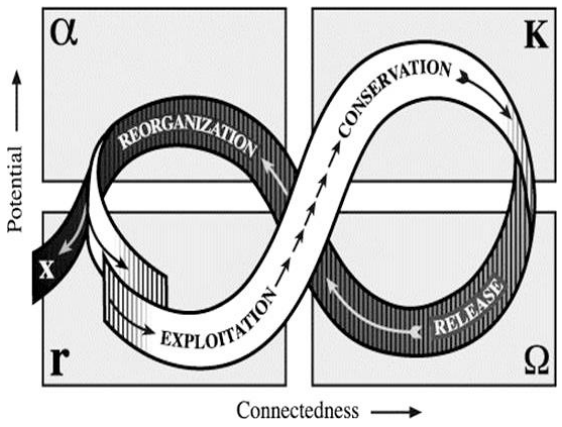

Figure 40: Adaptive Cycle (Holling and Gunderson, 2002)

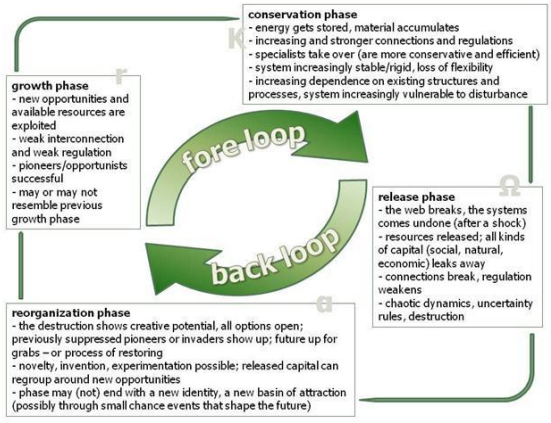

Figure 41: Phases of Adaptive Cycle (Holling)

Positive Development

Janis Birkeland proposed the concept of Positive Development as an answer for her questions such as "Can humans be of benefit to nature? Can we design not just with, or like, nature, but for nature? Can we design human habitats that will increase 'the total amount of ecosystems goods and services, as well as the health and resilience of the natural environment'?" (Birkeland, 2008, p.xi). Hes and Du Plessis summarize positive development in their book:

> It was called 'positive' development because it systematically identifies how all sustainable development processes and methods are 'negative' in that they can only slow down ecological collapse. It replaces all negative premises, analyses and methods with positive counterparts… Positive Development provides a process of eco-positive design, to achieve both ecological and social net benefits: providing more natural and social services, and thus more potential for survival and well-being than ever before (as required by an increasing human population) (2015, p.93).

Key concepts of Positive Development can be seen in Table 15. The concept suggests to "increase the health, resilience and natural, social and economic capital of the system, to over-compensate for the accelerating consumption, losses of biodiversity and threats to human health" (Hes and Du Plessis, 2015, p.94).

Key concepts
Ecological base is the means of survival – the whole natural life support system, including biodiversity, natural capital, carrying capacity and eco[system]-services. It includes the intrinsic, as well as instrumental values of nature.
Public estate refers to equitable access to the means of survival (the ecological base). It also refers to the support of human development through education, culture, art, history and so forth.
Eco-services are the natural systems that provide essential services that benefit humans and nature, such as air and water decontamination, pollination, flood control, climate stabilization, fertile soil, storm water retention, food and medical resources.
Design for eco-services is actively designing to support locally appropriate ecosystem functions, goods and services surplus to occupant needs.
Green Optimum is the decision rule for Positive Development: development should result in everyone, including nature, being better off than before, causing neither unjust enrichment nor harm to others.

Table 15: Key Concepts of Positive Development (as cited in Hes and Du Plessis, 2015, p.94)

'Whole systems change' and using 'design thinking' are the two fundamental points of the Positive Development. Birkeland re-defines design as "an interactive, imaginative process for creating something that has not existed before" (2008, p.xx) and "creating synergies, syntheses and symbioses across different dimensions" (2012, p.165). Birkeland suggests a 12-step process (with questions) called SmartMode (Systems Mapping and Redesign Thinking Mode) (2008, p.252) (Table 16).

In addition to that, Birkeland also emphasizes the importance of 'existing urban fabric' that provides numerous opportunities to establish ecosystems and provide ecosystem goods and services surplus to occupant needs. So, the "eco-retrofitting" is a very significant concept for positive development (Birkeland, 2012, p.171).

The concept of Positive Development and regenerative design has many similarities but regenerative design is distinguishable with its emphasis on seeing humans as an integral part of nature.

Table 16: 12 Step Process by Birkeland (as cited in Hes and Du Plessis, 2015, p.107)

APPENDIX B

The Completed Evaluation Worksheets for Each Regenerative Design Tool:

- REGEN
- ECO-BALANCE
- PERKINS + WILL
- LBC
- LENSES

Comparison of Regenerative Design Tools: Support

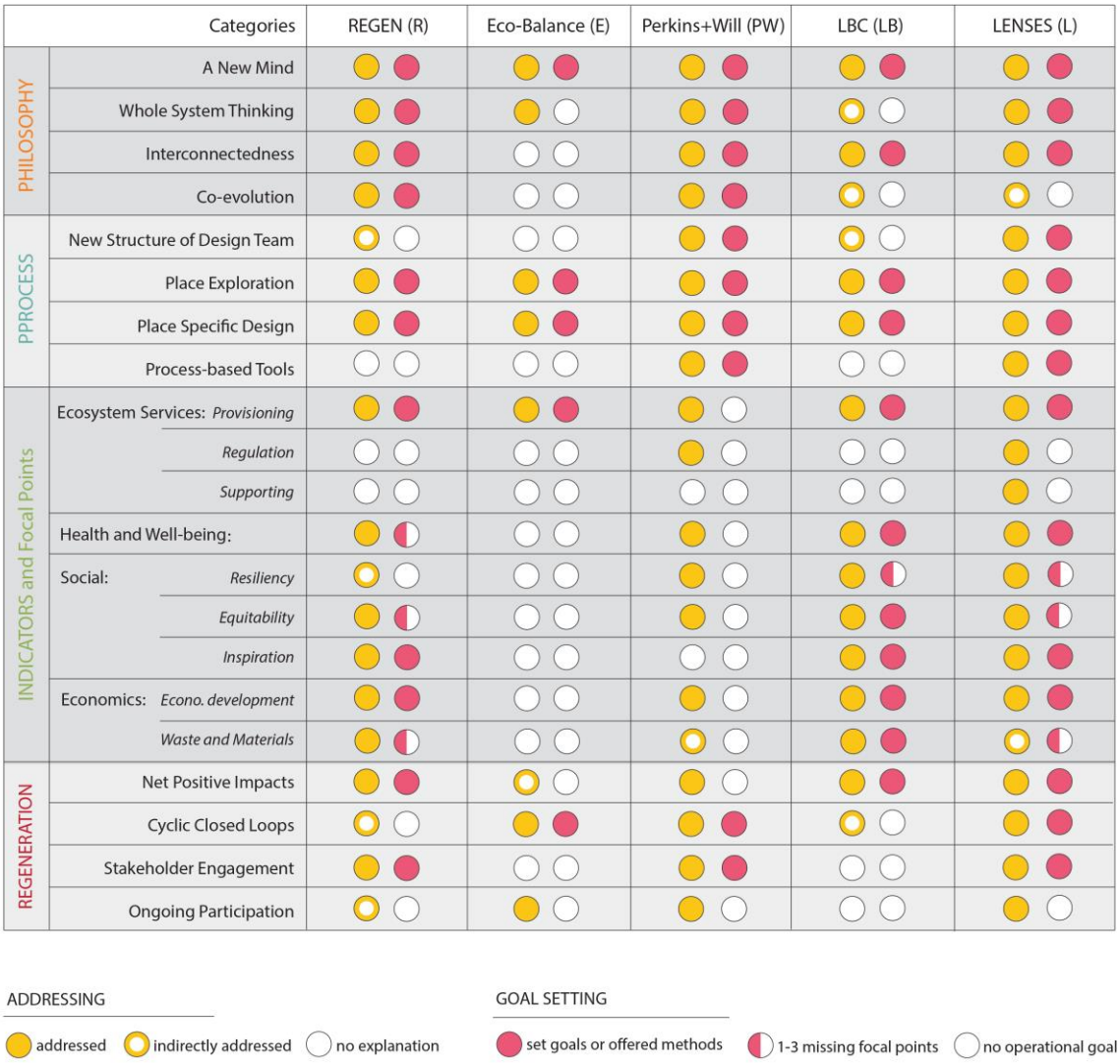

Table 17: The Comparison of the Regenerative Design Tools: Support

Comparison of Regenerative Design Tools: Theory + Practice Methods

	CATEGORIES	HOW TO: COMMON TECHNIQUES (Sources)	EXAMPLE INDICATORS
PHILOSOPHY	A New Mind	- Ecological worldview (All) - Place specific design (All) - Interconnectedness (R, PW, LB, L) - Flexible and descriptive strategies (E, PW, LB, L) - Process-based Framework (PW, L)	- Stewardship - Partnership - Intergenerational view - Education
	Whole System Thinking	- Link specific strategies to whole (R, L) - Make connections and relationships visible (R) - Outside in Thinking (L) - Holistic Performance Assessment (E) - Sandbox and Toolbox (PW)	
	Interconnectedness	- Ecosystem understanding (indirectly / All) - Nested model of the triple bottom line of sustainability (R, PW, L) - Story of Place (LB, L) - Link specific strategies to whole (R, L)	- Socio-ecological harmony - Co-evolution - Polyvalence - Synergy - Mutualism - Interdependence - Respecting limits
	Co-evolution	- Biophilia (R, LB) - Map multiple benefits of strategies (R) - Place diagram: representation of the interaction between human and natural systems (PW)	
PPROCESS	New Structure of Design Team	- Interdisciplinary and integrated team (PW, LB, L) - Use 'IDP roadmap' for design processes (PW)	
	Place Exploration (Patterns, Boundaries, Scale)	- Measuring the flows (historic, current, and future) (All) - Discover broader boundaries (All) - Scale Jumping concept (LB, PW) - Pattern Literacy (R, E) - The Living Transect (LB) - Using web-based data to gather information for place (R) - The Place and Flows diagram to explore a place (PW)	- Place - Water - Energy - Materials - Ecosystem services
	Place Specific Design	- Assessment of the Flows (All) - Define Unique Place (All) - Story of Place (LB, L) - Be uniquely connceted to the place, climate, and culture (LB) - Remediate, Repair, Restore and Regenerate a unique place (E) - Use place-based data (R) - Initial Stakeholder dialogue to discover place and create guidelines (PW) - Sandbox diagrams (PW)	- Geophysical - Infrastructure - Culture - Human and natural resources - Climate - Transportation - Flows - Land use
	Process-based Tools	- Guidance for design process (PW, L)	
INDICATORS	Indicators and Focal Points (Structure of the Tools)	- Series of graphics to explain the approach (All) - List of strategies / indicators /impreratives (R, E, LB) - Qualitative metrics: Scaled from degenerative to regenerative (L) - Rubrics and focal points for each rubrics (L) - Vitality Lens and its Planning and Evaluation Worksheet (numeric measurement option) (L) - Guiding Questions (PW)	N/A
REGENERATION	Net Positive Impacts	- Net positive goals (R, PW, LB, L) - Balance life support systems across life cycle phases (E)	- Net positive water, energy, waste - Positive surplus - Health and Happiness
	Cyclic Closed Loops	- Represent the importance of cyclic closed loops by creating circular (sphere) diagrams (R, E, PW, L)	
	Stakeholder Engagement (Evoking Deep Caring)	- Stakeholder involvement (R, L, PW) - Get feedback from stakeholders (PW, L) - Story of Place (LB, L) - Discover shared identity (PW, L) - Guided dialogue (R) - Ensure stakeholder participation in design processes; initial discussion, design charrettes and team meetings (PW, L)	- Stakeholder Engagement
	Ongoing Participation	- Ongoing participatory reflective process (E, PW, L) - Feedback processes (E, PW, L) - Whole life cycle (R, E)	

LEGEND | R: REGEN, E: Eco-balance, PW: Perkins+Will, LB: Living Building Challenge, L: LENSES | Techniques explored in more than two tools

Table 18: The Comparison of the Regenerative Design Tools: Theory + Practice Methods

THE EVALUATION WORKSHEET for REGEN

	Categories	HOW TO: COMMON TECHNIQUES	EXAMPLE INDICATORS
PHILOSOPHY	A New Mind	- Ecological worldview - Make connections and relationships visible - The visual representation of the tool provides a way to visualize the whole system relationships	- Stewardship - Education
	Whole System Thinking		
	Interconnectedness	- Link specific strategies to whole - Show interconnectedness of individual strategies - Show connections between important issues	- nested systems - multiple benefits of strategies - complex web of connections
	Co-evolution		
PPROCESS	New Structure of Design Team	N /A	N /A
	Place Exploration Patterns, Boundaries, Scale	- Use data and information provided by the tool for place-based resources - Input project location and get information about the current state of health of the place	N /A
	Place Specific Design	- Use information from the open-source database for the unique place	- water and water systems - energy systems - transportation systems - comfort systems - whole social systems - economic systems - fauna, flora - land use - materials - resources - operations - nutrients - earth
	Process-based Tools	N /A	N /A
INDICATORS	Indicators and Focal Points Structure of the Tools	- Open source data /web based tool - List of strategies and indicators - Circular diagram- links indicators	N /A
REGENERATION	Net Positive Impacts	- Net-positive goals - Gather data to explore the current state of health of the place - Improve conditions by considering the provided strategies	- net positive energy and water - food - safety - social justice - cultural heritage - biophilia - public health - happiness - services - employment - equity - productivity - innovation - progress
	Cyclic Closed Loops	N /A	N /A
	Stakeholder Engagement	- Guided dialogue	- community involvement - neighborhood amenities
	Ongoing Participation	- Active lifecycle	N /A

Table 19: The Completed Evaluation Worksheet for REGEN

THE EVALUATION WORKSHEET for Eco-Balance

	Categories	HOW TO: COMMON TECHNIQUES	EXAMPLE INDICATORS
PHILOSOPHY	A New Mind	- Ecological worldview - Place specific design - Holistic performance assessments - Flexible and descriptive strategies	N /A
	Whole System Thinking		
	Interconnectedness	N /A	N /A
	Co-evolution		
PPROCESS	New Structure of Design Team	N /A	N /A
	Place Exploration Patterns, Boundaries, Scale	- Measuring the flows (historic, current, and future) - Discover broader boundaries - Overlay the information about scale, boundary and footprint - Pattern Literacy	- spatial context - pattern - peer - connect - fauna - microzone - ecotone - ecosystem - ecozone - biome
	Place Specific Design	- Assessment of the Flows - Define Unique Place - Remediate, repair, restore, regenerate	- air - water - food - energy - material
	Process-based Tools	N /A	N /A
INDICATORS	Indicators and Focal Points Structure of the Tools	- List of indicators - Series of Graphics to explain the approach	N /A
REGENERATION	Net Positive Impacts	- Balancing resource flows or life support systems across life cycle phases	N /A
	Cyclic Closed Loops	- Represent the importance of cyclic closed loops by creating circular (sphere) diagrams	- source - process - use - re-source - feedback - learn - evolve
	Stakeholder Engagement	N /A	N /A
	Ongoing Participation	- Ongoing participatory reflective process - Feedback processes - Whole life cycle	- feedback - learn - evolve

Table 20: The Completed Evaluation Worksheet for Eco-Balance

THE EVALUATION WORKSHEET for PERKINS+WILL

	Categories	HOW TO: COMMON TECHNIQUES	EXAMPLE INDICATORS
PHILOSOPHY	A New Mind	- Ecological worldview - Place -specific design - Process-based framework - Questions instead of checklist - Flexible, less tightly prescribed realm -Sandbox	- 'Sandbox' notion of the framework - Stewardship - Education
	Whole System Thinking		
	Interconnectedness	- Explore the Place diagram to understand the interaction between human and natural system - Nested model of triple bottom line - Ecosystem understanding - Socio-ecological harmony - Look at the Synthesis Ring to explore interconnectedness	- socio-ecological harmony - co-evolution - polyvalence - synergy - mutualistic
	Co-evolution		
PPROCESS	New Structure of Design Team	- Interdisciplinary design process - Integrated team - IDP roadmap for design processes	N /A
	Place Exploration Patterns, Boundaries, Scale	- Measuring flows - Discover broader boundaries - Scale Jumping concept /adaptability - The Place and Flows diagram to explore a place - Place-specific analysis of project variables - Strategies at multi-building or community levels	- Project Elements: Who, What, Why, When, Where - spatial extend: room, building, site, neighborhood, city, and region
	Place Specific Design	- Assessment of the Flows - Define Unique Place - Use information from the open-source database for the unique place - Initial Stakeholder dialogue to discover place and create guidelines - Sandbox diagrams	- program and place - geophysical - infrastructure - culture - human and natural resources - topography - climate - transportation - flows - systems - values
	Process-based Tools	- Guidance for design process	N /A
INDICATORS	Indicators and Focal Points Structure of the Tools	- Series of graphics to explain the approach - Guiding Questions instead of clear metrics	N /A
REGENERATION	Net Positive Impacts	- Net positive goals - Toolbox part of the tool - Positive surplus	- equity - dependency - deficiency - availability - productivity - vitality - stability - longevity - positive surplus
	Cyclic Closed Loops	- Represent the importance of cyclic closed loops by creating circular (sphere) diagrams	- cycles, interventions, spans - feedback loops
	Stakeholder Engagement	- Expand dialogue between the design team and stakeholders - Get feedback from stakeholders - Discover shared identity - Ensure stakeholder participation in design processes; initial discussion, design charrettes and team meetings	- community - design team - nature
	Ongoing Participation	- Ongoing participatory reflective process - Feedback processes	N /A

Table 21: The Completed Evaluation Worksheet for Perkins+Will

THE EVALUATION WORKSHEET for LBC

	Categories	HOW TO: COMMON TECHNIQUES	EXAMPLE INDICATORS
PHILOSOPHY	A New Mind	- Ecological worldview - Place -specific design - Interconnectedness - Flexible and descriptive strategies - Trojan horse: a philosophical worldview cloaked within the frame of a certification program	N /A
	Whole System Thinking		
	Interconnectedness	- Symbiotic relationship - Realign our ecological footprint to be within the planet's carrying capacity - Story of place - Ecosystem understanding - Biophilia	- biophilic environment
	Co-evolution		
PPROCESS	New Structure of Design Team	N /A	N /A
	Place Exploration Patterns, Boundaries, Scale	- Incorporate nature's patterns - Incorporate nature through Environmental Features, Light and Space, and Natural Shapes and Forms - Scale jumping - The Living Transect - Measuring the flows (historic, current, and future) - Discover broader boundaries	Place: - limits to growth - urban agriculture - habitat exchange - human powered living Water Energy Materials: - red list - embodied carbon footprint - responsible industry - living economy sourcing
	Place Specific Design	- Assessment of the Flows - Define Unique Place - Story of Place - Be uniquely connceted to the place, climate, and culture through Place-Based Relationships	
	Process-based Tools	N /A	N /A
INDICATORS	Indicators and Focal Points Structure of the Tools	- Series of graphics to explain the approach - List of strategies, Petals, and Imperatives (indicators) - Detailed explanation for goals	N /A
REGENERATION	Net Positive Impacts	- Net positive goals and outcomes	- net positive water, energy, and waste Health and Happiness: - civilized environment - healthy interior environment Equity: - human scale +humane places - universal access to nature+place - equitable investment - just organizations
	Cyclic Closed Loops	N /A	N/A
	Stakeholder Engagement	N /A	N/A
	Ongoing Participation	N /A	N/A

Table 22: The Completed Evaluation Worksheet for LBC

THE EVALUATION WORKSHEET for LENSES

	Categories	HOW TO: COMMON TECHNIQUES	EXAMPLE INDICATORS
PHILOSOPHY	A New Mind	- Ecological worldview - Place -specific design - Process-based framework - Outside in Thinking - Flexible and descriptive - Foundation Lens of the tool	- stewardship - partnership - intergenerational view - education
	Whole System Thinking		
	Interconnectedness	- Ecosystem understanding - Integrated/ nested bottom line - Replace linear processes with cyclical ones - Learn from and follow nature's laws - Foundation Lens of the tool - Experience the tool to discover the interdependence - Story of Place	- respecting limits - interdependence
	Co-evolution		
PPROCESS	New Structure of Design Team	- (Inter) Multi-disciplinary teams - Group dialogue	N /A
	Place Exploration Patterns, Boundaries, Scale	- Measuring flows - Discover broader boundaries - Assess the historic and current condition of flows - Vision the future flows - Flows Lens of the tool	- ecosystem services - energy - land use - materials - money - water
	Place Specific Design	- Define Unique Place - Story of Place - Identify the relationships and synergies between flows - Use Rubrics for 12 Flows in the tool - Flows and Vitality Lens of the tool - The Vitality Planning Worksheet and Vitality Evaluation Worksheet	- culture - transport - health - wellbeing - justice
	Process-based Tools	- Guidance for design process	N /A
INDICATORS	Indicators and Focal Points Structure of the Tools	- Series of graphics to explain the approach - Qualitative metrics: Scaled from degenerative to regenerative - Twelve Rubrics and focal points for each rubrics - Vitality Lens and its Planning and Evaluation Worksheet (numeric measurement option)	N /A
REGENERATION	Net Positive Impacts	- Net positive impacts for the flows	- Net positive water, energy, waste - Health and Happiness
	Cyclic Closed Loops	- Represent the importance of cyclic closed loops by creating circular (sphere) diagrams - Replenish cycles rather than linear processes	- cycles, interventions, spans - feedback loops
	Stakeholder Engagement	- Engage representatives of all stakeholder groups - Determine team composition - Get feedback from stakeholders - Story of Place - Discover shared identity	- stakeholder involvement
	Ongoing Participation	- Ongoing participatory reflective process - Feedback processes and Complete lifecycle	N /A

Table 23: The Completed Evaluation Worksheet for LENSES