APPLYING THE PRINCIPLES OF CRADLE-TO-CRADLE TO URBAN PLANNING

By

Ryan Boucher

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Committee Membership

Dr. Michelle Lane, Committee Chair

Dr. David Sleeth-Keppler, Committee Member, Graduate Coordinator

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ABSTRACT

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The purpose of the research presented in this paper is to expand on the principles of the 'cradle-to-cradle' sustainability framework, as presented by William McDonough and Michael Braungart, to include how those principles can be applied to the process of urban planning. At this point, cradle-to-cradle design principles have primarily been utilized in product design, but there has been less research into the potential for the cradle-to-cradle framework to be applied to non-production based activities. This paper relies exclusively on published literature to describe cradle-to-cradle and the notions of eco-efficiency versus eco-effectiveness, an outline of the roles and duties of urban planners, an overview of how sustainability has been applied to urban planning, and concludes with examples of several cradle-to-cradle inspired architectural and park projects.

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INTRODUCTION

The purpose of the research presented in this paper is to expand on the principles of 'cradle-to-cradle' sustainability, as presented by William McDonough and Michael Braungart, to include how those principles can be applied to the process of urban planning. Cradle-to-cradle is a radical form of sustainable development that advocates for the complete elimination of waste in manufacturing and architectural systems. The ultimate goal of a cradle-to-cradle based manufacturing process would be to design a product whose materials could be fully reclaimed and reused without any degradation to the materials after the useful life of the product has concluded.

Cradle-to-cradle argues against a popular sustainability belief that promotes reduced use of natural resources in order to curb the negative effects of industrialization, including pollution and climate change. Instead, cradle-to-cradle claims that marginal reductions of negative externalities only works to delay an inevitable destruction of natural and social environments. Furthermore, it does so in such a way that the long-term ill effects of industrialization may go unnoticed as people gently adjust to surrounding changes caused by the non-regenerative aspects of the production process, rather than being shocked into advocacy by rapidly changing environmental and social conditions. Natural systems stunned by a sudden collapse have a far greater chance of returning to a safe equilibrium than those that have been systematically depleted over an extended period of time.

Rather than simply pursuing a reduced-use approach, often referred to as eco-efficiency, cradle-to-cradle advocates for a complete rethinking of how inputs in a system interact and the complete abolishment of waste. This approach, dubbed eco-effectiveness, utilizes the value of all resources to their full potential, mimicking natural systems which absorb all life and produce zero waste. The eco-effective approach doesn't demonize consumption, as reduced consumption sustainability campaigns might, but, rather, embraces continuous improvement and expansion of technology and industry (McDonough & Braungart, 2002).

In most cases, analysis of opportunities to utilize the eco-effectiveness framework has been restricted to manufacturing processes, product design, and architecture. What this paper proposes is that eco-effective design principles, the basis for cradle-to-cradle, can be applied more broadly to non-product based industries, such as the field of urban planning. Planners have the unique ability to influence social and environmental change in their design of urban and rural communities. Planning is a complex process of developing the infrastructure of a community, which requires understanding the needs of the various demographics of people that will inhabit the area, in both the short and long-term. It's important to note that though planners are most known for their work in designing physical layouts of areas, including urban design, parks, and transportation planning, they are also instrumental in resource planning, community development, zoning, and influencing public policy (American Planning Association, 2014).

Sustainable planning has been a topic of popular debate for several decades, specifically the role of planners in influencing the implementation of sustainable systems. In most cases, the approach to sustainable planning has been directed through the lens of eco-efficiency. While the eco-efficient approach can be a tool in the transition towards eco-effectiveness, it shouldn't be thought of as an end unto itself. This paper will approach how cradle-to-cradle principles can be utilized in the urban planning process by explaining cradle-to-cradle ideology, the roles, duties, and methods of the planner, and how eco-effectiveness is a superior method to eco-efficiency. Various other topics that will be discussed in the course of this paper will include the tools available to planners to aid in the sustainable planning process, the issues of land use planning, methods planners take in influencing public policy, and an overview of several cradle-to-cradle inspired development projects.

LITERATURE REVIEW

Urban Planning

Solving the issue of how to combat slums and plan cities sustainably is a necessary task for a near future in which the majority of the world's population will be living in densely populated urban areas. Redesigning the general approach to city planning is an incredible leverage point in alleviating disease, poverty, and devastating environmental impacts.

The United Nations reports that approximately 54% of the world's population currently live in an urban area and suggests that percentage will rise to nearly 67% by 2050. It's predicted that the highest urban population growth will occur in the 49 least developed countries, the majority of which are located in Africa and Asia (United

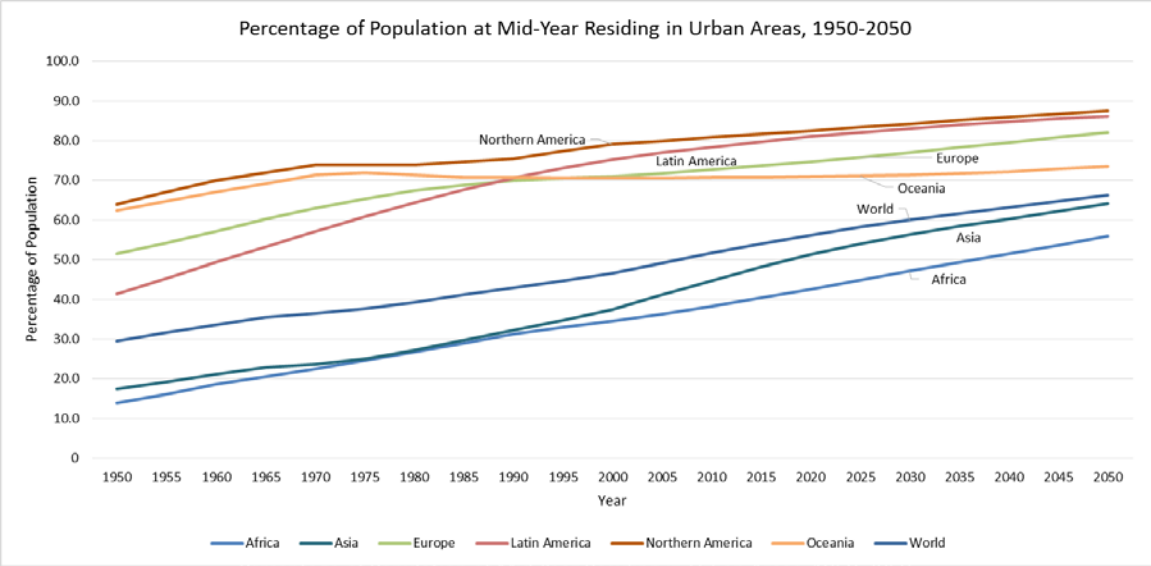

Figure 1. Data from United Nations representing world population proportions

Nations, 2014).

Increasingly industrialized farming practices in these countries are decreasing the ability for small communities in rural areas to adequately sustain themselves. As such, there have been large numbers of people who have traditionally lived in very isolated areas that are journeying into more populated urban regions, often in search of employment. The continued mass migrations to cities, many of which have assuredly yet to have even been established, in these underdeveloped nations will represent an incredible hardship on their already burdened economies and resource base.

Developed nations continue to experience unchecked suburban sprawl. Many American cities were constructed without a long-term plan, especially following World War II and the popularization of suburban communities. In Phoenix, Arizona, for example, housing development communities range as far as 30 miles from the city. This puts incredible stress on the single major freeway that transports residents daily into the downtown and is representative of how a lack of foresight when approaching the planning process has put incredible environmental and economic strain on a city (Yeung, 2008).

The already emerging megacities in the poorest world regions often represent unsustainable planning practices and an inability of planners and governments to keep up with the rapid growth of urban populations. In some areas, unregulated low-density sprawl creates an increased need for cars, which are often supported by ineffective motorways. In others, high-density populations are pressed into inefficient, often

dangerous, housing with limited access to basic needs. It's estimated that as many as one billion of the world's population are living in slums, the largest proportion of which are in Asia where urban growth is also highest. Often the impoverished living in these communities have limited or no access to utilities, such as water or proper sanitation, directly contributing to deteriorating health conditions, the spread of infectious disease, economic instability, and death (Ooi & Phua, 2014).

The role of the urban planner is to create plans for the various uses of urban areas for the future. Planners develop the plans and policies that ensure that cities have the ability to properly function and grow. Urban planning is a broad term and the process is most often controlled by a large team of people specializing in various areas. The ways in which urban planners affect cities include zoning laws, transportation planning, sewer and waste management systems, water services, parks and community buildings, energy planning, community development, and community design (Planning.org, 2010).

Though the title of urban planner is fairly well known, their exact roles are not always as well understood. The following table describes some areas of society affected by the actions of urban planners, on the left, and the related duties particular to the urban planner, on the right. The categories were determined by the American Planning Association to reflect some of the more common areas affected by urban planners. This is a general list and not meant to be exhaustive (American Planning Association, 2014).

Table 1. Areas Affected by Urban Planners

Homes	Estimate future population trends and recommend how many new households will need to be built, as well as where they should be located.
	Based on the culture of the community, determine the proportion of types and size of homes/lots, as well as proportion targeted towards homeowners vs renters.
	Develop policies affecting house pricing.
Employment	Identify areas within communities for factories, shopping, offices, etc.
	Identify employment needs within communities and work with employers and schools to ensure a worker base.
Transportation	Study transportation systems and habits of citizens to determine when to recommend additional transportation options, where they should be located, and what mix of options should be made available.
	Analyze effectiveness of current transportation.
	Ensure adequate transportation for industry and the movement of raw materials and goods.
Water and Waste Management	Coordinate with civil engineers for basic infrastructure.
	Understand land use effects of water and sewage.
	Coordinate with hydrogeologists to develop sustainable water usage plans.
Recreation	Plan for parks, open space, and community facilities.
	Study age distributions to determine appropriate types of facilities.
	Ensure fair distribution of parks across neighborhoods/communities.
Design	Develop rules for physical layout of communities.
	Develop and support building codes.
Community Development	Provide assistance to small businesses.
	Improve quality of affordable housing.
	Develop programs for increasing job skills of citizens.
Energy	Coordinate with utility companies to predict future energy demands.
	Determine locations for new energy facilities, plants and/or storage areas.
	Identify methods of reducing energy consumption.
	Plan for renewable energy sources.

Cradle-to-Cradle

In order to understand how cradle-to-cradle can be incorporated into the methodology of urban planning, it's first necessary to understand what cradle-to-cradle is and the key fundamental aspects of the system. One of the most important aspects of that system is a continuous improvement design method with the goal of decreasing the amount of waste generated from, during, and after a product or service is generated, used, and discarded. The framework also puts significant emphasis on culture, respect for diversity, and innovation during the design process.

Cradle-to-cradle is a sustainability framework meant to encourage people to rethink their production and consumption habits, and advocates for industrial systems to mimic nature. The concept was developed in collaboration between architect William McDonough and chemist Michael Braungart, who published their framework in the 2002 book *Cradle-to-Cradle: Remaking the Way We Make Things*. McDonough and Braungart had been working together for several years in developing products and processes to reduce the negative internal and external effects thought to be inherent in product design. Their collaboration gained world recognition when they published "The Hannover Principles", a set of sustainability based guiding principles, as a basis for planning the 2000's World's Fair in Hannover, Germany (McDonough & Braungart, 2003).

Sustainability is popularly thought of as only taking from the Earth what can be regenerated, and reducing negative externalities through reduced consumption methods.

Cradle-to-cradle argues that this basic notion of sustainability, eco-efficiency, is counter-productive as it simply advocates for people to be “less bad” rather than “more good”. They argue that this view of sustainability, by its very definition, is only the beginning of a longer process to develop products and systems that replenish the Earth rather than only draw resources away. Cradle-to-cradle was designed to be the next step in that evolution. For example, while a sustainable solution to carbon emissions might be to reduce the amount of fossil fuels burned, a cradle-to-cradle solution would be to redesign engines to run on alternative fuels that produce zero carbon output.

McDonough and Braungart argue that eco-efficiency delays an inevitable collapse of available resources. Even worse, thinking of the conversion of processes to be eco-efficient as a main goal may act to hide the deteriorating environmental and social effects that will continue to occur, though admittedly at a much slower rate. This could result in even more devastating consequences as eco-systems are systematically plundered rather than shocked by quick collapse, leaving some aspects of the original system intact. Whether a reduced use of resources allows current processes to continue uninhibited for another 50 years or another 500 is irrelevant, as the end result remains constant. Eco-efficiency simply means that things are equal, or as close to equal as possible. But the concept stops there and tends to treat regenerative activities as novelty (McDonough & Braungart, 2002).

Cradle-to-cradle design requires that when an item has concluded its useful life that its materials can either be recovered or biodegrade safely in a relatively short span.

McDonough and Braungart split their vision of how materials will be recovered into two sectors: the biosphere and the technosphere. The biosphere represents materials that come from nature and so can either easily be returned to nature or reused for additional purposes, an example may be a resource as simple as wood or gold. The technosphere includes materials that are not found in nature and are instead produced by humans. These materials cannot be returned to nature so caution must be utilized when considering their use in manufacturing, as an ideal closed-loop technosphere would not produce waste or degradation to the integrity of the material during the production process or its eventual recapture into the production process. This cycle is illustrated in the figure below (Nutrient Cycles, n.d.).

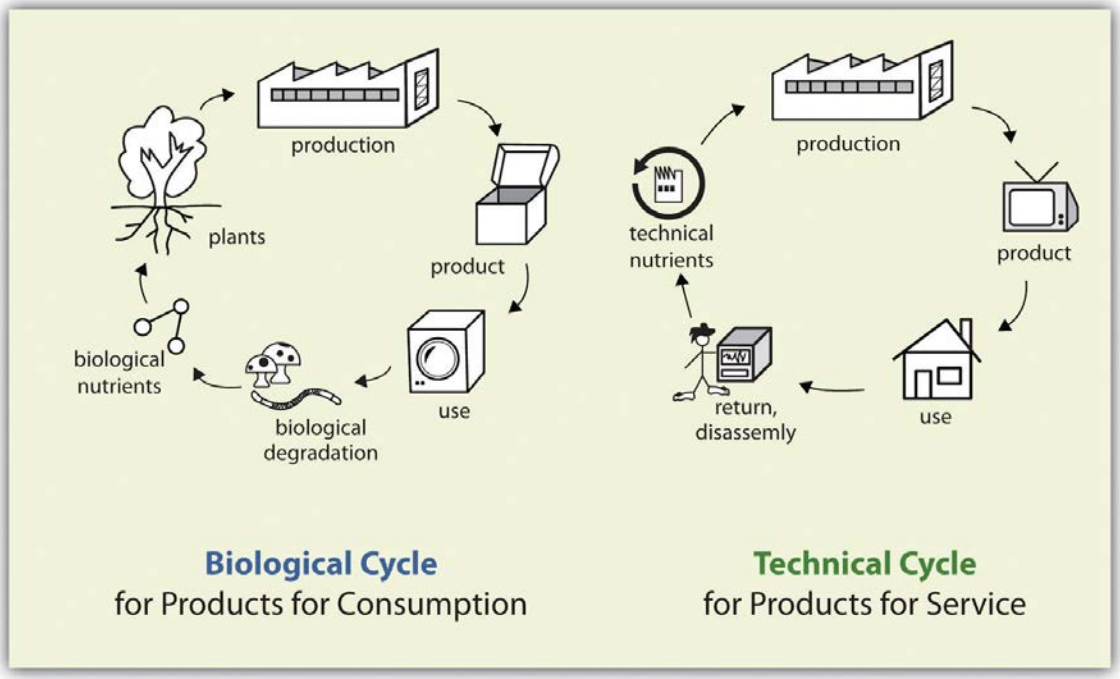

Figure 2. Biosphere and Technosphere

Many items today are produced with a combination of materials from both spheres, products that McDonough and Braungart coined *monstrous hybrids*. These items will have no recyclable value for either sphere, as separating the materials would either be too costly to justify or the process is otherwise impossible. In the majority of cases, these items, once used, have no value to any system and must be discarded into landfills.

Eco-efficiency and eco-effectiveness

Cradle-to-cradle recognizes that the goal of total eco-efficiency is a necessary next step before achieving eco-effectiveness, but warns against perceiving early victories as a complete reversal of the negative externalities that have begun to pervade society. This notion is encapsulated in the difference in the eco-efficient and eco-effective approaches. An eco-efficient system is the "less bad", and the world in which eco-efficiency is the goal is assuredly less polluted. As McDonough and Braungart write, taking the concept of eco-efficiency and re-writing the Industrial Revolution would result in steps to "release *fewer* pounds of toxic waste… measure prosperity by *less* activity… produce *fewer* materials that are dangerous… [produce] *smaller* amounts of useless waste". It's also one marked by less innovation, technology, and material goods. By demonizing consumption, advocates of eco-efficiency are treating humans as an all-together "bad" or unnatural thing. In this system, humans and the natural tendency to

desire new things are inherently evil traits. The eco-efficient approach is to produce less and live simpler lives.

Imagine the eco-efficient society, in which people drive cars with high gasoline efficiency, factories produce less goods, and all human systems match the ability of the Earth to replenish what could be reasonably produced, consumed, and then disposed of into landfills. Imagine the efficient housing unit with tightly packed, simply designed rooms. The efficient city is one in which similar design aesthetics are repeated and arranged in order to fully meet the basic needs of the citizens. The efficient society provides for all citizens while neither harming nor helping the Earth. It is one in which humans step outside of their place as creatures of the Earth and regard themselves as an entity that doesn't quite belong. As McDonough and Braungart put it, "As long as human beings are regarded as 'bad', zero is a good goal. But to be less bad is to accept things as they are, to believe that poorly designed, dishonorable, destructive systems are the *best* humans can do. This is the ultimate failure of the 'be less bad' approach: a failure of the imagination," (McDonough & Braungart, 2003, pp. 68-75).

Instead of striving for efficiency, what McDonough and Braungart suggest is endeavoring for effectiveness. By utilizing resources, designs, and systems in their most effective manner, production can be maximized in a way that doesn't degrade the usefulness of the material. The effective method requires high degrees of creativity and drive to achieve.

There are many differences that become immediately apparent when comparing the same society described earlier through the lens of eco-effectiveness. When exploring the world of eco-effectiveness the possibilities become much more abundant. People drive their cars without concern for the environment because auto manufacturers have designed vehicles that run on completely renewable resources that don't contribute to global climate change. Or maybe people are driving less because of a redesign of infrastructure that makes public transportation, bicycling, or walking more convenient. Factories produce more goods and all products are either returned to the Earth or the technosphere to aid in replenishment. Instead of waiting for resources to renew by the will of nature as a detached alien consumer, people become an active participant in naturally restoring cycles. Buildings are designed to enlighten people and provide cultural stimulation.

By approaching design issues from the viewpoint of the effective, more opportunities become available. Rather than meeting the stipulations of a flat line, there is freedom to explore new possibilities. In this system "waste equals food" and resources are created in an abundance that provides nourishment for other systems.

McDonough and Braungart outline the "Five Steps to Eco-Effectiveness" as being:

1. Get "free of" known culprits.
2. Follow informed personal preferences.
3. Creating a "passive positive" list.
4. Activate the positive list.

5. Reinvent.

Organizations seeking to implement eco-effective solutions should first move away from utilizing substances and process that are known to be harmful. It's of significant importance that a process or material not be replaced with something equally bad. They should then recognize within themselves as individuals what personal preference they have for sustainable functions and follow those preferences. McDonough and Braungart suggest three basic ideas to keep in mind when recognizing preferences, to "prefer ecological intelligence", meaning to be fully aware of the materials being used in projects and ensuring that they were created or harvested sustainably, to "prefer respect", respect for all stakeholders in a project, and to "prefer delight, celebration, and fun", to realize the goal of any project is to enhance the lives of the end-users.

Steps three and four deal with creating lists of materials that should and should not be used in projects, and developing policies to ensure that those guidelines are consistently followed. Though McDonough and Braungart wrote their own lists to exclusively include materials in manufacturing and architectural design processes, the concept could be applied to any form of design project. The final step is to find new ways of approaching design projects, and push those new approaches as far as possible. As they put it, "Don't just reinvent the recipe, rethink the menu." There is no true endpoint at which an organization has accomplished all steps, it's an evolution and continuous improvement exercise meant to inspire designers to push the envelope of what is possible in their field (McDonough & Braungart, 2002, pp. 165-180).

Petter Næss, professor at the School of Architecture, Design, and Planning at Aalborg University in Denmark, reflected on the need to move away from the eco-efficient approach in a 2001 article, “Urban Planning and Sustainable Development”. Næss poses the question as to whether or not “eco-efficiency and re-use [are] sufficient” to meet the growing needs of populations. He points out that though there have been trends in developed countries that lead to less persons employed at manufacturing levels and more at office locations, which have generally required less square feet per employee, that the number of buildings has continued to rise at increasing rates (Næss, 2001, p. 9).

Næss also points out a traditional trend in housing and office locations has been to allocate to low-income populations the areas that have been discarded by the middle-class after gaining wealth and moving into higher value neighborhoods. Without a definite break in socioeconomic patterns, the eco-efficiency approach will not result in long-term change. In order to be successful, the fundamental consumption habits of a large portion of the world’s population would have to decrease dramatically, and in a relatively short period, and then remain at a reduced level indefinitely. Næss writes that he is skeptical that this will occur and instead suggests a minimum standard of livability for all persons, which would require the reallocation of resources away from the improvements of residence of middle- and high-income populations to instead be used to develop low-income residences with low environmental impacts.

The conscious effort to reallocate necessary resources would have to occur as, at least in some small part, a fundamental change in the culture of the wealthy in many of the world's countries. The difference is that the change in culture becomes institutionalized rather than simply spontaneous, with marked goals for improvements and definable methods for achieving those goals. The change wouldn't have to rely on numerous individuals suddenly deciding to change their behaviors. Instead, social and political efforts can be put in place in order to influence behavioral change that ultimately benefit society. This also allows for a political culture in which experts in the fields of social need would be directing the change, again removing the spontaneous and random aspects of the shift in building and zoning developments (Næss, 2001, pp. 9-12).

Sustainable Planning Tools

When developing projects, planners often utilize tools to help organize their thoughts and determine possible outcomes of decisions. Scott Campbell designed the Triangle of Conflicting Goals for Planning (figure 3) in 1996 to describe how he felt sustainability fit into the matrix of urban planning. He writes in the same article, "Green cities, growing cities, just cities", that he finds the notion of sustainability a "laudable holistic vision" and considers the need to refine an approach to tackling the issues of sustainability in order to allow planners to develop urban and rural areas in ways that could address environmental and social issues.

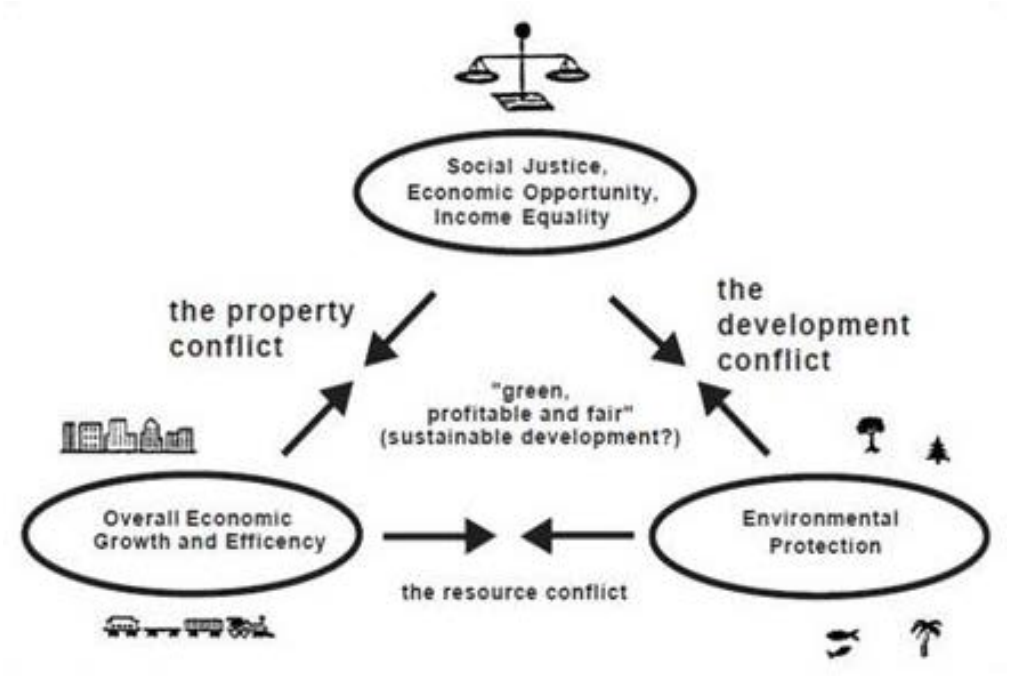

Figure 3. The Triangle of Conflicting Goals for Planning (Campbell, 1996)

Each corner of Campbell's triangle represents a goal of the planner and each side represents a conflict between those goals. The Property Conflict between economic growth and social justice occurs as a result of land ownership and zoning laws, the Resource Conflict occurs because of the need for resources in building and growth, and the Development Conflict represents the difficulty that society has in dealing with the Property Conflict and Resource Conflict in a way that satisfies communities. The center of the triangle represents perfect harmony between the conflicts. Campbell questions whether the harmony could be sustainability because of his confusion as to what would constitute a sustainable development process (Campbell, 1996, pp. 1-5).

Campbell's confusion highlights a necessary input into the strategic sustainability planning process: a working definition of sustainability. Without a proper definition of

sustainability to work from, the planner or planning team will be attempting to solve a problem with a tool whose function they don't completely understand. Creating a definition of sustainability that everyone involved in the project agrees upon is one of the essential first steps in a successful sustainable design project (U.S. Green Building Council, 2014).

Campbell's triangle has many similarities to William McDonough and Michael Braungart's Fractal Triangle. McDonough and Braungart designed the triangle around their concept of Fractal Ecology, which proposes that there are endless possibilities for creating value while reinforcing the pillars of sustainability. The usefulness of the tool is to create a visual representation of how elements interact and affect one another. It allows the user to objectively weigh the effects of certain elements when making a decision, whether that means the chemicals used in the production of children's toys or the decision to add independent bike lanes to city streets.

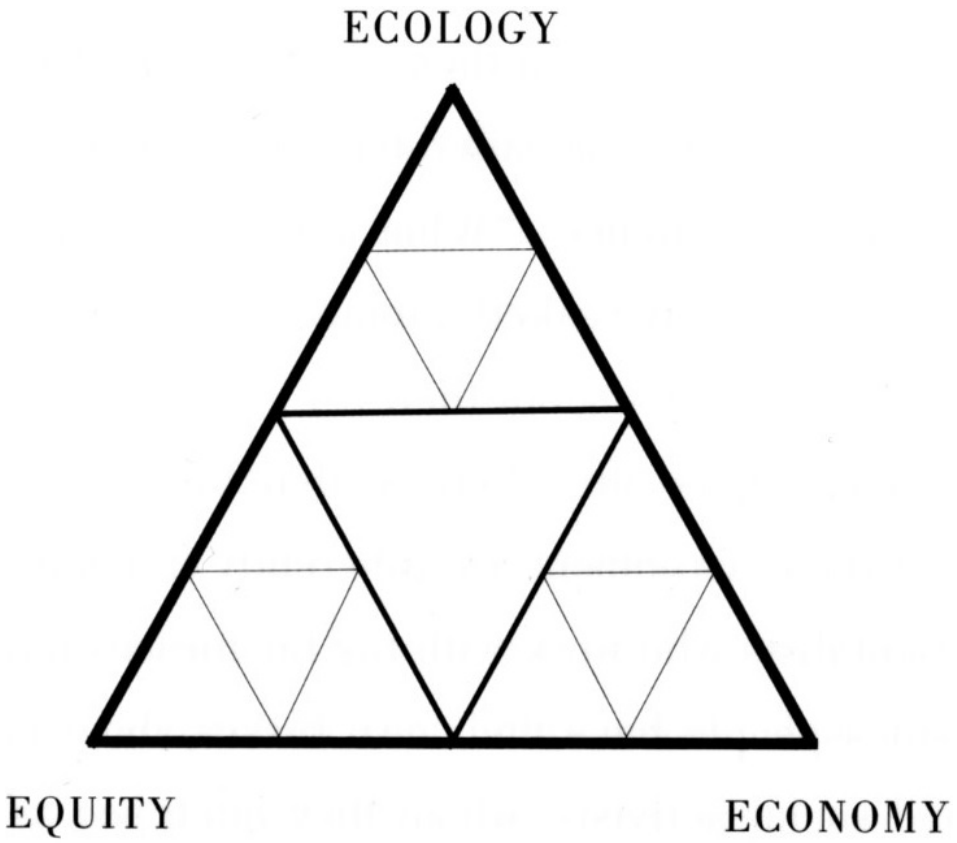

Figure 4. The Fractal Triangle

Aesthetically, it's immediately obvious that McDonough and Braungart's triangle is much simpler in its design. Each corner of the triangle, like Campbell's triangle, is the ultimate extreme of that aspect of sustainability. But unlike Campbell's interpretation of sustainability, McDonough and Braungart don't propose conflicts between the extremes. Campbell sees sustainability as a series of competing needs, only a few of which have the ability to be met. This is because Campbell is attempting to create a balance between the extremes. The Fractal Triangle rejects that notion in favor of an outlook that doesn't put areas of progress at conflict or competition, but, rather, asks the individual to empirically categorize the impact of their processes and maximize value through intelligent design

strategies. This can be seen when breaking down the McDonough-Braungart triangle to show its various parts. (McDonough Braungart Design Chemistry (MBDC), 2002).

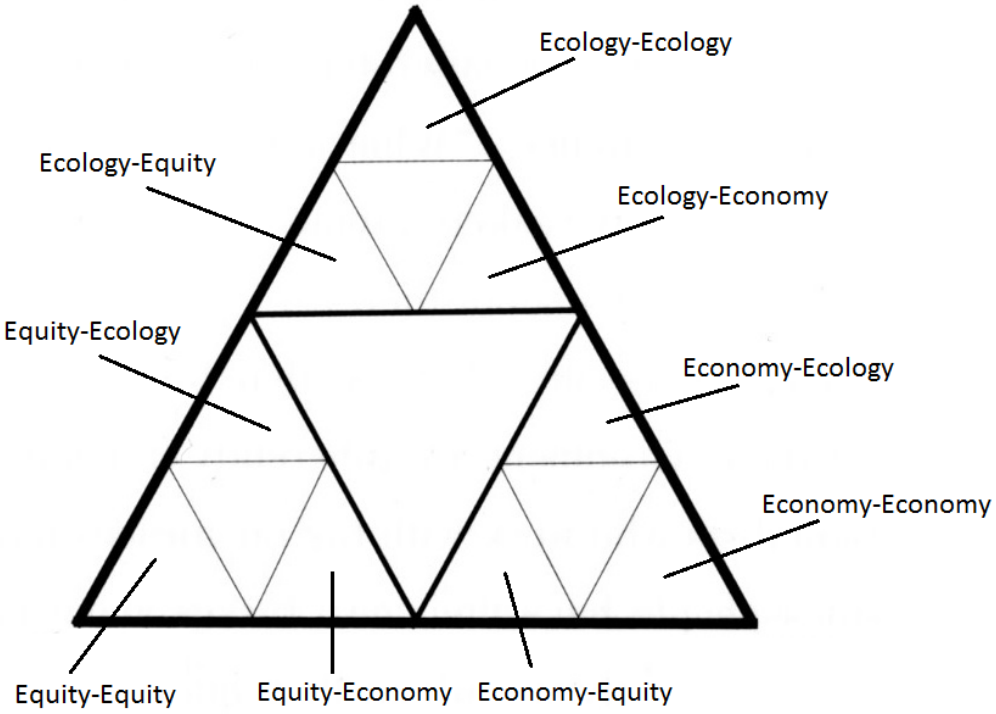

Figure 5. The Fractal Triangle explained

Each area of the fractal in figure 5 is given equal space for the specific reason that any one area is not meant to be more important than another. Generally speaking, in terms of sustainability, though, great care should be observed if a project is aligned in any one extreme. As would be expected, the economy-economy will focus solely on the profitable aspects of the project and the only questions the project will have to answer will be whether it will make money and how it could make more money. Economy-Equity begins to incorporate more concepts of fairness and ethical considerations. The

Equity-Economy sector shifts even more towards justice into the Equity-Equity corner, where social aspects, such as segregation, are considered.

Moving to the Equity-Ecology area, issues such as the fairness of exposing people to certain chemicals or the location of low-income housing in relation to potential health hazards or distance from hospitals, will be deliberated. Continuing to Ecology-Equity, more emphasis is put towards the actual environment and the ethical considerations in land use development that may cause long-term degradation to the land or wildlife. In the pure Ecology-Ecology corner, all functions of the project follow the laws of nature and work to preserve all species without inhibiting the will of nature.

The Ecology-Economy section is meant to represent that all projects have to be financially viable in order to succeed. The majority of planners work for the government and often the projects they engage in are not meant to provide profits, but they still must be financially viable to undertake, especially considering the political aspects of how tax revenue is utilized. Finally, the Economy-Ecology section is representative of the focus of eco-effectiveness, in which people cease to do "less bad" and engage in activities that are "more good" (McDonough & Braungart, 2002, pp. 150-153).

McDonough and Braungart also briefly introduce a cradle-to-cradle tool that they often utilize as the "triple top line". The tool is based on the well-known triple bottom line approach, which is based on the same three major pillars of sustainability covered in the Fractal Triangle. The purpose of the triple bottom line is to increase corporate accountability for their actions, as well as provide an opportunity to report on activities

that did not directly contribute to the bottom line, or only did so indirectly. McDonough and Braungart write, though, that in their experience the triple bottom line tends to continue to focus only on economic considerations. And, because any social or environmental benefits aren't weighed until after the conclusion of business practices, organizations tend to invent benefits based on what was accomplished and ignore consequences. Without arranging for goals and "budgeting" environmental and social outcomes, they are free to only report what is in the best interest of the company, effectively green washing their operations.

The advantage of changing this approach to the triple top line is to give equal weight in decision-making to environmental and social considerations as well as economic considerations. By creating actionable goals and reporting on progress to achieve an intended benefit, organizations will be better equipped to create meaningful positive change. McDonough and Braungart suggest combining the triple top line with the fractal triangle in order identify the specific needs of a project and explore any issues that may be affecting its success. In doing so, new solutions may arise that might not have otherwise been imagined.

Land Use Planning

When approaching how to design sustainably, planners have experienced a particular issue in regards to how to plan for the sustainable development of land. Land development is one of the few issues which tends to tilt the pyramid and create

inequalities among all the three pillars of sustainability. Only in rare situations will planners be able to develop a solution to land use planning that doesn't negatively affect at least one, if not multiple, aspects of the sustainability pyramid.

Imagine a plot of land. Generally speaking, the best, most sustainable option for the eco-system and wildlife is to not disturb the land and establish the area as a wildlife and nature preserve. Any development of the land will somehow negatively affect the planet facet of the sustainability principles. Establishing the area as a reserve may also contribute to the well-being of the people, as community members are able to experience nature, explore the preserve, and enjoy a beautiful addition to their community.

But, if a shopping center was built on the land there would be more jobs and economic prosperity for the community, perhaps negatively affecting the planet but positively affecting profits and creating a marginal positive effect on the local community. If a school were built instead, then the people aspect would be more positively affected but retailers may be upset that they won't have the opportunity to expand into that area, and the natural eco-systems native to the land may also be negatively affected.

The above example is an extremely simplified approach to the incredibly complex issue of land use planning. Planners must consider all effects of decisions in both the short and long-term to a number of varying groups, each with their own paradigm and goals. In doing so, planners will be better equipped to not only make decisions in the

best interest of society but have the capacity to explain these decisions when confronted (Godschalk, 2004).

Livability is one of the central concerns affecting land use planning. The issues of livability occur at both the micro and macro scale, as small as a city block or as large as a county. Livability specifically describes diverse aspects of society and human interactions with each other and space. The Interagency Partnership for Sustainable Communities (IPSC) created the following definition to describe livability:

> "The term 'livable communities' means a metropolitan, urban, suburban, rural or neighborhood community that provides safe and reliable transportation choices; promotes location and energy-efficient housing choices for people of all ages, incomes, races and ethnicities to increase mobility and lower the combined cost of housing and transportation; enhances economic competitiveness; protects farmland and open spaces; revitalizes neighborhoods; and supports public health outcomes and improved quality of life (America, 2009, p. 3).

Livability and sustainability are generally thought of as distinct notions, though there is some overlap, particularly in the areas of social justice. Additionally, the issues affecting livability can often be better highlighted when goals are considered within a sustainability framework.

The IPSC established the following six livability principles as a livability framework and guide to planners (Porter, 2015). These principles highlight the areas with the most need and opportunity for positive social change.

1. Provide more transportation choices.
2. Promote equitable, affordable housing.
3. Enhance economic competitiveness.
4. Support existing communities.
5. Coordinate and leverage federal policies and investment.
6. Value communities and neighborhoods.

The two main competing approaches to dealing with livability are New Urbanism and Smart Growth. New Urbanism is a movement committed to the architectural and physical design layout features of sustainable planning. Their charter puts focus on the tangible results of planning and the study of how infrastructure, land development, architectural design, and materials affect social and economic environments. Smart Growth instead focuses more intently on influencing public policy and the psychological needs of inhabitants than on design principles. Smart Growth is more concerned with how they can influence plans, policies, and interest groups while also promoting overall planning decision-making. The movement is very loosely defined, with no official charter, so interest groups generally bend the intent of the Smart Growth movement to meet the needs of their individual projects (Godschalk, 2004).

The addition of livability as a central issue to the sustainable planning process adds another dimension to the issues discussed by Campbell and McDonough and Braungart. As a result, it becomes necessary to move the sustainability triangle into the third-

dimension by adding another corner. The result is a pyramid structure dubbed the Sustainability/Livability Prism (Godschalk, 2004, pp. 4-5).

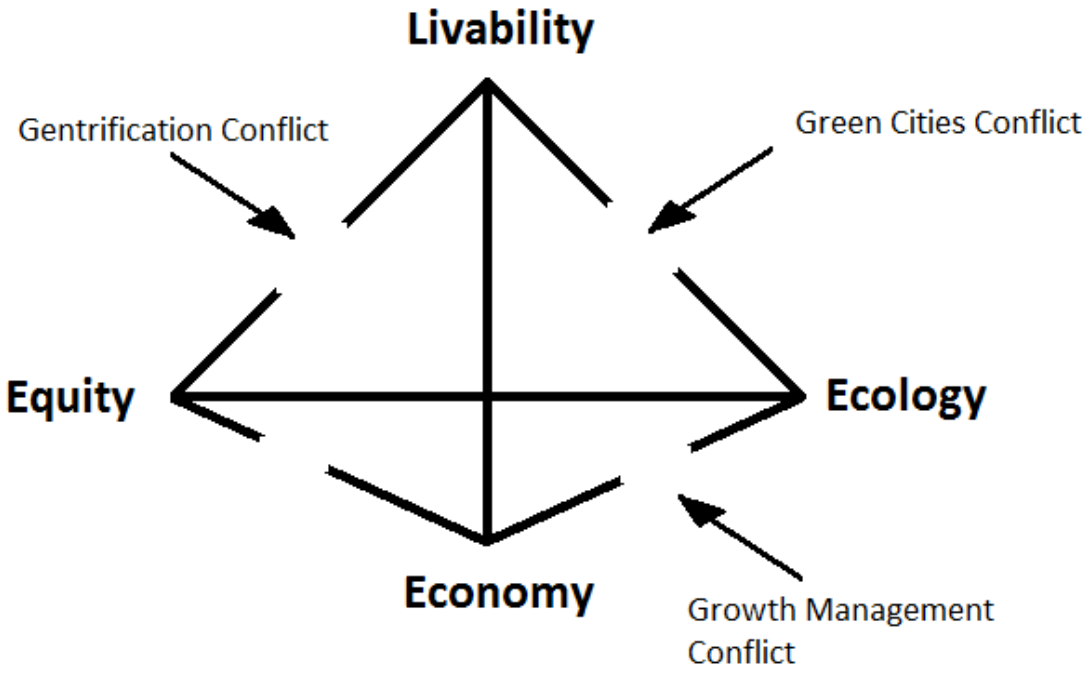

Figure 6. Sustainability/livability prism

Like the other conceptual design tools discussed thus far, the purpose of the Sustainability/Livability Prism is to facilitate thoughtful expression of the varying aspects affecting the outcomes of planning decisions. The added dimension of livability addresses the issues that are especially particular to the surrounding region in which the project is being conducted.

The conflicts represented in the Sustainability/Livability Prism are different than what have been previously explored but also retain distinct similarities. In the prism, these conflicts are more defined and tend to approach more human issues. The Growth

Management Conflict, for instance, represents the issue between economy and ecology specific to the level of management over development in an area. This conflict divides the natural environment and basic characteristics of capitalism to achieve unregulated business development. The Green Cities Conflict occurs between livability and ecology as competing beliefs are again put at odds.

One necessary input of livability is development, which will nearly always create conflict with the ecological environment. Disagreeing beliefs concerning how much and what area should be preserved for poorer residents of cities over re-development for middle- and upper-class populations represents the Gentrification Conflict. It's important to note that the magnitude of the area being surveyed will influence the consequences of each conflict. For example, the Gentrification Conflict will generally be more important when designing for large cities over rural communities (Godschalk, 2004).

Neither approach to working with livability, New Urbanism or Smart Growth, have been able to properly address the issue of how planners can develop areas to be better suited for people, the environment, and the economy. The Sustainability/Livability Prism used as a tool, though, allows planners to dissect areas in which need is most significant and where actions will have the greatest impact.

Ultimately, how planners decide to engage in land use planning must result from both the needs of the community and the ability of the local region to support those needs. It may be easy to feel that the needs of the individual outweigh the needs of the eco-system, but often there are solutions that address both equally. One proposition for

incorporating cradle-to-cradle urban planning techniques into coastal towns, for example, involved creating, in essence, a “rebuildable city”. The planners recognized that climate change will continue to cause unpredictable weather patterns and increasingly violent and destructive storms, creating economic and emotional hardships for residents of coastal towns. In order to build the resiliency of the town to storms, disappearing land, and encroaching ocean, the team of planners developed the *High Flux* model. In this model, the coastal town would be designed to respond quickly to potential threats of changing weather patterns. The goal would be to have a clear idea of the materials all the buildings in the town were constructed from and work towards designing buildings that could be easily torn down, rebuilt, or modified. Buildings could be demolished effectively and moved to safer areas, or damaged buildings could be harvested for their useful materials and rebuilt. Materials would be specifically selected so that if they became so destroyed that they were unable to continue to function as proper building material, that they could be easily composted and returned to the biosphere. (Wardekker, de Jong, Knoop, & van der Sluijs, 2009). In addition to coastal towns, this same model could be used in other areas with highly unpredictable weather, such as the U.S. Midwest which suffers from high numbers of devastating tornadoes. It could also be a highly effective approach to designing temporary housing and office space.

Influencing Public Policy

In addition to the design aspects of the position of urban planner, there is an inherent ability to influence politics and public policy. Whether in the realm of land use planning, or any of the other areas affected by and through urban planners, the opportunity to affect change through public policy influence is available. Because of their technical expertise, planners are often utilized by governing officials when they are considering the impacts of legislative decisions on the social and environmental well-being of a region. This might include a range of areas as diverse as the long-term implications of zoning regulations to the complete restructuring of a town's commitment to sustainability (Kaufman, 2013).

It's more common for planners to offer technical advice and fact based analysis than to become involved in advocacy. But there is significant opportunity for planners to partner with community development groups, environmental advocacy groups, and civil rights leaders in order to influence movements towards more sustainable urban design features. Particularly, urban planners working in sustainability and the cradle-to-cradle framework could help influence the success of low-income and minority empowerment advocacy groups and campaigns.

Generally, the ones most affected by the work of urban planners are the poor because of their relative inability to move in response to social inequality and environmental degradation. They are also the least able to campaign against pollution and discriminatory housing and business practices. Designing for urban areas that will be

inhabited by the poor and minorities is a significant factor in the future of sustainable design practices. Notably, change leaders advocating for poor and minorities have often ignored the natural environment, favoring job opportunities over the preservation of land. This is understandable, though representative of a "false choice", as studies have shown that sustainable industries can be more profitable than non-sustainable, and with proper planning the natural and economic environments can both operate effectively without impeding on one another (Campbell, 1996, pp. 13-14).

Cradle-to-Cradle Development Projects

William McDonough established his architectural firm, McDonough + Partners, in 1981 and has since contributed extensively to the development of sustainable architecture. His work in sustainable design practices and sustainability advocacy culminated in him being the only individual citizen to be awarded the Presidential Award for Sustainable Development, the most prestigious award for contributions to sustainability that is offered (Core Jr., 2011). McDonough is a staunch supporter of architectural designs that contribute to a more sustainable society and has worked with numerous organizations to design sustainable buildings, including NASA, Google, Ford, and others.

Oberlin College

Completed in 2000, the goal of the Adam Joseph Lewis Center for Environmental Studies building at Oberlin College in northern Ohio was for William McDonough +

Partners to design “a building like a tree”. The building would be completely self-sufficient, absorbing all of its needs from renewable sources and producing zero waste by-products as a result of its use. The building was commissioned as a research project in order to test various designs for closed-loop systems and gauge their effectiveness (McDonough W. , 2002, p. 4).

Solar panels were installed on the roof of the building that would generate more electricity than was required, feeding the excess energy back into the grid. A treatment system was installed to purify wastewater and release clean water. Also, large windows were installed to allow for natural light, largely dismissing the need for electric light. The building is an experiment in the possibilities of restorative design aspects (McDonough & Braungart, 2003).

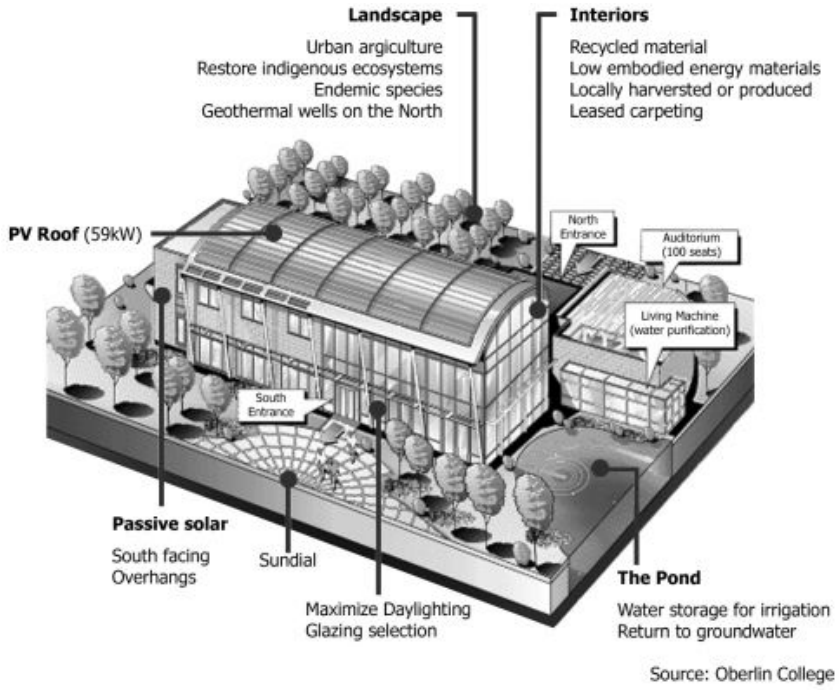

Figure 7. Adam Joseph Lewis Center for Environmental Studies (Han, 2000)

As can be seen in figure 7, there are several key features to the building that could be easily reproduced in other similarly designed buildings. The Living Machine, for example, is a small room occupied by tanks filled with plants specifically used to treat wastewater produced in the occupancy of the center. Once water is treated, it's either used for irrigation for an urban agriculture project on the north side of the building, or it returns to an outdoor pond, which acts as a habitat for native species of plants and animals, as well as a "living classroom" (Han, 2000, p. 1).

The building is utilized by students to obtain hands-on training in working with ecologically friendly systems. Although the design of the center doesn't lend itself immediately to mass reproduction, it's a step in the direct of eco-effectiveness in inspiring designers to rethink traditional building principles and methods (Lee, 2008). Following the completion of the Adam Joseph Lewis Center, the U.S. Green Business Council incorporated the Cradle-to-Cradle Certified Program into the Leadership in Energy and Environmental Design (LEED) certification (MBDC, 2013). LEED certification is recognized as a gold standard in green building design certification, distinguishing best practices and strategies in sustainable design (USGBC, n.d.).

Ford Rouge River Plant

Cradle-to-cradle aesthetics recognize the need for culturally enlightening designs, whether that design is for a shoe or a skyscraper. The cultural aspects of design elements are crucial to the success of cradle-to-cradle sustainability. Aspects of building design

that contribute to employee satisfaction and productivity are a simple example of how design can influence behavior.

In 1999, McDonough + Partners was commissioned to redesign the Ford Rouge River Plant in Dearborn, Michigan. The two-billion dollar project was given a timeline of 20 years to fully complete, though most of the dramatic changes were completed within the first year. The project was an interesting step for Ford; in the past, manufacturers, and car companies in particular, had found it cheaper and more cost efficient to abandon a factory after the conclusion of its useful life and build a completely new one in another location. By choosing to redesign of the Rouge River Plant, rather than decommission it, Ford has invested more into a factory redesign project than any other manufacturing company in history.

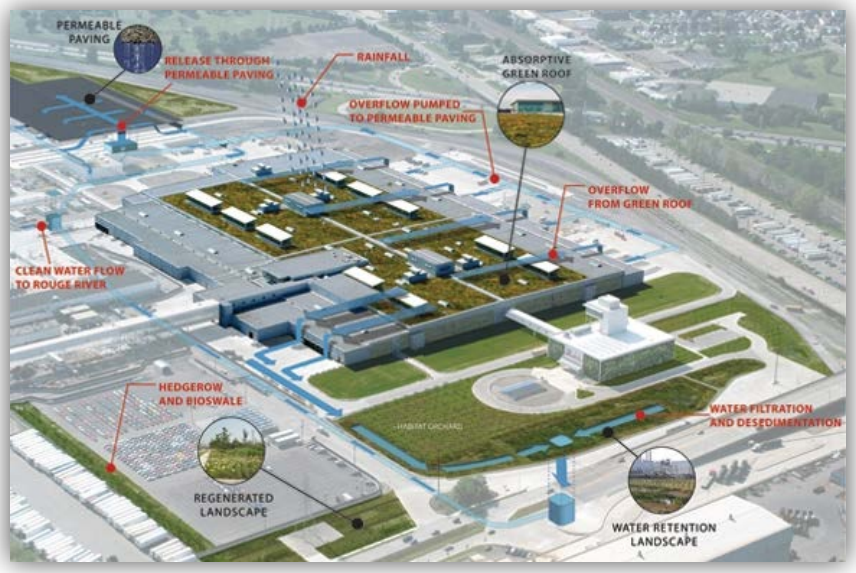

Figure 8. Ford Rouge River Plant (McDonough + Partners, 2003)

Major changes to the assembly plant, shown in figure 8, included planting 454,000 square feet of native plant species on the roof of the building to absorb water, produce oxygen, and sequester carbon, among other functions (McDonough W. , 2002). The “living roof” at the Rouge River Plant is not only the largest in America, but it was one of the first of its kind. When the living roof was installed, there were less than 50 in the United States. As of 2013, there were over 10,000 and represent a booming industry for companies that specialize in installation and consulting (Priddle, 2013, pp. 1-2).

The effect of the living roof for Ford was a 7 percent reduction in the plant’s energy costs and a 40 percent improvement in air quality (Architectural Record, 2004). As of 2015, the roof has been installed for over 10 years. For conventional roofs, this would be the time that arrangements would begin to be made for large scale replacement of materials. Conversely, it’s estimated that the managers at the Ford Rouge River Plant will not have to begin making similar arrangements for approximately another 60 years (Priddle, 2013).

McDonough also replaced large parts of the walls and ceiling with windows and skylights. The natural light and ability to view the outdoors from the machining floor immediately increased employee productivity and job satisfaction and has since lowered employee turnover. Additionally, the use of natural light reduces the need for artificial light, resulting in significant energy savings (The Henry Ford, n.d.).

Park 20|20

In one of McDonough + Partners most ambitious ongoing projects, the company has been designing and building a business park that will fully incorporate the cradle-to-cradle principles the firm's founder developed. All aspects of the business park will be designed by the firm, including buildings, streets, irrigation, lighting, community parks, and all other infrastructure necessary. Principal planning for the project began in 2004 and construction began in March 2010. The park is scheduled to be fully completed by 2017 (ASLA, 2010). The difficulty in the project has been in understanding how all aspects of the buildings, infrastructure, and human behavior interact in the proposed system.

The planned development, called Park 20|20, is located just outside of Amsterdam, Netherlands. The primary goals and objectives of the project were aligned to the three pillars of sustainability. Socially, they wanted to develop a business park that was united with the cultural integrity of the Dutch people. The landscape and natural areas have for centuries been a point of incredible pride for the Dutch, something that is emulated in the work of some of their most celebrated artists. The firm also aimed for the park to create social wealth with neighboring communities by creating a healthy connectivity with local communities and reducing traffic congestion through "transit-oriented development". A major goal of the environmental aspect was to eliminate contributions to climate change by creating renewable energy from on-site sources and introducing cradle-to-cradle cycles to eliminate waste while promoting health and

enhancing regional ecological systems. They hoped to promote the economic pillar by differentiating the park, leading to a greater attraction and retention of employees, and also by extending the life cycle of the buildings.

For McDonough + Partners, these goals meant taking into account numerous aspects that are generally overlooked in the planning process, such as mapping the path of the sun through the day and the year in order to determine the best placement of buildings and landscaping in order to optimize solar access for urban agriculture, energy production, and access to sunlight during winter months. They also mapped wind patterns in order to develop ventilation strategies and protection against cold in winter and humidity in spring and summer. Using aspects of permaculture, they have designed roof and interior gardens for the buildings that incorporate an ecologically diverse selection of native plant species. In adhering to the principles of cradle-to-cradle and creating zero waste, the firm has also incorporated into the business park a wastewater treatment plant to eliminate sewage discharge (Scott, 2014).

Figure 9. Master design for complete Park 20|20 project (Park2020.com, 2015)

As of 2015, many of the buildings have been completed and the park is scheduled for full completion in 2017 (ASLA, 2010). In the time since tenants have begun to move into the Park 20|20 offices, rents have averaged a staggering 80 percent above the general market, despite an ongoing real estate and financial crisis in the Netherlands. Additionally, it has been discovered that productivity of workers has increased after organizations have moved into the Park 20|20 offices. As Dutch developer Coert Zachariasse, a partner of McDonough + Partners in developing the Park 20|20 project, said in a June 2014 interview with *Newsweek*, "At a typical office building at Park 20|20 there is a multiplier of about 20 to 25 times the cost of the building itself in terms of labor." Zachariasse's multiplier is especially lucrative when considering that companies traditionally spend only a fraction on facilities as compared to personnel. Something as simple as creating a healthier environment for employees that results in each employee taking just one less sick day a year could have staggering results on the bottom line of an organization with high levels of personnel (McDonough & Zachariasse, 2014, pp. 1-7).

DISCUSSION

Sustainable planning, though several decades old, is still in its infancy and represents a key opportunity in developing more sustainable infrastructure. According to Næss, much of the available literature into sustainable planning has stressed the following factors as being key to the future of sustainable development (Næss, 2001, pp. 5-7):

1. Reduction of the energy use and emissions per capita in the area (city, municipality, or region) down to a level compatible with the ecological and distributional criteria for sustainable development at a global level.
2. A minimizing of the conversion of and encroachments on natural areas, ecosystems and soil resources for food production.
3. A minimizing of the [use] of environmentally harmful construction materials.
4. A replacement of open-ended flows, where natural resources are transformed into waste, with closed loops relying to a higher extent on local resources.
5. A sound environment for the city's inhabitants, without pollution and noise damaging to the inhabitants' health, and with sufficient green areas to give opportunities for the population to experience and become emotionally related to nature.

From Næss's analysis, it's obvious that some aspects of cradle-to-cradle are already being promoted, if not by name. Specifically, factors four and five are both indicative of the eco-effective approach in their promotion of closed-loop resource systems and the level of importance laid upon community health and culture. Though, factors one, two,

and three show the disconnection between current sustainable planning goals and other goals that might be better fitted for long-term planning, specifically goals aligned with eco-effective principles.

The very purpose of the sustainability movement is recognition that current trends of spatial expansion and resource use cannot continue indefinitely. While an equilibrium between current levels of environmental degradation and what is reasonable for the Earth will occur along the path towards eco-effectiveness, treating that equilibrium as an ideal can lead to future issues. There are two very distinct concerns that occur from treating the equilibrium as the ultimate goal of a planning project. The first is that there is no ultimate defined answer for where that equilibrium sits. The factors which affect the carrying capacity of the Earth and its ability to regenerate resources are nearly too numerous to even completely discover, much less quantify into a simple variable. But even if there was, hypothetically, a set number of tons of carbon that could be safely released into the atmosphere, the second concern is that there is no accounting for the future. Fluctuations occur, especially in something as vast and unpredictable as a city. A region would only ever meet exactly that hypothetical standard when operating within a hypothetical situation. In reality, the energy usage, emissions, degradation of land for use in food production, etc., will vary with just as many innumerable factors that affect the Earth's carrying capacity to effectively deal with those externalities.

McDonough and Braungart write that the "transformation to an eco-effective vision doesn't happen all at once, and it requires plenty of trial and error – and time, effort,

money, and creativity expended in many directions." They further write there are "Five Guiding Principles" (McDonough & Braungart, 2002, pp. 181-186) that can be utilized by designers and businesses in order to better transition to the eco-effective approach:

1. Signal your intention.
2. Restore.
3. Be ready to innovate further.
4. Understand and prepare for the learning curve.
5. Exert intergenerational responsibility.

These principles were designed to be just vague enough to apply to nearly any organization or process. In order to successfully "signal your intention", the planner must make it clear to their team, as well as the governing body employing the team, that they intend to work in a manner that reflects the eco-effective approach. The more members of a project that are on the same page concerning the ecological and social element goals, the better chance the project has for achieving those goals.

The "restore" principal encourages the planner to look for opportunities to support "good growth" over simply "economic growth". This may be difficult, especially when working with governments which will often place more importance in the cost savings opportunities in projects rather than the potential long-term value of projects with higher initial investments. McDonough and Braungart encourage the planner to consider this principle as "seeds" to be planted for the future growth of an area. They write,

> "A dilapidated neighborhood can be planted with such seeds as a new transit system, innovative ways of providing services that are not linked to waste and sprawl, water purification, the increase of green space and the planting of trees for cleaner air and beauty, the restoration of old and crumbling buildings, the revitalization of storefronts and marketplaces. On a smaller scale, buildings can be restorative: like a tree, they can purify water and send it out into the landscape in a purer form, accrue solar income for their own operations, provide habitat, and give back to the environment" (McDonough & Braungart, 2002, pp. 183-184).

In order to accept the "be ready to innovate further" principle, planners must be willing to admit that there is no perfect plan or design. Furthermore, it can be detrimental to the process to attempt to invest largely into redesigning a single idea. Innovation can't be ignored or over-emphasized as one of the most important and celebrated aspects in the cradle-to-cradle framework. In order to incorporate this principle, planners should "be open to 'feedforward', not just feedback," and seek information from all environments, internal and external.

There will be a "learning curve" in understanding how eco-effectiveness will work in the urban planning process. All projects and planners have the touch of individualism to them so that no two will ever follow exactly the same path. Each project will require extensive research and creative thinking to discover how and where eco-effective elements can be achieved. The simplest way to prepare for the learning curve is

to approach each project with a “loose fit”, designating time and resources to allow for opportunities to brainstorm innovations and experiment with alternative possibilities.

The final principle is a reminder that planners are responsible for outcomes that will last for generations. Planning is a necessarily long-term process that affects as few as one and as many as millions of people. In the case of many urban planning projects currently in process, the majority of the people that will be most affected by the development in their lifetime are not yet born. Designs should be constructed with them and a clear vision of the eco-effective future in mind.

Cradle-to-cradle has been successfully implemented into several basic manufacturing processes at this point, and experiments to create designs that apply to more complex products and architecture have been on-going. When considering urban planning practices and the incorporation of cradle-to-cradle sustainability, it will be important to note that cradle-to-cradle will apply most effectively as guiding principles. There will be few items specific to urban planning that could be tested, much less certified, for their conformance with cradle-to-cradle dynamics. It will be the theory of cradle-to-cradle that will be the most useful to urban planners, rather than the grounded practice. Planners can be most successful in utilizing the eco-effective approach by recognizing small opportunities to incorporate cradle-to-cradle dynamics into larger design projects.

RECOMMENDATIONS FOR FURTHER RESEARCH

Urban planning is an incredibly complex and rich field of study. There are numerous topics of particular interest that could fill volumes of books. This paper focused on the general approach of urban planning without committing extensively to anyone facet. The single section with concentration into land use planning is representative of an important area of the urban planning process, though ultimately one whose issues are mostly theoretical.

Further research through the perspective of cradle-to-cradle and the eco-effective approach into any one of the specific areas of urban planning would be sure to yield fascinating results. These areas might include transportation planning and what, if any, social and environmental benefits occur as a result of expansions in public transit systems; the effects of community gardens on public health; the benefits of closed-loop waste water treatment plants; ways to incorporate renewable energy production mechanisms into urban areas; or innumerable other topics that relate to all the touch points planners have in influencing the design and operations of a city.

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