DRAFT: Local Biomimicry

Transitioning a Community to Self-Reliance through Biomimicry

What would Naperville look like if it followed the biomimicry principle to be 'locally attuned and responsive' in all of its (re)designs?

The purpose of this paper is to introduce the concepts of biomimicry, or the conscious emulation of nature's genius to influence design, to the Transition Town Initiation Board and other community leaders strategically planning for the future of Naperville, Illinois. With its vibrant downtown, commuter train access to Chicago, wonderful schools, and active community, Naperville is poised to continue this positive trajectory into the future. But what about the externalities that community leaders have not planned for? How will this community adapt when cheap oil is no longer available? Using biomimicry as the basis for this discussion, Naperville's leaders will learn from nature to redesign the community and respond to the challenges of the future.

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The Intersection of Biomimicry and the Transition Town

Biomimicry is learning from and then emulating natural forms, processes, and ecosystems to create more sustainable designs. The Biomimicry Institute created a series of principles they call "Life's Principles" to describe the conditions conducive for life to thrive. These principles include:

Evolve to survive
Be resource (material and energy) efficient
Adapt to changing conditions
Integrate development with growth
Use life-friendly chemistry
Be locally attuned and responsive

This paper has focused on the principle to "be locally attuned and responsive," which describes a community that fits into and responds to the surrounding environment. Being locally focused and responsive to the environment is the focus of another initiative, currently in formation stages in Naperville, called Transition Towns. This initiative sets up a framework for creating conditions in local communities that allow them to be self-sustaining and adaptable to changing conditions, such as climate change and the end of cheap oil.[ii] Together, they ask the question – ***how can we learn from nature to design our local communities for the better?*** This paper asks four questions of nature, and then seeks to learn from its wisdom how to redesign our community:

How do we (re)design an economy to cultivate cooperative relationships?
How can local government respond to feedback loops?
How do we (re)design our community using readily available materials & energy?
How do we (re)design our food distribution to leverage cyclic processes?

How do we (re)design an economy to cultivate cooperative relationships?

In order to be self-sustaining, a local economy must develop mutually beneficial relationships among its varied interests, changing the paradigm from "winner takes all" to a spirit of working together to achieve "enough for all[iii]." This principle is prevalent among species in the natural world which have had 3.8 billion years of experience mastering their coexistence. Life had to in order to survive.

How does nature cultivate cooperative relationships?

- Squirrels eat abundant acorns in the fall and store what they can't eat in the ground around their habitat. They forget where approximately one-half of the acorns are, and through them, the Oak tree has a natural gardener that helps sew their seeds for the next spring. By sacrificing a few seeds for the squirrels, the tree guarantees the survival of its species.
- Mycorrhizal fungi (the underground network of mushrooms that look like white threads in healthy soil) and vascular plants have formed a beneficial, mutualistic relationship[iv]. The fungi[v] colonize the roots of a vascular plant, creating stable, spongy soil that holds water and minerals. The fungi feed on carbohydrates secreted from the plant while the plant feeds from the water and minerals held in the fungi. This mutualism is a win-win for both organisms.
- The cleaner shrimp, sea anemone, and the anemone's partner fish have formed a mutualistic relationship between all three organisms. The cleaner shrimp cleans detritus from off of the sea anemone, and the anemone sends out stinging compounds to keep predators away from the shrimp. The anemone has also formed another mutually beneficial relationship with one fish that picks up the scraps the shrimp leaves behind and defends the anemone from its predators.[vi] This mutualism is a win-win-win for each organism involved.

How can we learn from nature to cultivate cooperative relationships?

- Cooperative economic structures that can be used as examples for how innovative local economies are modeled include community owned credit unions and cooperatives.[vii] These structures create conditions where both the community and the individual benefit in a mutualistic relationship.
- Thinking forward, Naperville's existing infrastructure can be modified to create locally focused mutualistic relationships. For example, industrial parks can be converted into eco-industrial parks where symbiotic industries are located near each other and the waste of one becomes the input for another.[viii]
- Using the economic values espoused by the triple bottom line, where people and planet are accounted for in addition to profit, externalities such as pollution can be accounted for and decisions can be made that accurately reflect costs to all stakeholders.

By gathering together local business leaders and visionary thinkers, many more locally focused, mutually beneficial relationships can be created and nurtured.

How can local government respond to feedback loops?

Responsive government and careful planning are essential to a peaceful transition to self-reliance, and feedback loops are a system that allows for feedback and self-correction, adjusting itself according to differences between the actual output and the desired output.[ix]" A continuous cycle of information, response, and learning can amplify or dampen changes in a system for both the short- and long-term, and life has learned this. Learning from ones mistakes by adjusting their actions, one can respond to feedback loops.

How does nature respond to feedback loops?

- Pelican birds off the coasts of Florida dive into the sea to catch fish swimming in shallow waters. Most of the time, they can be seen coming up with empty mouths, but this is an example of a feedback loop. Every time a bird dives for prey and misses, he or she learns a lesson from their mistake and responds by changing tactics. With enough tweaks to their strategy, they will end up catching their dinner and be satisfied.
- The mosquito has an antenna that detects carbon dioxide, the gas warm-blooded animals exhale during respiration.[x] These antennae signal to the mosquito that prey is near and the respond by following their antennae.
- Long-term evolutionary mistakes have been weeded from the population through natural selection. Approximately 1% of the life that has been on this planet survives today. We are the success stories.[xi]

How can we learn from nature to respond to feedback loops?

- Government needs to be attuned to the needs of its constituents, actively seeking opinions, and adjusting their actions as necessary. One way to ensure that all constituents are on equal footing is the mandate of federally (or municipally) financed elections. By creating a system through which all citizens are treated equally, not according to the level of their campaign donations, the system will work more fairly and give politicians the freedom to make hard choices that plan for the future rather than merely meeting the needs of the powerful today.

How do we (re)design our town using readily available materials and energy?

Petroleum is a finite, ecologically expensive (while currently economically cheap under standard valuation) resource that dominates energy production and many of the materials we rely on. Nature, on the other hand, uses freely available and abundant materials in its material and energy production, namely sunlight, water, carbon, and found objects.

How does nature harvest and store materials and energy?

- Plants capture energy from the sun using photosynthesis to make sugar from the abundant photons given freely by the sun each day, storing it in their roots. Mammals obtain energy from

the calories in their food, and excess energy is stored chemically in the form of fat on their bodies. Life-friendly chemical energy storage using abundantly available sunlight, water, and carbon dioxide is the ideal way to store energy.

- Groundhogs stay warm in the cold winter by huddling together in underground boroughs with the rest of their colony. Tree squirrels stay warm by fledging, or growing a thicker fur coat, and by moving their nests to more protected locations. Nature finds ways to stay warm in the winter with minimal energy expenditure.
- Birds use their bodies as their mode of transportation. They obtain the energy they need for flight by stopping on known routes along the way. Nature is efficient with its transportation.
- Birds create their nests using objects found in nature, such as mud, twigs, leaves, feathers, and fur. Nature uses readily available materials for habitat creation.
- Natural materials are either organic or inorganic. Organic materials biodegrade and become fuel for future life. Inorganic materials, such as rocks and minerals, can be broken down into their component parts and used by life or reassembled into new inorganic formations.
- The abalone, a marine mollusk, creates extremely hard ceramic by self-assembling components readily available in sea water.[xii] "Heat, beat, and treat" is not necessary in nature, where chemistry is life friendly.

How can we learn from nature to redesign our energy and materials supply?

- Naperville's leaders have the opportunity to invest heavily in alternative sources of energy production in order to be self-reliant and free from dependence on foreign oil. Local, distributed energy production, such as solar electric, solar thermal, wind turbines, biomass, and methane capture are all viable energy sources that are economically feasible, especially when carbon emission costs are factored into the accounting.
- Abundant wind farms have been built sixty miles south of Naperville, but they are tied to the antiquated national electrical grid. Investment in a national smart grid that allows two-way power flow and distributed generation while remaining reliable is a national priority with a local component. Fortunately, Naperville is at the forefront of this movement having been chosen as a smart grid pilot community through the Smart Grid Initiative.[xiii] Additionally, recent ordinances that allow for distributed wind generation have provided a baseline from which we can expand our local renewable energy generation.
- Sewage treatment facilities, landfills, and livestock farms have developed a simple system to capture their methane byproduct and use it as an energy source for electricity, heat, combined heat and power, and even as transportation fuel. This is an economically viable energy source currently in use throughout the country. The added benefit of this capture is that it is not emitted into the atmosphere where it is a greenhouse gas 22 times more powerful than carbon dioxide.[xiv]
- Community leaders have an opportunity to learn from and keep abreast of breakthrough technology. For example, photosynthesis emulation has been an elusive goal for generations of scientists, but researchers at the Joint Center for Artificial Photosynthesis at Caltech have found a way to inexpensively convert solar energy to chemical fuel using sunlight, water, and carbon

dioxide.[xv] If it proves to be scalable to size, it would be a game changer in the field of renewable energy and fuel cell technology.

- We can minimize our energy expenditures for transportation by creating robust commercial centers with high-density residential housing in a central location, easily accessible by walking and biking. Multigenerational living conditions were once common and may be again to conserve energy. Naperville's downtown attracts many residents and neighboring communities, and abundant bike lanes and bike parking will encourage carbon-free transportation.
- In our predominantly heating climate, the majority of energy costs are incurred through heating homes and businesses. Design and retrofit solutions, such as passive solar heating strategies and air tight construction, have the potential minimize energy use to acceptable levels. While it does get hot during the summer, our buildings can be designed to be passively cooled with little energy input using sun shading, passive ventilation strategies, whole house fans, and super insulting walls. For extreme temperature conditions, centralized cooling centers are a lower energy way to maintain safe conditions without cooling every individual residence.
- Creating homes and businesses from found objects has been intuitive to our species prior to the industrial age, and we are beginning to reference this practice again. Web services such as freecycle.com and swap.com as well as local salvage yards are resources to allow building materials and fixtures to be reused.
- Promising work in nano-structures is being done by using genetic self-assembly to get away from the traditional model of "heat, beat, and treat." Life-friendly chemistry should be the working guideline for all material creation.
- The materials we create can emulate nature using the cradle to cradle system where "waste = food[xvi]." By separating "technical nutrients" (inorganic plastics, metals, etc) from "biological nutrients" (organic materials that can decompose, such as wood, paper, etc), we can eliminate nutrients degradation ("downcycling") until they are no longer usable. This system has been used for everything from office chairs to buildings and entire cities.

How do we (re)design our food distribution to leverage cyclic processes?

Life is beholden to the cyclic processes of the seasons and the seasonal temperature fluctuations greatly affect our food supply when viewed at a local level. When it is no longer affordable to grow kiwi in New Zealand and lettuce in Mexico to be shipped to our stores in January, we will need to again work with nature's cyclic food abundance and work within these constraints. We can then leverage these cyclic processes and take advantage of the change they bring.

How do local organisms leverage cyclic processes to find food during harsh Midwestern winters?

- The Northern Cardinal, the Illinois state bird, does not fly south and lives in the cold Midwest all year long. It survives by eating seeds, berries, and buds from native plants, in addition to the bird feeders we humans leave for them. This animal simply works with the constraints given to it by its climate and leverages them by being one of the select few who can survive the harsh conditions without expending vast amounts of energy by migrating.

- Hibernating animals, such as the groundhog, reduce their metabolism to minimal levels and sleep through the winter. They leverage the cyclic processes of the seasons by storing food in their bodies as fat during abundance and minimize the amount of calories they need during the winter when the world is frozen and food is scarce.
- Perennial plants, such as our native prairie, store sugar in their roots and gradually draw from those stores after shedding their leaves, only to regrow them the following spring. They leverage the cyclic processes of the seasons by storing abundant sunlight energy in their roots when the sun is plentiful and then shedding their solar collectors during the winter when the sun is blanketed by clouds and the light is weaker due.
- Nature has an operating principle that one organism's waste is another's food.

How can we learn from nature to redesign our food supply?

- By leveraging nature's food cycle, we will be able to reconnect with natural rhythms and combat the epidemic of obesity due to this disconnection. By eating abundant fresh vegetables and fruits during the summer and fall and storing abundance (in cellars, by canning, drying, freezing, etc) during the winter and early spring, we adjust our diet to fit the seasons. It's healthier and much less expensive when people grow their own food in backyards and garden plots. Minimizing winter food needs is natural and better for human bodies because caloric needs are less during the largely sedentary cold months.
- Three- or four-season greenhouses constructed on top of our grocery store roofs can extend the growing season and provide many vegetables year round while incurring minimal transportation costs.
- When fossil fuel is no longer abundantly available, our local farms may not be able to as easily sell commodity corn and soybeans across the globe. These planting fields have been abused by industrial agriculture for decades and they will need a great deal of support and the farmers given education to return them to their natural abundance. Composting, inoculating with mycorrhizal fungi, and restoring them to productive, agriculture prairies[xvii] to grow grain locally is potentially the highest and best use for these former fields. The grain, vegetables, and fruits grown could be used as a local commodity to trade for other goods and services.
- Co-ops and community supported agriculture[xviii] organic vegetable farms are already present in Naperville and CSA meat farms[xix] exist in farms to the north. By transitioning our farms from commodity farms to locally productive farms that support and feed our local community, we create a more self-reliant local food supply.
- We can create redundancy in our food supply by educating homeowners about permaculture and Liberty Gardens[xx] (home gardens that liberate ourselves from the industrial food supply), where homeowners learn to grown their own perennial and annual foods on their lots.
- Where feasible, homeowners should be educated about how to compost kitchen scraps for use in their planting beds or vegetable gardens. In high density areas, where backyard composting is not feasible, worm-based vermiculture or centralized compost collection in addition to garbage and recycling, is an excellent way to recycle nutrients to prepare the soil for next year's planting season.

- Chicken farming is easily accomplished in small back yards with minimal inputs. The chickens provide their caretakers with abundant eggs and occasionally their meat to add protein to the local diet. Naperville currently allows chickens in residential areas except in a 25' lot line setback. This ordinance may be overly restrictive in narrow downtown lots, but the framework exists and ordinances can be changed as necessary.

A volume of books could be devoted to this topic alone, and I have only scratched the surface with this topic in an effort to start a dialogue. It is my hope that local farmers, designers, distributors, and retailers will take this topic and work together to create a framework that works for our local economy.

Conclusions

The intent for this paper is to provide a brief overview of how the ideas of Biomimicry and Transition Towns can create a vision of Naperville, Illinois, as a self-reliant and responsive community whose economy cultivates cooperative relationships, whose local government responds to feedback loops, whose commerce uses readily available materials and energy, and whose citizens leverage cyclic process is their food consumption and distribution. Using the Transition Town framework, community leaders, local decision makers, community activists and visionaries can work together and feel empowered to start a formalized dialogue and strategically plan for the needs of the future.

Suggested Resources

Biomimicry: Innovation Inspired by Nature[xxi]. Janine Benyus. 1997.

The Transition Handbook: From Oil Dependency to Local Resilience. Rob Hopkins. 2008.[xxii]

Green Drinks – Naperville. Monthly lectures focused on Transition Naperville. 2011.

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[i] Liquid Triangle: Naturally Inspired Design is a consultancy working to integrate biomimicry and sustainability into the built environment and the design of our world. www.liquidtriangle.com

[ii] The Transition Town initiative frequently references "peak oil," but the author has eliminated that reference in this paper in favor of "cheap oil," because after the oil reserves are on the decline, natural gas will take its place. But natural gas extraction through hydrofraking is very costly environmentally. An economic structure that takes into account displaced pollution costs and the triple bottom line will more accurately address these concerns. http://www.nytimes.com/2011/03/04/us/04gas.html

[iii] Green Drinks lecture by Jodi Trendler on Transition Towns. January 2011.

[iv] http://en.wikipedia.org/wiki/Mycorrhiza

[v] Paul Stamets on 6 ways mushrooms can save the world. http://www.ted.com/talks/paul_stamets_on_6_ways_mushrooms_can_save_the_world.html

[vi] Dr. Dayna Baumeister lecture. Biomimicry's Life's Principles class for Biomimicry Professional Certificate Program. February 2011.

[vii] Dr. Dayna Baumeister lecture. Biomimicry's Life's Principles class for Biomimicry Professional Certificate Program. February 2011.

[viii] Dr. Dayna Baumeister lecture. Biomimicry's Life's Principles class for Biomimicry Professional Certificate Program. February 2011.

[ix] http://www.thefreedictionary.com/feedback+loop

[x] Dr. Dayna Baumeister lecture. Biomimicry's Life's Principles class for Biomimicry Professional Certificate Program. February 2011.
[xi] Dr. Dayna Baumeister. Biomimicry Lecture.
[xii] Dr. Dayna Baumeister lecture. Biomimicry's Life's Principles class for Biomimicry Professional Certificate Program. February 2011.
[xiii] Naperville Smart Grid Initiative. http://www.naperville.il.us/smartgrid.aspx
[xiv] http://www.nytimes.com/2007/11/13/news/13iht-renmeth.1.8311233.html
[xv] http://media.caltech.edu/press_releases/13365
[xvi] *Cradle to Cradle: Remaking the Way We Make Things* by William McDonough and Michael Braungart. 2002.
[xvii] The Land Institute. http://www.landinstitute.org/
[xviii] Green Earth Institute. Local vegetable community supported agriculture (CSA). http://www.greenearthinstitute.org/
[xix] Cedar Valley Sustainable. Meat CSA. http://cedarvalleysustainable.com/
[xx] Liberty Gardens – liberating us from industrial agriculture. www.libertygardens.com
[xxi] *Biomimicry: Innovation Inspired by Nature* by Janine Benyus. 1997.
[xxii] Transition Network. http://www.transitionnetwork.org/resources