
ON THE PATH TO MATERIAL RE-USE

Navigating the Complexity of Material Sustainability for Architectural Practice

by

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AUTHOR'S DECLARATION

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

ABSTRACT

The aim of this thesis was to understand how to define sustainability holistically, and how architecture can contribute to holistic sustainability by way of its material form. I conducted a literature review of definitions for sustainable development, looking for a holistic definition that addressed common attitudinal barriers to its practice. It became apparent that it's useful to study sustainability under a systems science framework that takes environmental, social, and psychological sustainability as interdependent variables. In accordance with this, I reviewed different approaches to material sustainability in architecture, the lifecycles of several common building materials, and the links between material industries, to establish a system-based understanding of how material sustainability can be practiced. In the latter part of my thesis I focus on material re-use as an underrepresented approach to material sustainability, and study the opportunities and barriers in practicing it, particularly in the context of Southern Ontario. I propose that a monitoring tool that draws on public data sources could relieve one barrier to using reclaimed materials by making it easier to find available sources. I find that material re-use can be an architect-driven way to practice material sustainability, it conveys a message about the problems of materialism in our society, and it provides challenging but fulfilling craft-based work.

PREFACE

Craft has been a part of my life for as long as I can remember. I have vague childhood memories of watching my grandmother knit socks from scrap wool on four needles, of learning to knit from my mom and promptly deciding to knit a bracelet in two colours—an advanced technique—by making it up as I went along. My mom told me I wasn't really doing it the right way, but let me do it anyway. Reaching even further back in my memory I even remember her using craft as a bargaining chip—I could only have my embroidery if I would give up my soother. When I was seven I joined a crochet group at my school in Russia with other young girls and became engrossed with crocheting doilies despite having no use for them. When I was nine I crocheted an owl for a school project in Canada and I don't think my teacher quite believed that I made the whole thing myself. I, on the other hand, didn't understand what the big deal was, it was just an owl I made up of oblong crocheted shapes in white and brown acrylic with googly eyes glued on. Over the years I've dabbled in many different crafts. My love of crochet slowly waned and knitting eventually became my main hobby.

Throughout architecture school I kept my craft and academic work close, but separate. It's a bit embarrassing to admit now, but I didn't really see what they might have in common. My advisor once asked why I wasn't doing a thesis that involved knitting, probably since I'm always carrying around some piece of knitting with me, and I said I just couldn't see myself doing it, I wasn't inspired by the prospect—I drew a blank at the idea. I worked on another topic that I'm passionate about—sustainability—and wouldn't you know it, I came back to craft. I guess I had to come at it from a different direction to find a place for it.

It is through craft that I began to increasingly think about different materials in terms of their provenance and performance. It is through knitting specifically that I learned hard lessons about the



Figure i.i: *The bracelet in question.*

subtle nuances of material, having made bad choices regarding fiber types only to come out with a garment that can't be styled anything like the one pictured in a pattern. It is through craft podcasts that I understood that the same things that are important to me are important to many independent fiber entrepreneurs, such as ecological sustainability, sense of community, local economy, meaningful work, and the issues of human and environmental exploitation on a global scale. It is partly through these experiences with craft that I started looking at architectural materials in the same way. It is through craft that I learned to be patient and perseverant in learning to work with new-to-me materials.

Curiously, I rarely encountered the same mindset by working in architecture. Aside from the fact that there is little opportunity for an architect to be directly in contact with construction materials, the lifecycle of materials is rarely a question. *Where does it come from? Far or near? How did it affect the people who had to make it? How did it affect the environment, what kind of disturbances did it create to ecosystems? How does it make people feel when they see it in the city or have to work and live next to it? Does it offer any delight or other psychological balm? Does it exacerbate global problems or help address them? What are the global impacts of locally using a material in your project?*

These are issues that I came to understand through food, fashion, and craft before I really understood that they exist in architecture as well. We are in an age where a multitude of questions have to be asked and considered to understand the complexity of material choices, especially if we want them to be sustainable. The only way we can be protected from greenwashing is by becoming informed. In part, this thesis is just that—informing myself about the materials we regularly use in architectural design and understanding what makes them more, or less, sustainable than others; then informing myself about approaches to material sustainability from current literature on the subject; and finally coming back to craft as a sustainable time investment which encourages intimate knowledge of material, slows

down the rate of flow of materials, and provides meaningful work and psychological fulfillment. The loop comes full circle when I discover material reclamation as an approach to material sustainability that requires craft intelligence, and which has similar challenges.

I hope that this thesis will be useful to other architects (or aspiring architects) who are sick of greenwashing and who want to address some of the ecological, social, and psychological concerns of material culture that I've identified. I hope it will inspire meaningful architectural choices that have a wider global impact.

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1 INTRODUCTION

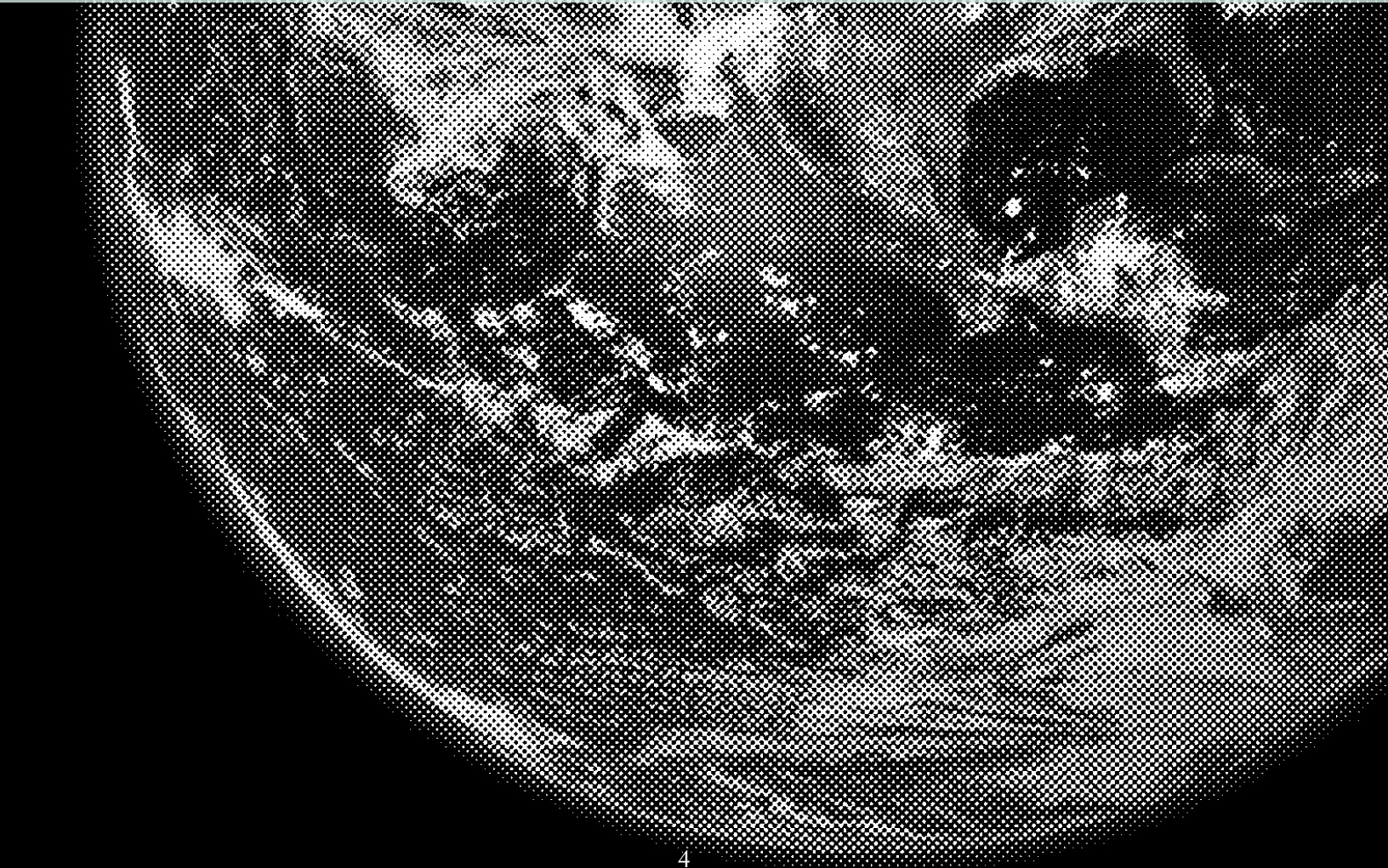
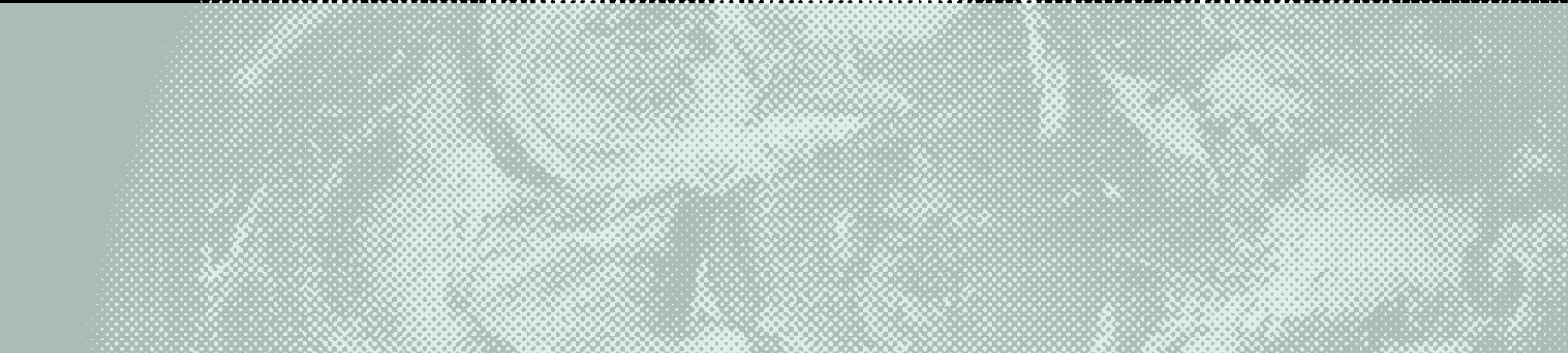
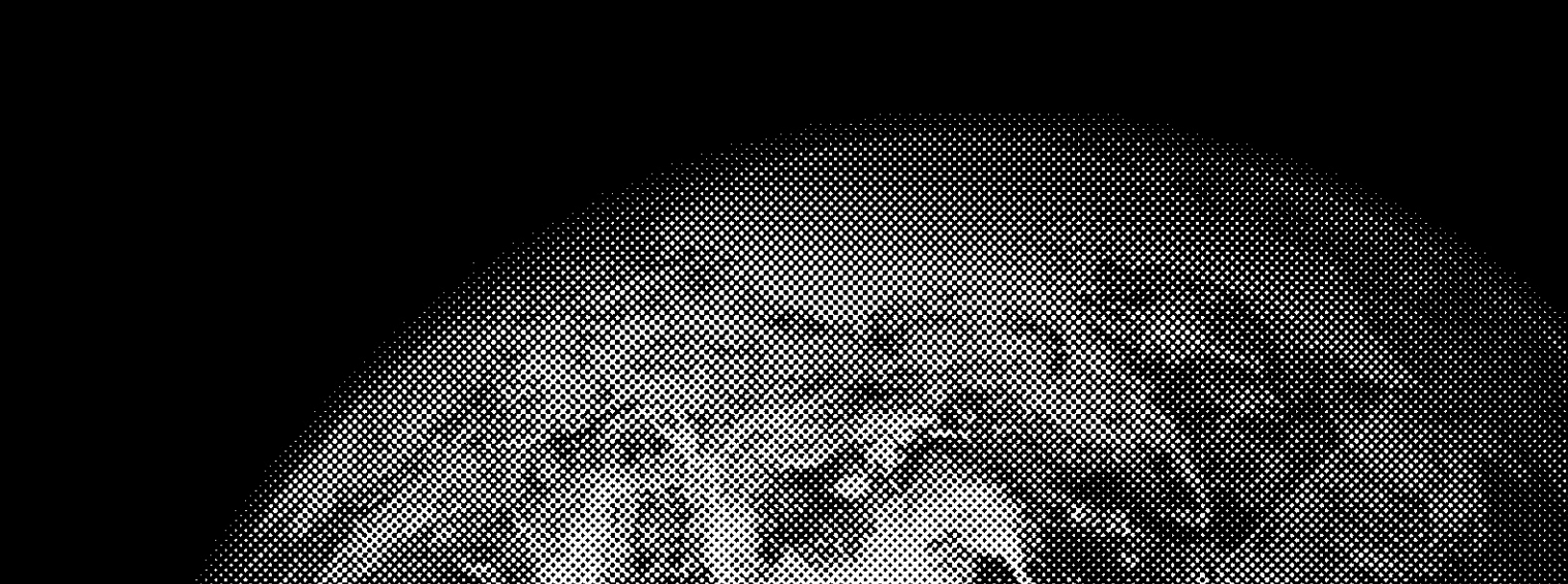
The first section of the thesis focuses on defining what constitutes “sustainable development” or “sustainable architecture” by drawing on previous literature and connecting concepts of green building, environmentalism, complex systems theory, and needs theory. It outlines why sustainability is much more than the ability to live out a balanced set of environmental inputs and outputs—namely because such a view of sustainability can become anti-humanist when it doesn’t consider that we have a range of other needs for well-being. I propose that looking for a combination of ecological, social, and psychological sustainability is necessary to make significant headway in this cause, because these three parameters are closely interrelated as a complex system; extremism in satisfying any single one is apt to damage the other two. This section ends by looking at why material sustainability specifically is relevant to architects and examines the ways in which material goods, such as architecture, do or don’t meet our needs for ecological, social, and psychological sustainability.

This thesis seeks to understand what exactly constitutes a “sustainable material” or more generally, “material sustainability.” To attempt to find an answer, the thesis looks at material sustainability in the construction industry through a holistic analysis of ecological,

social, and psychological impacts of different approaches suggested in current literature. These approaches include creation of new materials to address problems with existing materials, renewable materials, local materials, dematerialization, recycling, Cradle to Cradle, industrial ecology, design for disassembly, adaptive reuse, and material reuse. The approaches are compared and contrasted, using issues of material culture such as greenhouse gas emissions, ecosystem destruction, human health impacts, social exploitation, and psychological dissonance. Through this review, the thesis finds that materials from the waste stream have the biggest impact on the urgent need to curb greenhouse gas emissions. In particular, material reuse has the most impact because it doesn't require significant reprocessing and remanufacture. Additionally, material reuse addresses social and psychological issues of material culture, which are crucial for long-term sustainability. The thesis argues that this is because material reuse, unlike other approaches, acknowledges aspects like aging and imperfection and requires skill-based craft ingenuity to implement, fulfilling needs for competence and purpose.

The thesis goes on to explore what this finding means in architectural practice through review of reuse literature and case studies. Two major challenges are consistently identifiable: the uncertainty of sourcing reclaimed materials, and the act of putting them together in an aesthetically cohesive way. The two issues are intertwined, as a change in availability may have to lead to a change in design. Working methods are studied to learn how these challenges are currently dealt with, and the design for a digital tools that helps reduce some of the uncertainty in sourcing is proposed out of a study of the reuse industry in Southern Ontario.

The thesis concludes with some notes on the aesthetics of reuse, acknowledging that it is much different from an architecture of new materials, but arguing that there is beauty in imperfection by drawing on Japanese concepts of shibui and wabi-sabi.



PART 1 : SUSTAINABILITY

Figure 2.1: *(previous spread) Earth from space.*

2 THEORETICAL POSITION ON SUSTAINABILITY

*What is sustainability? What angles should we study it from?
How is material sustainability important?*

Sustainability is broader than green building

Sustainable and green buildings are often conflated to mean the same thing, but the two have key differences in scope. Green buildings can be defined as buildings that reduce environmental impact and consider the health and comfort of their occupants. Kwok and Grondzik, authors of *The Green Studio Handbook*, define it as:

a building, project, or philosophy based upon reducing environmental impacts related to energy, water, and materials use; green buildings respect building occupants as well as those indirectly affected by building construction/operation.^[1]

That is to say, green building embodies some degree of greater social and environmental responsibility, as well as individual comfort, though it is unclear to what extent; it is mostly focused on making reductions and improving efficiencies. The aim is to be better than average new buildings, maybe even better by a specific and measurable target, but not necessarily to question the way that architecture is conceived. The environment, and the well-being of people as animals

¹ Alison G. Kwok and Walter T. Grondzik, *The Green Studio Handbook: Environmental Strategies for Schematic Design* (Oxford: Architectural, 2007), p.341.

within that environment, are the main focus, which hints that green building falls in line with environmentalism—a “concern with the preservation of the natural environment, esp. from damage caused by human influence.”^[2]

Compare this to the definition of “sustainable” from the same source, the Handbook, and it is:

a building, project, or philosophy that is based upon allowing this generation to meet its needs without impeding the ability of future generations to meet their needs; in essence a project with no net negative environmental impacts. ^[3]

This definition is clearly derived from the definition coined in *The Brundtland Report* (also known as *Our Common Future*) in 1987, which states that sustainable development is that which “meets the needs of the present without compromising the ability of future generations to meet their own needs.”^[4] Both definitions are more precise in their environmental goal to “have no net negative impacts” and have an explicitly long-term view that asks us to figure out *how* we will ensure future generations are able to meet their needs. This remains an open-ended question, but it is understood that it is a question about multiple concerns, including not just the environment but also its relationship to economics and social well-being.^[5] Although the Brundtland definition of sustainability is often critiqued when it’s taken to mean that we should aim to sustain our current lifestyle^[6]—which is by definition unsustainable because projecting

2 Oxford English Dictionary online

3 Kwok and Grondzik, *Green Studio Handbook*, p.348-49.

4 As quoted, for example, in Jenneth Parker, *Critiquing Sustainability, Changing Philosophy* (New York: Routledge, 2014), p.22.; and Terry J. Williamson, Antony Radford, and Helen Bennetts, *Understanding Sustainable Architecture* (New York: Spon Press, 2003), p.4.

5 Kwok and Grondzik, *Green Studio Handbook*, p.15.

6 Jeremy Till, “Scarcity Contra Austerity,” *Places Journal*, October 2012, <https://placesjournal.org/article/scarcity-contra-austerity/>; says that according to the Brundtland definition “sustainability is assumed to be a matter of sustaining what we already have in terms of lifestyle and consumer behavior”

this lifestyle into the future would fail to provide for future generations—I see it as a question of what fundamental needs we actually have to meet in order to have fulfilling lives.

While green building helps us to move towards sustainability by reducing our impact on the environment, sustainability is an ongoing research endeavour which involves an analysis of the relationships between environmental and human systems.^[7] Exactly which system relationships should be studied, and how their performance should be measured, is still being explored. In fact, Jenneth Parker, a philosopher who focuses on sustainability, calls it a ‘live theory,’ which is to say that it isn’t a fully developed or fully consistent concept yet.^[8] In light of that, though this thesis critiques some approaches to material sustainability on the basis of a framework proposed specifically for this thesis, it should be noted that the aim of this critique is not to discredit as many approaches as possible but rather to compare them from a consistent viewpoint and to learn from their weak points. The fact that there are multiple theories for material sustainability in the first place is encouraging proof that there’s an attempt to address the complexity of it. However, these ‘live theories’ should be cross-examined. I will discuss some of the different parameters of human-environmental systems, and explain the ones I’ve chosen for thesis, further in this section. For the time being, I’d like to more closely address why the “human” part of human-environmental relationships is just as important as the “environment.”

Sustainability and environmentalism

“Needs theory” suggests that people need at least nine things for well-being: subsistence, protection, affection, understanding, partici-

7 Kwok and Grondzik, p.15.; Parker, p.24-25 (also p.8, which acknowledges systems thinking as a concept found throughout the book).

8 Parker, p.21.

pation, leisure, creation, identity, and freedom.^[9] Sustainability without its caveat to meet human needs other than subsistence is simply environmentalism. It's clear that sustainability is ultimately a measure of whether people are capable of interacting with the environment in a way that can be perpetuated for years to come; in fact, the goal is to find a way that can be perpetuated forever. However, as previously described, the question of *how* we meet such a goal is the big question of sustainability.

The environmentalist answer is to focus on the preservation and perpetuation of the environment. This seems like sound logic because human survival is inevitably tied into environmental stability and well-being (whereas the opposite is not true because the environment doesn't necessarily need humanity). However, this suggests that human quality of life is less important than saving the environment, or that saving the environment must happen regardless of impact on quality of life, and this leads to a couple of problems. One approach to impose environmentalism on people is to dictate what they are allowed to do and how they have to act, which is justified by the fact that it will be "for the greater good." It is tempting to say that all it would take for us to reach environmental sustainability is for our political leaders to go along with the best current science and heavily regulate industries. In fact, they could never do so because it is too contentious—the havoc from sudden sweeping regulations to eliminate environmentally unfriendly practices could be socially and economically catastrophic. It takes time for systems to change, so politicians favour an approach that leaves a range of market options, while offering incentives for those that are more in line with environmental sustainability. Instead of banning fossil-fuel guzzling appliances and machines, there are rebate programs that encourage the choice of less energy-intensive models. Similarly, on an industrial level, "cap and trade" programs allow an industry or partnership of industries to self-regulate and trade carbon credits; as long as the total allowance

9 Jackson, Jager, Stagl from Ann Thorpe, *The Designer's Atlas of Sustainability* (Washington, DC: Island Press, 2007), p.114.

of carbon emissions is not exceeded, everyone is free to work as they please, while those that emit less can improve their profits by selling unused portions of their “carbon allowance” to other companies. Another option is taxing high carbon emitters—thereby not dictating what they must do, but making them pay a price for their excesses. When these taxes are paid to the government, there is the opportunity to channel the money back into research and development of cleaner technologies and energy sources. There is good logic to pursuing such policies, since history shows us that oppressive regimes don’t end well. People, when feeling oppressed by a higher power which they presume is keeping them from a more fulfilling life, tend to revolt. In this way, prescriptive rules are likely to fail to instate even environmental sustainability because it is socially unsustainable. It further solidifies the belief that environmental sustainability results in lower quality of life. We can see how human-environmental systems are inextricably intertwined. Part of the task of creating a sustainable world then, is to respect people’s needs, such as the need for freedom, and to convince them why they might want to act more sustainably of their own free will. Financial incentive is one way, though others will be discussed.

Even when it doesn’t infringe on people’s freedom, narrow-minded environmentalism can become anti-humanist, for example by opposing famine and pandemic relief in favour of population control^[10] or attempting to preserve a pristine nature that excludes people from the land without considering their reliance on it for livelihood.^[11] Both measures undermine the human need for subsistence, while the former also undermines a need for pro-

10 Lorraine Elliott, “Environmentalism,” Encyclopedia Britannica Online, accessed August 02, 2016, <https://www.britannica.com/topic/environmentalism>. Social Ecology and Deep Ecology subheading; also Jeremy Till, “Scarcity contra Austerity,” referencing Iain Boal: “Scratch an environmentalist and you will find a Malthusian underneath’ — a reference to the Reverend Malthus’s infamous proposition that future food shortages can be only be managed through population control, particularly of the poor.”

11 Parker, p.21, 28.

tection, affection, and understanding. These anti-humanist qualities are an example of the extreme end of a philosophy called “biocentric environmentalism,” but even “anthropocentric environmentalism” (which postulates that environmental degradation is mostly a problem because of its negative effects of humans) is problematic when it goes to its own extreme and suggests that “human survival ultimately require[s] the sacrifice of human freedom,”^[12] similar to the idea of environmental absolutism described previously.

Jenneth Parker’s philosophical approach to the question of sustainability points out that it is specifically the conservationist quality of environmentalism which is problematic. In light of that, she distinguishes sustainability from environmentalism as an “attempt to harmonize environmental sustainability, human development and social equity. ... Sustainability is centrally about a positive human future in the light of our current best science.”^[13] That is to say, sustainability is an attempt to ratify both human and environmental needs, thereby reaching a compromise between biocentric and anthropocentric concerns, but instead of adopting conservationism it asks what kind of development can happen while respecting both people and environment. In fact, Parker states that inquiries into sustainable development are “not just a research programme, but a research *and development* programme,” which don’t “simply seek to find things out” but also have “an overall development aim: to develop ways of human living, consistent with ecological health, sustainable use of resources, human flourishing and social justice.”^[14]

If we can’t force environmental sustainability on people by anti-humanist means that take away freedoms, how do we convince people to make the choice to act sustainably? We can learn a lot from the practice of green marketing, which is largely to thank for re-

12 Elliott, Apocalyptic Environmentalism subheading. The text is summing up the main argument found in Robert Heilbroner’s *An Inquiry into the Human Prospect* (1974).

13 Parker, p.21.

14 Ibid., p.24.

search about the motivations that truly move people towards making sustainable choices. This is because marketing is not only a study of what people want, but also of why they want it. Findings show that the reason why people want certain things and not others is based on how well those things meet a list of tangible and intangible needs, such as the need to save money, have a high-performance object, or the desire to project a certain image, for example to be perceived as trendy, prestigious, or any number of other positive qualities.^[15] That is to say, they look for goods that help meet needs for subsistence, leisure, and identity.

Researchers find that an appeal on environmental grounds is not enough to convince a person to invest in a product. The product must show that it meets multiple needs.^[16] Take for example the design for one of the first CFL lightbulbs. Although it was marketed as environmentally friendly, and in fact did help to save energy in comparison to standard incandescent bulbs, the delivery of the product was so solely focused on environmental concerns that it failed to take into account the need to fit into existing light fixtures. Furthermore, it failed to communicate that savings in energy amount to long-term monetary savings to the buyer. “Green marketing myopia,” as the authors call it, is an overemphasis on environmental performance over customer satisfaction.^[17] It’s derived from an older term coined by Harvard professor Theodore Levitt, the more general “marketing myopia” which puts too much emphasis on product features instead

15 Jacquelyn A. Ottman, Edwin R. Stafford, and Cathy L. Hartman, “Avoiding Green Marketing Myopia: Ways to Improve Consumer Appeal for Environmentally Preferable Products,” *Environment: Science and Policy for Sustainable Development* 48 (5)(2006), doi:10.3200/ENV.48.5.22-36.

16 Ottman, Stafford, and Hartman, p.24; and P. Julio Cesar Rivera, O. Bernabé Hernandis, M. Sheila Cordeiro, and O. Omar Miranda, “Immaterial Elements as Drivers of Sustainability in Products and Services,” *Procedia CIRP* 29 (2015): 615-620, doi:10.1016/j.procir.2015.02.205.; and Manfred Lenzen and Robert A. Cummins, “Lifestyles and Well-Being Versus the Environment.” *Journal of Industrial Ecology* 15 (5)(2011): 650-652. doi:10.1111/j.1530-9290.2011.00397.x.

17 Ottman, Stafford, and Hartman, p.24.

of consumer benefits.^[18] Focusing on the feature of environmentalism made the CFL lightbulb a commercial failure, but when it was redesigned and rebranded with consumer needs and benefits in mind it was much more readily adopted. This further goes to show that the sole focus on environmentalism is unproductive—human needs have to be considered. The CFL lightbulb didn't make any positive environmental impact by simply existing as a good and scientifically sound idea; it only started to make a positive impact when it appealed to people on the basis of needs and benefits. This paradoxical relationship goes to show even further how human-environmental systems are intertwined, and why sustainable design must include both.

To take the point of environmentalism in marketing a bit further, research shows that consumers believe that products specifically marketed as environmentally friendly “require sacrifices—inconvenience, higher costs, lower performance—without significant environmental benefit,”^[19] a two-part counter-productive effect based on: first, the fact that early green products didn't perform well or were impractical for their price point; and second, the phenomenon of greenwashing whereby environmental claims actually turn out to be false. Both have contributed to a distrust in “green” or “environmentally-friendly” products, and a sense that the needs of people are not considered when it comes to environmental efforts. This extends to negatively impacting sustainability efforts, when the two terms are conflated. Ottman (et al) note that this distrust endures partly because, “often, consumers don't have the expertise or ability to verify green products' environmental and consumer values, creating misperceptions and skepticism.”^[20]

Finally, market research has shown that as much as 33% of the population is environmentally indifferent when it comes to prod-

18 Ibid., p.26.

19 Ibid., p.25.

20 Ibid., p.31.

uct decisions, and only 9% actively seek out and buy green products regularly.^[21] It remains true that the environmental argument appeals to a small niche market, while “the vast majority of consumers, ... will ask, ‘If I use “green” products, what’s in it for me?’”^[22] However, this doesn’t mean that there can’t be greater adoption of environmentally-friendly and sustainable products when they deliver on a more holistic set of needs. One study finds that sustainable development does not mean that a sacrifice in happiness is necessary from the current generation.^[23] Another study finds that “sustainability transitions will be easier to implement if they also increase individuals’ well-being.”^[24]

Environmentalism is important to the degree that it focuses on making sure of human survival. However, it is not suitable to define long-term sustainability solely on this basis, as people prove that the need for subsistence is only one of many needs. Furthermore, these needs don’t have a strict hierarchy, as demonstrated when people go on voluntary hunger strikes to make a point out of spiritual or intellectual beliefs.^[25] People can and will seek ways to meet needs other than survival, and if this is not possible within environmentally-friendly means then they may very well be ignored or subverted.

The parameters for sustainability

By now it will have become clear that human and environmental systems are closely interlinked, and that sustainable design has to meet the needs of both. There is a plethora of theories on sustainable design which attempt to categorize these needs as components

21 Ibid., p.35.

22 Ibid., p.24.

23 supported by Aleksander Zidarsek, “Sustainable Development and Happiness in Nations,” *Energy* 32 (6)(2007): 891-897. doi:10.1016/j.energy.2006.09.016.

24 E. Verhofstadt, L. Van Ootegem, B. Defloor, and B. Bleys, “Linking Individuals’ Ecological Footprint to their Subjective Well-being,” *Ecological Economics* 127 (2016): 80-89, doi:10.1016/j.ecolecon.2016.03.021.

25 Thorpe, p.114.

integral to the idea of sustainability, which makes it possible to set up goals and to enable compartmentalized research and action plans. The most basic categorization is into material and immaterial systems, which reiterates the idea that sustainability deals with the way that the physical environment, and the socially-imposed structures that govern our relationship to that environment, are interdependent. Another common way to break down sustainability into components is to say that it is at the intersection of the triad of viable ecology, economy, and society. Others speak of a tetrad of ecology, economy, policy, and culture.^[26] In *Critiquing Sustainability, Changing Philosophy*, Jenneth Parker speaks of five ‘knowledge domains’ pertinent to the study of sustainability: cosmological/atomic, ecological, social-ecological, social-institutional, and cultural. Others speak of six dimensions^[27] and upwards.^[28]

When framing this thesis I first considered the dual split between material and immaterial to be most succinct and complete set of considerations which can be used to structure a discussion on material sustainability. These two categories are capable of hosting more specific subconsiderations such as resource use and ecosystem impact (material) as well as politics, economics, and culture (immaterial). However, there is another subdivision that gave me pause, and that is Felix Guattari’s idea of *The Three Ecologies*: nature, psyche, and socius. Guattari is both a philosopher and psychoanalyst, so it makes sense that his view of the world explicitly acknowledges the role of

26 Circles of Sustainability, as developed by Paul James for the UN Global Compact Cities Programme. See “Circles,” Circles of Sustainability, accessed August 03, 2016, <http://www.circlesofsustainability.org/circles-overview/>; and “About Our History,” Circles of Sustainability, accessed August 03, 2016, <http://www.circlesofsustainability.org/about/about-our-history/>.

27 environmental impact, health and safety, quality in process and product, human rights, business ethics, and economic development; from: “Welcome to 6DS - Tools for Sustainable Development,” 6DS - Six Dimensions of Sustainability, accessed August 03, 2016, <http://www.6ds.se/>.

28 spiritual, human, social, cultural, political, economic, and ecological; from: “Seven Dimensions of Sustainable Development,” Environmental Technologies, accessed August 03, 2016, <http://greentechninnovations.blogspot.ca/2010/07/seven-dimensions-of-sustainable.html>.

the individual psyche, which is missing in other divisions. Although the presence of “culture” in other categorizations begins to touch on the psyche because culture is communicated through implicit “value-loaded images of the world”^[29] as opposed to explicit messages, culture is actually an element that acts upon the psyche. Culture itself is socially and environmentally constructed, and its effects on the psyche can range from positive and empowering to negative and suppressive.^[30] This is to say that culture can be problematic and can be part of the obstacle to achieving sustainability depending on how it acts on the psyche. And although the psyche does fall under the immaterial category, it is likely to get lost in a milieu of broader considerations about social structures. Some needs have to be met as much on the individual level of the psyche as on the larger scale of the society, such as needs for affection, understanding, creation, identity, and freedom. Furthermore, any grassroots social change is going to start on the level of individual psyches—just as society and environment are interlinked and interdependent, the psyche and society are too.

Guattari presents the argument for these interdependencies, pointing out that: whatever happens in the environment affects us psychologically; individual psyches make up social structures which decide what to do with the environment; and again, what we do to the environment comes back to affect us psychologically and socially:

If today, human relationships with the socius, the psyche, and ‘nature’ are increasingly deteriorating, then this is attributable not only to objective damage and pollution but to the ignorance and fatalistic passivity with which those issues are confronted by individuals and responsible authorities. ... The withering away of social praxis ... [is due to] a widespread incapacity to perceive the erroneousness of partitioning off the real into a number of

29 Parker, p.25.

30 As supported by Estes’ comments on culture’s influence on women specifically, in Clarissa Pinkola Estés, *Women Who Run with the Wolves: Myths and Stories of the Wild Woman Archetype* (New York: Ballantine Books, 1992), p.204, 226-7.; depending on culture, the feminine can be celebrated or suppressed.

separate fields. It is quite simply wrong to regard action on the psyche, the socius, and the environment as separate.^[31]

Because of this three-way interdependence, the psyche is key to forming, and changing, the social systems which impact our environmental systems, such as policies and economics. On this basis, Guattari coins the term “ecosophy” which posits that nature, society, and psyche are all ecological.^[32]

The psyche is susceptible to being subconsciously affected through message-laden imagery such as that used in marketing, and this can be used both to undermine or progress sustainable causes.^[33] For example, due to the fact that sustainability and environmentalism are cause for popular concern, they represent a possible barrier to people’s purchasing habits; buying too much “stuff” can make us feel guilty because we know consumerism isn’t very good for the environment; however, “business as usual” markets operate largely on consumerism; the two together create a cognitive dissonance that marketers try to overcome by “building in” social consciousness that ultimately undermines goals to be more sustainable. This is a problem to look out for specifically for material sustainability.

The link between environment and psyche is now beginning to be described by a field known as ecopsychology. This subfield of psychology posits that the negative impacts we see in the environment lead to deep-seated psychological pain, and whether this pain is repressed or simply undiagnosed it still takes its toll on human well-being.^[34] This is particularly plausible because the industrial revolution, which has led to widespread environmental change

31 Felix Guattari, “The Three Ecologies,” translated by Chris Turner, *New Formations* no.8 (Summer 1989): 134.

32 Félix Guattari, *The Three Ecologies* (New York: Continuum, 2008), p.19.

33 Marketing here is taken to have “neutral” value, seeing as it can be used both to advance to sustainability as well as to act against it, all the while possibly not mentioning sustainability in either context.

34 Daniel B. Smith, “Is There an Ecological Unconscious?” *The New York Times*, January 27, 2010, http://www.nytimes.com/2010/01/31/magazine/31eco-psych-t.html?_r=1.

and often destruction, is very recent in the history of the human race;^[35] it may very well be that it has taken over a hundred years for the effects of industrialization to become prevalent enough, and affect enough people, to finally be noticed and given a name. Glenn Albrecht is a professor of sustainability at Murdoch University in Perth who specializes in ecopsychology and has coined the term “solastalgia” to describe “the pain experiences when there is recognition that the place where one resides and that one loves is under immediate assault ... a form of homesickness one gets when one is still at ‘home.’”^[36] He created the term to describe the anxiety and unease felt by residents of the Upper Hunter Valley in Australia, who experienced a sharp increase in coal mining activity in their region that made them feel displaced, like their home was not their home anymore.

Perhaps solastalgic pain is also the root of the anxiety and depression reportedly felt by climate change researchers, who must be wary of showing such emotions for fear that they will be viewed as irrational scaremongers.^[37] These emotions present a very real psychological challenge when considering how to proceed on the matter of climate change. It can be very tempting to give up, to live knowing the truth and even contributing new knowledge to it but not actively doing anything about it—this is the route of hopeless apathy. It can also be tempting to create a psychological safety net and refuse that a problem exists because that way you don’t have to deal with it, and you don’t have to consider the risks of present actions for the future; you can keep doing what you know instead of facing uncertainty—this is the path of denial. It is also possible, but perhaps the most challenging, to come to terms with it long enough to consider creative strategies that can incentivize positive change—this is the path

35 Thorpe, p.120.

36 Smith, “Is there an ecological unconscious?”.

37 John H. Richardson, “When the End of Human Civilization Is Your Day Job,” *Esquire*, July 11, 2015, <http://www.esquire.com/news-politics/a36228/bal-lad-of-the-sad-climatologists-0815/>.

of hopeful optimism combined with pragmatism. The latter, which I suggest is the most desirable, is as E. F. Schumacher puts it, “as simple as it is disconcerting: we can, each of us, work to put our own inner house in order.”^[38] An important element here is that although changing the way we do things represents risk, there is a much larger and more long-term risk if we don’t do anything.

With regard to the relationship between psyche and socius, it is widely acknowledged that cultural structures can strengthen or diminish psychological health.^[39] We are social creatures that pick up on behaviours, attitudes, and feelings of the larger milieu. In cases where these only diminish health they may become “complexes” that an individual then has the work of uncovering and healing in order to live a happier life. So it is that we can pick up behaviours from the socius that only exacerbate psychological pain from a poor connection to nature and from consumerist economic structures that drive social inequality; at the same time, it is also possible to pick up behaviours that heal solastalgia when we witness and experience more sustainable ways of living.^[40]

Resolving psychological needs is important in striving for sustainability. If sustainable solutions don’t meet these needs, it will not be truly sustainable as people look to other means to have their needs met. Social norms and consumer behaviours take time to change, but this change begins with people who find that a new way of doing something meets their needs better than another way. In

38 E. F. Schumacher, *Small Is Beautiful: Economics as If People Mattered* (New York: Harper & Row, 1973), p.281.

39 for example, from Estés makes the point about the celebration or suppression of the feminine in a society; in the context of this thesis I propose that the necessity of a healthy relationship to nature can also be celebrated or suppressed by society.

40 This idea connects to findings in studies of social networks that measure, for example, happiness, and find that happy people can influence others to be more happy. The reverse is also true, unhappy people can influence others to be more unhappy. It has also been found to be true with physical well-being. The determinant might be the characteristics of the social group around you.

this way, the socius and psyche are central to a holistic definition and successful execution of sustainability projects.

Sustainability, systems, and complexity theory

By now, I have made several references to components that contribute to sustainability as interdependent—ecological sustainability is dependent on social and psychological sustainability if it going to be perpetuated for generations, and likewise social and psychological sustainability depend on ecological sustainability for survival and a rooted sense of place. We depend on the environment as mammals who are nourished by it, but the environment also increasingly depends on us in terms of how ecologically friendly or hostile our actions are. This quality of interdependence means that sustainability can, and should, be considered from a systems perspective. Donella H. Meadows defines a system as “a set of elements or parts that is coherently organized and interconnected in a pattern or structure that produces a characteristic set of behaviours, often classified as its ‘function’ or ‘purpose.’”^[41] Put more succinctly, “a system must consist of three kinds of things: elements, interconnections, and a function or purpose.”^[42] The world with which sustainability is concerned with is a system, but what is its purpose? Purpose is determined by behaviour, and “an important function of almost every system is to ensure its own perpetuation.”^[43] As much as people want to ensure their perpetuation, so does—in a manner of speaking—the environment, and changing weather patterns are one indication that the planet is trying to adapt. The fact that we are even discussing sustainability is a sign of trying to ensure our perpetuation, the caveat being that we don’t want simply to exist, we want to exist with a good quality of life, which brings social and psychological concerns into

41 Donella H. Meadows, *Thinking in Systems: A Primer*, edited by Diana Wright (White River Junction, VT: Chelsea Green Pub., 2008), p.188.

42 Ibid., p.11.

43 Ibid., p.14.

the mix of considerations alongside environmental balance. A good quality of life, therefore, is part of our social systems' purpose, and it's evidenced by our constant attempt at progress. We tend to innovate to try and make our lives better in some way, which is a clue that the cause for sustainability can't be based solely on fighting negative circumstances but also has to be about finding ways to improve our lives without the negative ecological impacts usually associated with societal development. In this thesis on material sustainability, this means looking at what kinds of needs material goods meet, and whether those could be met better, without compromising the environment. In defining something as sustainable or not, it is seen as crucial to make sure that ecological purposes don't clash with the human pursuit to a high quality of life but coexist productively.

Complexity theory is complementary to systems theory when it comes to an issue like sustainability. Systems theory acknowledges that relationships between actors (components of a system) are important to the behaviour or function of the system. Complexity theory deals with complex systems: systems that have a moderate to large number of variables (or actors) with nonlinear interactions which result in dynamic and emergent behaviours that are often difficult to predict.^[44] This is to say, there is no one formula that describes the behaviours, nor is it possible to take an "average" behaviour and predict an outcome.

The question of complexity has been with us at least since 1948, when Warren Weaver coined the term "organized complexity" to contrast against simple problems and problems of "disorganized complexity" (which are most relevant to thermodynamics). The defining characteristic of organized complexity is that the relationships of actors (either beings, or objects, or other entities) to each other matter in order to make any conclusion about possible outcomes; by contrast, these relationships don't matter in disorganized complexity which allows us to use averages to make good predictions, and these

44 *Unit 1: What Is Complexity?—Introduction to Complexity*, by Melanie Mitchell, Complexity Explorer, accessed 2014.

relationships are very few and simple when it comes to problems of simplicity (such as the simple relationship of few variables that we can find in Newtonian physics).[45] To consider the question of sustainability holistically means to look at it as an organized complexity.

Not all complex problems are equally complex. It has been suggested that a global problem that is influenced by an especially large number of actors—such as sustainability—is “wickedly” complex.[46] This means that in addition to exhibiting dynamic and emergent behaviour, wicked problems don’t have any one perfect solution that we would be capable of finding, but rather a range of *better* and *worse* ones.[47] Wicked problems are also so unpredictable that “the next day’s consequences of the solution may yield utterly undesirable repercussions which outweigh the intended advantages of the advantages accomplished hitherto.”[48] Every attempt at solving the problem counts because it has some degree of irreversibility.[49] It is important to make a good quality judgement on whether a solution is better or worse, and in order to do this I propose that we have to analyze its effects in a multitude of domains as holistically as helps to describe the problem. For the purpose of this thesis I suggest that this can be done through the lenses of ecology, psyche, and society with a focus on meeting the *needs* of each system[50] as best as we can tell from current science. As stated before, these are all important considerations in striving for sustainability due to their interdependent nature.

45 Warren Weaver, “Science and Complexity,” *American Scientist* 36 (1948): 536-44.

46 Horst W. J. Rittel and Melvin M. Webber, “Dilemmas in a General Theory of Planning,” *Policy Sciences* 4, no. 2 (1973):160, doi:10.1007/bf01405730.

47 Ibid., p.162-3.

48 Ibid., p.163.

49 Ibid.

50 e.g. limiting carbon emissions, keeping ecosystems intact, psychological well-being, economic well-being, social justice, etc.

A couple of concepts from complex systems have been especially useful in formulating this thesis: the idea of “the edge” of chaos,” and the process of system feedback.

Complexity science tells us that systems flourish “at the edge of chaos,” and not in complete order or complete chaos.^[51] The latter is fairly easy to understand because complete chaos is self-destructive. The former is less straightforward, but the reason why complete order isn’t very productive is because it lacks any redundancy; it is a “perfect” state, but its lack of imperfections also makes it “brittle”—more likely to have a catastrophic response to change.^[52] Variety and imperfection provide the necessary redundancy so that if/when conditions change, a minor player may have the qualities needed to innovate and flourish. Essentially, diversity is important for adaptability because it allows certain behaviours to emerge and dominate under specific conditions. This concept is as important culturally as it is ecologically. In *Understanding Sustainable Architecture*, Williamson (et al) word this idea well: “Maintaining ... cultural diversity must be seen as an integral component of a sustainable architecture, because history would seem to show that variety among human societies is the source of adaptation and of innovation.”^[53] This idea carries through to analyzing different approaches to material sustainability in this thesis. Although I critique the weak points of some approaches, as a system their variety provides resilience. And so, the aim of this thesis is not to suggest that there is one best solution, but to consider strengths and weaknesses to start to identify the roles of these varying strategies in the larger scheme of material sustain-

51 *Unit 6: Cellular Automata—Introduction to Complexity*, by Melanie Mitchell, Complexity Explorer, accessed 2014.

52 Robert B. Northrop and Anne N. Connor, *Ecological Sustainability: Understanding Complex Issues* (New York: CRC Press, 2013), p.399: “A system in equilibrium does not have the internal dynamics to enable it to respond to changes in its environment and will die ... A system in chaos ceases to function as an organized system. The most productive state to be in is at the *edge of chaos*, where there is maximum variety and creativity, leading to new possibilities of behaviour.”

53 Williamson, Radford, and Bennetts, p.89.

ability. There is an understanding that sustainability is more likely about nimble adjustments and options that allow a state of dynamic equilibrium rather than a completely static state; I expect that the parameters that feed into choosing a solution will develop in time, which will require adjustments and new methods. For now, there is the current state of social, environmental, and psychological affairs which implies a question: is there an approach that addresses current problems in these domains more holistically than other approaches? The section on identifying current issues related to material culture will set specific concerns for analysis.

The second concept which has been informative is that of feedback, which is also directly related to adaptability. Feedback is “the interconnections, the information part of a system.”^[54] It is present when the levels of stock inform its own flow in a system. “Balancing feedback loops” help a stock stay in a specific range, while “reinforcing feedback loops” tend to create growth or quick collapse.^[55] The stocks can be things like money, energy, and atmospheric CO₂. Systems, especially complex systems, have many feedback loops, and behaviours often arise (or “emerge”) as the relative strengths of feedback loops shift thereby changing the dominant behaviour of a system.^[56] Dynamic equilibrium is the point at which feedback loops balance out but things are still happening in the system.

I have discussed how sustainability can be defined by the interconnected nature of environment, society, and psyche, and how this quality of interconnectedness shows them to be part of the same system. Feedback has the role of binding these components together to make them interdependent, and it can be physical or nonphysical. “Many of the interconnections in systems operate through the flow of information. Information holds systems together and plays a great

54 Meadows, p.30.

55 Ibid., p.27-32.

56 Ibid., p.45. i.e. there can be shifting dominance among feedback loops

role in determining how they operate.”^[57] This is bound together with the fact that “the least obvious part of the system, its function or purpose, is often the most crucial determinant of the system’s behaviour.”^[58] The function or purpose can be used to interpret the information feedback in a system and evaluate it to determine a mode of action. Feedback is crucial to meeting system purposes because it enables appropriate adjustments in behaviour. Similarly, system purposes determine what kind of feedback is taken to affect behaviour. Meeting basic needs is a purpose—and as discussed previously this includes subsistence, protection, affection, understanding, participation, leisure, creation, identity, and freedom—but the feedbacks become more complex when profit-seeking growth enmeshed with production of material goods is sought to increase quality of life, for example; the negative unintended consequences on social equity, environmental health, and psychological well-being of such a purpose are just now beginning to be widely understood. In that light, I’ve suggested that the purpose that defines sustainability is based on considerations for both human and environmental needs.

It’s important to understand feedback in sustainable design on multiple scales, because when it isn’t built into a design or isn’t used for learning and adaptation, sustainable designs fail. This can happen both because a designer made an inappropriate assumption about the use of space, or because the occupant was ignorant of how to make the most of the design. Designers could make more use of post-occupancy feedback to learn from their (and others’) designs, which will tell them where design intentions go awry. At the same time, occupants of spaces might require more tangible feedback to let them know when their behaviours are counter-productive.

Collective intelligence is also a form of socially-accepted action in response to certain kinds of feedback. We can learn from other cultures about the ways they achieve certain purposes, such as techniques for staying warm in winter and cool in summer. This is

57 Ibid., p.14.

58 Ibid., p.16.

not to say that it is always appropriate to “import” these strategies, but they’re useful sources for reflection.

When it comes to green building, the interconnections between different strategies are important for understanding synergies and mutual exclusions, and this should be used to make judicious tradeoffs that are specific to each project. Attempting to paste all green building strategies together regardless of how they will interact results in a “Frankenstein”^[59] design in which the parts don’t work well together, and don’t create a well-functioning system. With regard to sustainable design, the interactions between green building strategies and the occupants have to be considered, to ensure that there’s adequate feedback for them to work as a system.

Two examples where parts of a design don’t work well together are with regard to solar heat gain. Solar heat gain is a primary green building strategy in cold climates. It is used in many designs across all building types in an effort to cut down on the need for energy to heat a building. However, it often doesn’t have as much beneficial impact as designers expect because occupants don’t behave in ways that maximize energy gain. For example, they might draw the blinds because there’s some glare from the sun, which means that the sunlight never hits the concrete floor that was designed to absorb the solar radiation; or perhaps they’ve covered the concrete with carpet or wood. The occupant doesn’t necessarily know that what they’re doing isn’t good because there isn’t any serious consequences or tangible feedback; even energy efficient passive houses are designed with mechanical means of regulating temperature as a back-up. Multiple case studies show us that solar heat gain hasn’t been as effective as the designer had intended, but it appears that designers keep doing the same things, and occupants keep making the same “mistakes.” There is a need to incorporate feedback into an adaptive strategy both from the point of design and of occupancy. There is a need for an ongoing discussion when green building strategies don’t work out so that a more sustainable solution might be found. There is nothing wrong

59 Parker, p.159.; reference to “Frankenstein Interdisciplinarity”

with the concept of solar heat gain, but there might be better ways to integrate it with occupants needs.

A second example that shows a misunderstanding of the tradeoffs in green building parameters comes from Palette 2030. This is an online manual made by the creators of the Architecture 2030 Challenge, which is aimed at the creation of carbon neutral architecture by the year 2030. The Palette is well-intentioned, but its page on solar heating through direct gain is paradoxical. It suggests that the further north you go, the higher percentage of glazing you should have to maximize solar heat gain. The fact that walls are much better at keeping in heat than glass is acknowledged only in a footnote that suggests that insulating blinds should be used at night. However, it still misses a crucial relationship between hours of sunlight and time of year: the further north you go, the more you will find long and cold winter nights that outweigh daytime sunshine; in the time that you most need solar heat gain, you will be least likely to get it. This isn't viable system logic. Furthermore, it suggests that you find glass that has a high solar heat gain coefficient *and* a low U-value;^[60] as I discovered when trying to design an energy efficient building during my Bachelor degree, this is an unlikely combination—it is usually a tradeoff between the two.

Conclusion

Sustainable design is an idea that encompasses broader concerns than green building or environmentalism because it conceives of the world as a set of interdependent systems. For the purpose of this thesis, these systems are said at minimum to be the natural, social, and psychological. Sustainability is a question about how we can ensure that we can meet the needs of future generations, and what those needs are to begin with. It does not take the status quo of the way that nat-

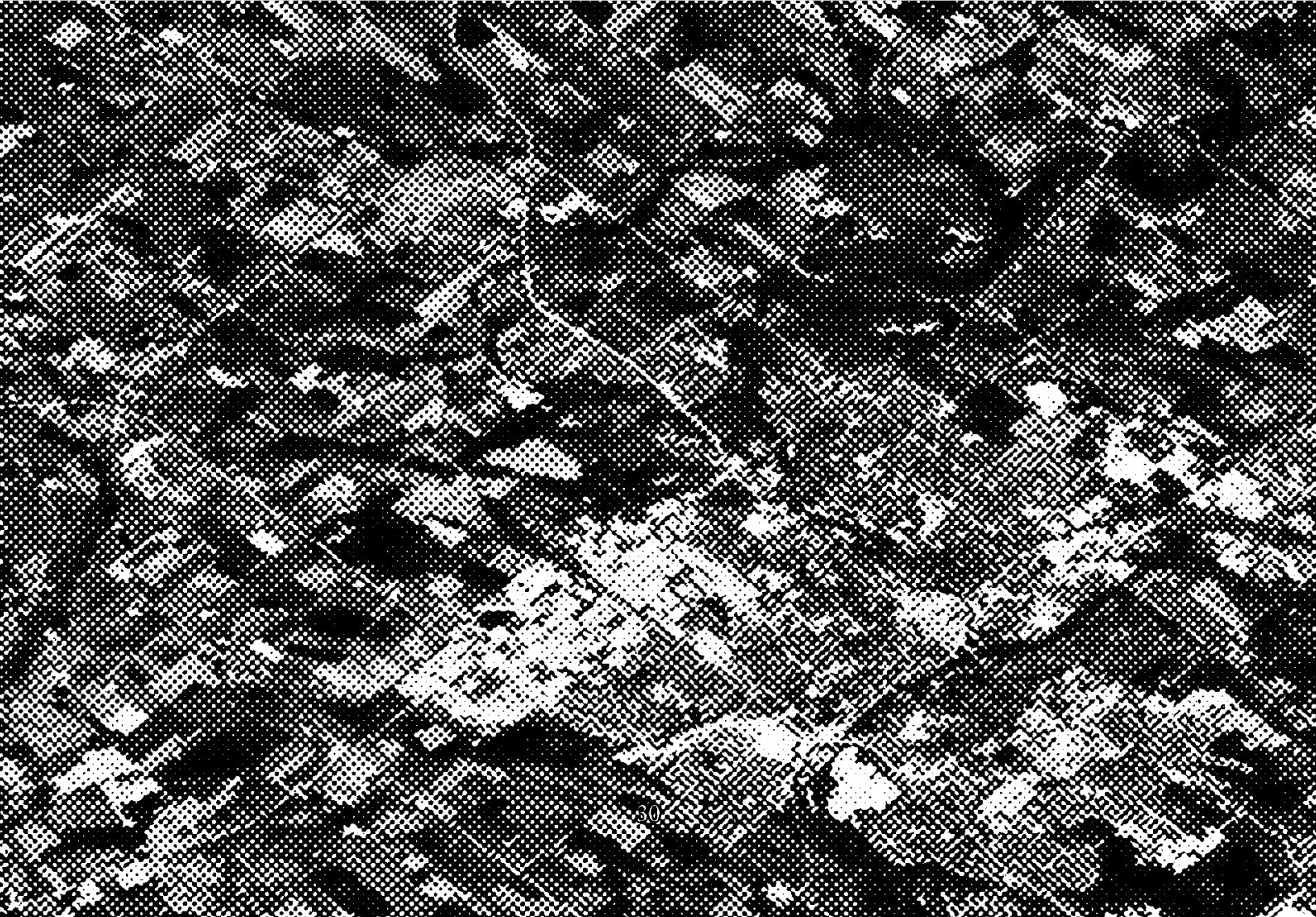
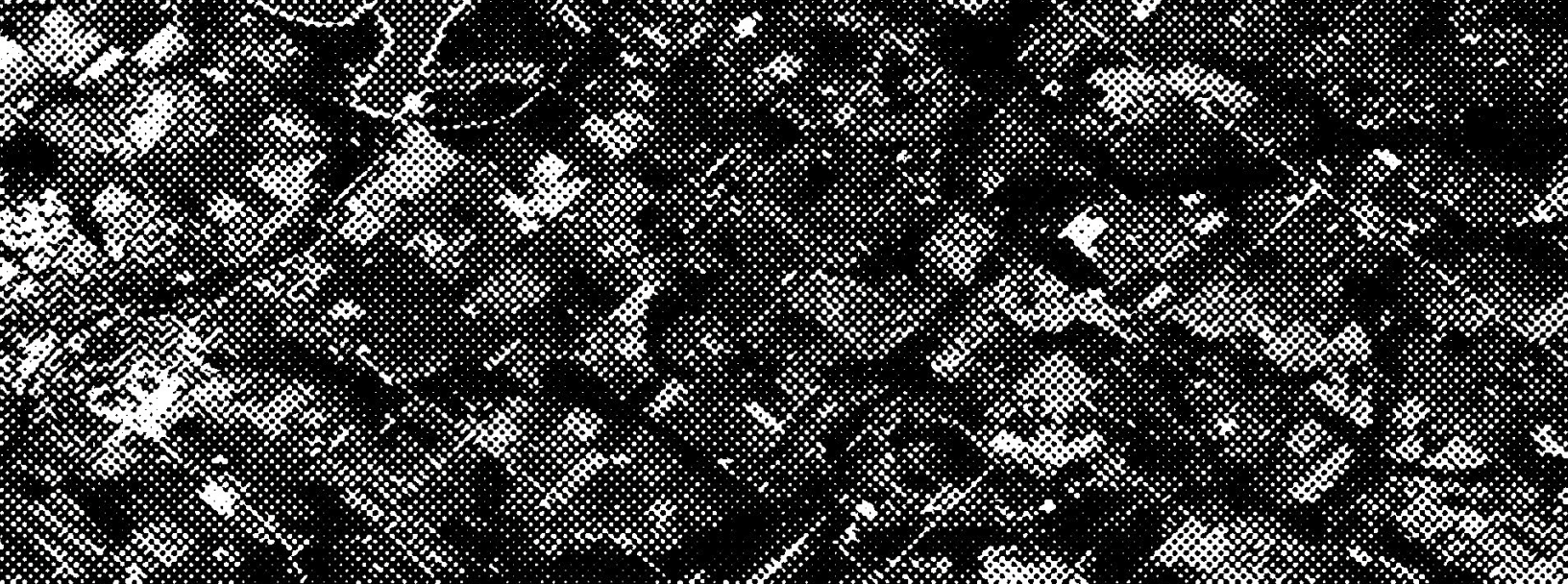
60 Architecture 2030, "Sizing Solar Glazing," 2030 Palette: Design and Planning Strategies for the Next Built Environment, Today, accessed August 10, 2016, <http://2030palette.org/swatches/view/direct-gain-glazing/sizing-solar-glazing>.

ural, social, and psychological system attempt to meet their needs as a baseline for what should be perpetuated, but asks if there are ways to fulfill those needs more synergistically.

By taking a broader range of concerns, sustainability attempts to harmonize human-environmental relationships. Instead of trying to save the environment (and ourselves) through conservationism, it asks how we can save it through cooperative development that recognizes interdependencies. By doing so, it has the potential to reach sectors of the population who have come to see environmentalism as meaning a lower quality of life, and those who don't believe that the environment is in serious danger. The three-way interdependence of society, psyche, and environment as described in this thesis indicates that a high quality of life is dependent on the environment, which may help to be optimistic about planning sustainable action in the face of uncertainty.

Systems theory is referenced to further support the hypothesis that psyche, society, and environment are key system components that make or break sustainability goals because of their interdependence. The variety and diversity of ideas we're experiencing the development of the "live theory" of sustainability is recognized to contribute to system adaptability, and may be especially important in light of sustainability as a wicked problem that doesn't have a clear "best" solution. Finally, feedback is understood as the mechanism that makes it possible to implement successful solutions and to be able to adapt if our initial solutions prove not to be very successful.

The next section will explore how material sustainability in particular highlights many of our issues with regard to trying to meet environmental, social, and psychological needs, and why this is relevant to sustainable architecture.





PART 2 : MATERIAL SUSTAINABILITY

Figure 3.1: *(previous spread) Aerial photo of Southern Ontario.*

3 MATERIAL SUSTAINABILITY

Why is it important to study material sustainability?

A lot of discourse in sustainable architecture currently focuses on operational energy, water conservation, and (more recently) food security, while discussion of buildings as artifacts that take energy to create and eventually dismantle remains marginal. There are good reasons for focusing on energy, food, and water, since: operational energy of buildings makes up a large percentage of all energy used annually, thereby contributing carbon emissions and driving climate change; and food and water are basic subsistence needs that are threatened by climate change effects such as desertification, as well as by land speculation and environmental pollution.

However, in marginalizing the discussion of the material form of architecture with regard to sustainable design, we fail to give due attention to the way that built form—in and of itself—can shape and reflect cultural paradigms, including sustainability. This is to say, material form can address both the cultural question of how materiality can contribute to the social and psychological sustainability of architecture, as well as an ecological question of how architecture can be practiced with respect for the environment. It is this dual interest

that informs an analysis of different approaches to material sustainability, as well as different materials, in the next chapter.

Materiality carries associative meanings or messages, which means that it can potentially play the role of “feedback” in sustainable architecture by communicating issues back to the society that has created them or even showing how those issues might be resolved. Since materials can carry cultural meaning, they fall under what Parker refers to as “value-loaded images of the world” that “[help] people make sense of the world,”^[61] which implies that they can impact how people use ecological resources and how they treat their natural context by communicating a particular view of the world. The effect of communicating through materiality can be bigger than just its ecological impact if it starts to influence other social spheres, such as economics, patterns of energy use, and patterns of urban development. A focus on materiality may help to overcome issues of materialism and negative perceptions about living sustainably.

Pallasmaa addresses the fact that architecture communicates identity:

Buildings, structures, and cities are constructed material images of our view of the world, belief systems, and fears, as well as of ourselves, as much as they are practical devices. The interplay or, better, total fusion of the mental and material dimensions of life is usually disregarded when thinking of architecture. We tend to forget that every human construction, beautiful or ugly, reasonable or outrageous, always originates in the human mind.^[62]

When we begin to see different constructions of “ourselves” in the world, it contributes back into forming our own identities. We form identities through interactions with the external world, including

61 Jenneth Parker, *Critiquing Sustainability, Changing Philosophy* (New York: Routledge, 2014), p.25.

62 Juhani Pallasmaa, “Architecture and Human Nature: A Call for a Sustainable Metaphor,” in *Local Architecture: Building Place, Craft, and Community*, ed. Brian MacKay-Lyons and Robert McCarter (New York: Princeton Architectural Press, 2015), p.34.

urban environments and social interactions, not in isolation.^[63] The visual, material presentation of sustainable architecture has at least as much a role in creating a more sustainable future as its ability to save on energy, conserve water, or grow food.

What are important issues/relationships in material sustainability that affect ecology, psyche, and society?

A driving factor for our problems with material culture may stem from the fact that new things bring a brief thrill, a feel-good reaction, and thus novelty can become the coping mechanism for much deeper-rooted problems ranging from unhappiness with one's job, to the pain of solastalgia, to the fear of an uncertain future in a world of scarcity. Marketing can choose to exploit this feel-good reaction by helping to convince us to, indeed, buy more new things, thereby perpetuating the problem.

Scarcity in particular is a pervasive social problem that affects us on all levels: ecologically, socially, and psychologically. Ecologically, a very real source of scarcity is the fact that we're running out of fossil fuels. However, this one source of scarcity makes itself felt throughout the rest of our lives. Psychologically, scarcity becomes a constant feeling of never having enough: enough sleep, enough safety, enough love, enough money or GDP, enough stuff, or enough resources. It is a deep-seated mental burden that becomes reflected in social problems. Societally, scarcity is in the unequal distribution of wealth and

63 Backed up by sources such as Mark Johnson, "Ecology and the Urban Aesthetic," in *Ecological Design and Planning*, ed. George F. Thompson and Frederick R. Steiner (New York: John Wiley, 1997), p.172-184; Andrew M. Smith, *Roman Palmyra: Identity, Community, and State Formation* (New York, NY: Oxford University Press, 2013), p.8-10; even Richard George Rogers and Philip Gumuchdjian, *Cities for a Small Planet* (Boulder, CO: Westview, 1998), p.8-22, which talks about identity formation in "open-minded" spaces. Research into social networks also shows that dominant traits can spread in a network i.e. that we change based on who and what is around us and has influence on us.

resources—that causes nearly 800 million people to go hungry,^[64] nine million to die of malnutrition,^[65] 2.8 billion to live on less than \$2 a day^[66]— but perversely enables us to act on the psychological desire for more stuff by exploiting poverty and inequality to produce cheap goods. At the same time, the growing awareness of these inextricable issues has negative psychological effects like guilt, sadness, or depression. It’s a psychological double-bind embedded into the problem of using material goods as coping mechanisms.

As we collectively become more aware that consumerism and materialism are socially and environmentally problematic because of how wasteful and exploitative they are, marketing has become more sophisticated in overcoming this purchasing barrier. To overcome the dissonance between wanting to purchase goods and wanting to be environmentally and socially friendly, marketers have come up with “built-in social consciousness,”^[67] such as a small portion of profits donated to charity, or the use of recycled/recyclable/biodegradable packaging. These strategies send the message that it’s ok to consume because the act of consumption is no longer “bad,” but they are a “band-aid” solution at best and completely ineffective at worst.^[68]

In fact, an issue of material sustainability is that it has become a marketable quality, making it subject to various forms of greenwashing through over exaggerated and non-credible claims of

64 “2015 World Hunger and Poverty Facts and Statistics - World Hunger,” Hunger Notes: Fight Hunger with Knowledge, November 25, 2015, accessed August 10, 2016, <http://www.worldhunger.org/2015-world-hunger-and-poverty-facts-and-statistics/>.

65 Alyssa Cogan, “Quick Facts: What You Need to Know about Global Hunger,” Mercy Corps, March 18, 2015, accessed August 10, 2016, <https://www.mercy-corps.org/articles/quick-facts-what-you-need-know-about-global-hunger>.

66 “The State of Consumption Today,” Worldwatch Institute, accessed August 10, 2016, <http://www.worldwatch.org/node/810>.

67 Slavoj Žižek, *The Pervert’s Guide to Ideology*, Channel 4 DVD, 2013.

68 Such as the prevalent wishful belief that disposable coffee cups are recyclable (they’re not widely recycled because they’re a composite of paper and thin plastic film), or that biodegradable serving containers actually biodegrade (they don’t unless you have a composting bin to put them in, and that bin makes it to a compost processing facility).

helping to solve environmental and social problems. Greenwashing is more concerned with marketing a “green” quality that can increase profits than with making positive impacts. As architects, as much as we might want to make choices that really are sustainable, we also have to scrutinize what’s being presented to us to make sure we aren’t being fooled. Sadly, as a consequence of being deceived by greenwashing many people have become mistrustful of sustainability claims, as discussed in the previous section on defining sustainability. Although we want to make sustainable choices, not everything presented to us as sustainable really is. Architects wishing to make good choices often have to do the work of checking against greenwashing in the products they’re selecting. This is why it continues to be important to analyze claims of material sustainability and to educate ourselves about material sustainability.

For example, looking back on my work experiences in architecture offices I have encountered greenwashing during lunch-and-learns, whereby a representative of a building product manufacturer would present us with their product and inevitably tell us how it is sustainable. One flooring manufacturer claimed that their composite wood flooring, made of an engineered particle-board base and a wood veneer top, was more sustainable than conventional wood flooring because we are running out of solid wood products. The claim made me suspicious, but without looking into the industry myself I wasn’t sure if it was false. Looking back on it, there may be other reasons to explain the existence of such a product, such as the expense of some hardwoods, but it is a far stretch to say that it is “more sustainable” if you start asking some questions about the product. The flooring uses less solid wood, but it’s less durable because it can never be refinished the way a solid wood floor can be. Is this a “sustainable” tradeoff? Was the embodied energy of the product considered and shown to be significantly lower than solid wood? Are the glues in the product hazardous to indoor air quality? What about to the workers who are exposed to them in high concentrations at a factory? The answers to these questions just scratch the surface of determining how

sustainable a material is, and they were not addressed. However, the decision-making process starts with asking the right questions about material sustainability, both from the point of view of incorporating them into the building and their larger world influences.

The phenomena of greenwashing, social exploitation of poor workers in developing countries, and the export of environmentally damaging material practices to developing countries that have fewer regulations are some of the examples of ethical issues found in private sector product development. Free markets have shown themselves capable of finding the best way to make a profit, but have also shown that they can't be trusted to find the best long-term solutions because they are prone to unethical choices. Since ethics and environmental policy are constantly having to catch up with private sector innovations, we should use caution when investing in new material approaches and production methods before their repercussions are understood.

Globalized markets have also enabled a throwaway culture by making things cheap enough as to devalue their potential for longevity. Architecture is not exempt from a culture of cheap production and consequent disposability: the EPA cites 40% of solid waste to come from the building sector.^[69] This throwaway culture is disconcerting because physical resources are finite and disposal sites contribute to global environmental degradation.

Finally, a deeply embedded issue of material culture is that we operate under an economic structure that seems to rely on material extraction, perpetual growth, and consumerism. The idea is that we must continue to grow our economies in order to have economic well-being, and if the economy isn't growing we begin to fear that it will crash. In recent months reading *The Globe and Mail* makes one think it is some kind of civic duty to behave as a consumer and buy things "for the greater good" of the Canadian economy. Reportedly, the reason that consumers have stalled their buying is that household

69 "Lifecycle Building Challenge," Green Building | US EPA, accessed August 10, 2016, <https://archive.epa.gov/greenbuilding/web/html/lbc.html>.

debt has become preventive. Putting aside that perpetual growth is an unlikely scenario unless we decouple it from raw material extraction, the concept that national economic well-being rests on consumerism is in no way sustainable.^[70] Continuous growth that's tied to material extraction is impossible in a world that has finite physical resources.

In terms of current ecological problems, greenhouse gas emissions are a prominent issue. Greenhouse gas concentrations, of which CO₂ is the most copiously emitted, regulate how much of the sun's heat is trapped by the atmosphere and how much is reflected back into space. Due to rising concentrations of CO₂ from industrial activities such as energy production, motorized transportation, and goods manufacturing, there is now an ongoing discussion on how much we need to reduce our emissions, in what time frame, and in what way. The recent Paris Agreement which came out of the COP21 summit in December 2015 agreed that we have to limit global warming to 1.5°C. This imperative aims to manage the risk presented by global warming, which could see more extreme weather, rising sea levels, desertification and a reduced food supply, as well as security threats when countries try to ensure their own perpetuation. The 1.5°C limit has been put in place partly to try and avoid reaching the "tipping point" of climate change which has been suggested by scientists.^[71] Once this point is reached, global climate change will have enough positive feedback to drive itself towards increasingly rising temperatures regardless of human intervention to try and affect it. Reaching the tipping point is a threat because it could result in catastrophic conditions that require a major re-ordering of Earth's systems to the extent that discussions of sustainability, architecture, or material systems will be irrelevant; it will be a question of pure survival, which is why it's imperative to act and adapt now.

70 More on why it's unsustainable in Scott Barlow, "Too Much Stuff, No One to Buy It," *The Globe and Mail*, February 3, 2016.

71 Bill McKibben, "A World at War," *New Republic*, August 15, 2016, <https://newrepublic.com/article/135684/declare-war-climate-change-mobilize-wwii>.

What does this 1.5°C goal mean for us? What kind of action does it need to translate to? In the wake of the Paris conference, a few scientists gave us their proposals. Rob Jackson, an environmental scientist at Stanford University, warns us that we have only ten years to reach 1.5°C warming if we don't start doing anything differently immediately. What we have to do to avoid going over that target is reduce emissions by 10% each year (presumably until we reach zero). Gideon Forman, from the David Suzuki Foundation, has a different suggestion. He calls for conversion to 100% renewable energy within 35 years to keep within 1.5°C global warming. His advice is to switch from fossil-fuel power (specifically coal) to renewable sources like wind and solar. The article then talks about switching to electric cars and electric public transit, and implementing a carbon tax. Corinne Le Quere, director of the Tyndall Centre for Climate Change Research in the UK, focuses on citizen participation, which may require a behavioural or attitudinal shift to accept driving less in smaller electric cars, constructing wind turbines, consciously disposing of their trash, and making personal investments to make their homes energy efficient.^[72] The range of this advice makes at least two things clear: that reducing CO₂ emissions is an urgent task, and that we have to reduce our reliance on fossil fuels for energy use and transportation. This lines up with statistics that transportation and building operating energy are the two biggest contributors to CO₂ emissions.

Unfortunately, the political timeline doesn't seem to line up with the ecological timeline, as the Paris conference led to an agreement to have a meeting in 2018 to discuss ideas for reducing emissions, and in 2023—8 years after the original conference—to take stock of global progress towards reductions and the 1.5°C goal.^[73]

72 Aleksandra Sagan, "COP21: Canada's New Goal for Limiting Global Warming 'perhaps a Dream' - Technology & Science - CBC News," CBC News, December 11, 2015, <http://www.cbc.ca/news/technology/climate-change-talks-canada-emissions-goal-1.3357770>.

73 Robinson Meyer, "Is Hope Possible After the Paris Agreement?," *The Atlantic*, December 12, 2015, <http://www.theatlantic.com/science/archive/2015/12/can-we-hope-after-the-paris-agreement/420174/>.

And the strategies proposed for meeting this commitment have been heavily criticized, not least because they appears to try to “save the world while leaving lifestyles and aspirations unchanged.”^[74]

Material sustainability can play an important role when it comes to understanding the behaviours, attitudes, and lifestyles that drive up greenhouse gas emissions. Our relationship to the material world is markedly unhealthy, if the common definition for “standard of living,”^[75] or the economic emphasis on growth, or the constant advertising to purchase more goods are anything to judge by. Material sustainability is a way to tangibly address consumerist patterns that are at the root of using too much of the Earth’s resources too quickly, and visually expressing a different vision of material use may help to form a more sustainable future.

According to statistics published by Architecture 2030, architectural material production and construction contributes only a small amount of greenhouse gas emissions, putting them at 5.9% of all energy consumption in the US economy. By contrast, the energy needed for building operation uses 41.7% of energy in the US.^[76] However, this small fraction may still be important in reducing overall emissions in a timely manner. Also, after operational energy in buildings has been reduced, embodied energy and recurring embodied energy are the next most significant energy expenditures on buildings. This is to say that embodied energy becomes increas-

74 Tom Bawden, “COP21: Paris Deal Far Too Weak to Prevent Devastating Climate Change, Academics Warn,” *The Independent*, January 8, 2016, <http://www.independent.co.uk/environment/climate-change/cop21-paris-deal-far-too-weak-to-prevent-devastating-climate-change-academics-warn-a6803096.html>.

75 example, from Investopedia (<http://www.investopedia.com/terms/s/standard-of-living.asp>): “the level of wealth, comfort, material goods and necessities available to a certain socioeconomic class in a certain geographic area” and comments on “quality of life:” “Financial decisions usually involve a tradeoff where quality of life is decreased in order to save money or, conversely, quality of life is increased by spending more money.” (<http://www.investopedia.com/terms/q/quality-of-life.asp>)

76 Architecture 2030, “Why the Building Sector?”, Architecture 2030, accessed January 2, 2016, http://architecture2030.org/buildings_problem_why/.

ingly more important as operational energy is reduced. For example, in a Passivhaus, the energy it takes to produce ultra-thick insulation might never be “repaid” in operational energy savings^[77] because each doubling of the insulation layer halves the transfer of energy through a wall—you can go on doubling the insulation and halving the energy, but there comes a point where the increase in material is significant but the energy savings approach zero. This is to say, embodied energy, the energy that it takes to acquire, process, and transport materials to be made into a building, becomes increasingly important as buildings become more operationally efficient. This is the long view of crunching the numbers on material energy, assuming that we want to move towards a less energy-intensive society such that there isn’t as much pressure on renewable energy sources.^[78] However, it is also worth mentioning that embodied energy data is contentious and often inconsistent due to inconsistent calculation methods; it is in itself a complex problem with many variables that depend on where sources, manufacturing, and building site are located in relation to each other, and how materials are produced (efficiency of the equipment itself, recycled content, use of renewable energy, etc.).

Finally, with regard to environmental sustainability, the material sector interfaces with the environment from production to disposal, and has the potential for adverse toxicological and energy effects along the way; it impacts sustainability in many ways, and we cannot ignore it while we continue to address operational energy concerns (especially with regard to active reduction strategies which usually result in more and new technologies being produced and used).

77 Martin Holladay, “All About Embodied Energy,” GreenBuildingAdvisor, November 15, 2013, , <http://www.greenbuildingadvisor.com/blogs/dept/musings/all-about-embodied-energy>.

78 Renewable energy sources are still not widespread enough to meet a significant fraction of our energy expenditures; we have to meet somewhere in the middle by increasing our stock of renewable energy at the same time as reducing the amount of energy we require day to day.

Even though building materials and construction don't make up the largest contributions to CO2 emissions, the reduction of emissions is a serious consideration throughout an analysis of material approaches because it is a problem that warrants urgency. If architectural materiality helps to shift attitudes about consumerism in other spheres by changing people's attitudes, aspirations, and tastes, then its indirect impacts on CO2 emissions reduction could be even greater. I hope that my approach to analyzing the interdependent nature of social, psychological, and environmental sustainability will raise new questions with regard to strategies for operational energy.

In the following sections I look at different approaches to material sustainability to see which ones help to address issues of material culture, with a focus on materialism. I also look at a few common building materials to understand the processes for producing and disposing of them, and then I look at the relationships between industries which process materials. This methodology is in keeping with the complex systems framework I set out in the first section, which encourages identification of different actors, their relationships, and feedback loops.

holarchy: "a holon refers to a system considered at one scale and from one perspective. A holarchy (or holonocracy) is a nesting of holons, each at a different scale of observation, but all seen from the same perspective."^[79]

The aim of reconstructing the material industry from three different system perspectives is to understand the broad context of material sustainability. It is intended to help understand how architects interact with construction materials from various streams, and at which stages of the design process. This section describes these interactions in order to set up a knowledge base to consider possible

79 David Waltner-Toews, James Kay, and Nina-Marie E. Lister, *The Ecosystem Approach: Complexity, Uncertainty, and Managing for Sustainability* (New York: Columbia University Press, 2008), p.27.

interventions. If relationships between actors are altered, it may be possible to better facilitate a materially sustainable architecture and overcome some of the systemic challenges in material culture.

4 CURRENT APPROACHES TO MATERIAL SUSTAINABILITY

*What are current approaches to material sustainability?
—and do they address current concerns holistically??*

The previous section briefly discussed the relationships between environment, psyche, and society that are necessary for a holistic evaluation of sustainability. In particular, the psyche is focused on, as it is largely missing from current discourse.

In this section I will discuss how the three conditions for sustainability (ecological, psychological, and social) are met or not met by current approaches to sustainable materials and material sustainability. Although the distinction between the two categories is slight, I see sustainable materials as object-based whereas material sustainability is more system-based. This will lead into a discussion of the merits of material re-use as an underrepresented approach to material sustainability which benefits all three criteria for sustainability.

With regard to sustainable materials I will look at new materials research, renewable materials, and local materials; for material sustainability I look at recycling, Cradle to Cradle, industrial ecology, design for disassembly, dematerialization, and adaptive re-use. There are often overlaps between the strategies (e.g. renewable and local materials could be the same thing, depending on climate context) so what I will be looking to critique is the overarching ethos of each

one. It will become clear that each strategy has strengths in principle, but weaknesses if these principles are taken to extreme or without consideration for relationship to other principles. That is to say, weaknesses are exacerbated if several principles are not considered from a systems perspective and interdependencies are not addressed. In part, this research led me to look for an approach that takes a middle position between extremes, taking advantage of the strengths and minimizing the weaknesses of opposing sets of principles found in material culture, such as consumerism and asceticism, globalism and localism, and others (as touched on in the previous section on issues in material culture).

NEW MATERIAL INVENTIONS

New materials are being researched and developed for several different reasons in the name of sustainability. Some are developed to replace material goods that are toxic to people, either during production, daily use, or by ecosystem pollution when they are disposed of. This includes green building “essentials” such as the cadmium used in solar panels, but can also apply to everyday building materials that contain things like formaldehyde and off-gas VOCs (volatile organic compounds). Other material research focuses on bio-based materials that could help phase out our reliance on fossil fuel-based materials which appear in everything from insulation to any kind of plastic.

However, many materials are developed in the name of efficiency, including greater energy efficiency, construction speed, and material use in terms of weight^[80] and volume. Many of the building materials developed specifically for the construction industry are increasingly complicated composites. This includes panel systems such as SIPs and ICF panels, and individual products such as Conwood, a mix of cellulose and cement that imitates wood and purports to be more sustainable than the real thing.^[81] Then there are fiber-reinforced polymers which are advertised for durability (non-corrosiveness, non-rotting), light weight (less transportation energy, less energy to install), and energy-saving.^[82]

New construction materials that have a composite structure are problematic because they make it difficult to create a more closed

connections:

- » health (toxicity)
- » ecosystem pollution
- » embodied energy vs. durability
- » speed
- » resource depletion

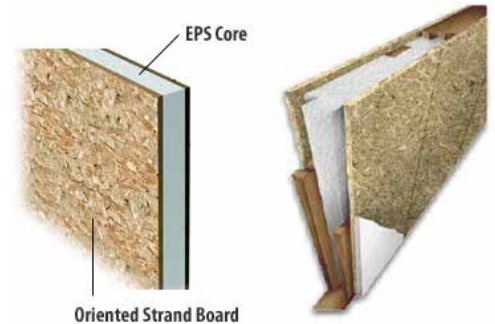


Figure 4.1: SIP panels are a composite of extruded polystyrene rigid insulation and oriented strand board. They are difficult to recycle.



Figure 4.2: Insulated concrete forms (ICF) are a composite of insulation and spacers that act as formwork for concrete. They can speed up construction time because the insulation does double duty.

80 I feel compelled to add that while weight reduction may be prudent for objects that have to be propelled, such as automobiles, it may have more drawbacks than benefits when it comes to the stationary buildings that I’m concerned with in this thesis. More on this in “dematerialization.”

81 “Conwood,” Holcim Singapore, accessed April 24, 2016, <http://www.holcim.sg/solutions/conwood.html>. and “Company History,” Conwood, accessed April 24, 2016, <http://www.conwood.co.th/Who-we-are>.

82 *Composite Building Materials for Green Building*, PDF, Ashland, December 2011, <http://www.ashland.com/Ashland/Static/Documents/APM/Composites%20Bldg%20Mtrls%20for%20Green%20Building.pdf>.

material loop by recycling or composting at the end of their use. For example, the different materials have to be cleanly separated to make recycling possible. To be compostable, all the materials have to be biodegradable, and they shouldn't contain any harmful chemicals. If composites can't be recycled or composted easily, they become much more likely to end up as waste in a landfill.

As an example, fiber-reinforced polymers are problematic in a few ways. To begin with, they're plastics derived from fossil fuels, and they have some of the same problems that other plastics have: they aren't really recyclable because their chemical structure breaks down each time they're reprocessed (i.e. they get downcycled) and they don't age gracefully.^[83] Although plastic products attempt to be ageless, somehow they are fastest to become dated in a way that natural materials don't. Then, their composite nature exacerbates the problems of recycling because it's almost impossible to separate the fibers out.

Although these polymers tout their high durability as an environmentally friendly factor, this claim is troubling when considering that one issue of material culture is disposability and consumerism. We can't forget that durability has a cultural dimension to it. Objects that are not considered fashionable, trendy, beautiful, or at

83 A list of possible construction polymers: "Polymers in Construction," Sandberg, accessed August 26, 2016, <http://www.sandberg.co.uk/consultancy/polymers/polymers-in-construction.html>. Fluoropolymers in particular are extremely dangerous to people during production and lead to serious environmental contamination. Article: Nathaniel Rich, "The Lawyer Who Became DuPont's Worst Nightmare," *The New York Times*, January 6, 2016, <http://www.nytimes.com/2016/01/10/magazine/the-lawyer-who-became-duponts-worst-nightmare.html>. The FluoroCouncil has more information about how fluoropolymers are used in construction: "Building and Construction," FluoroCouncil, accessed August 26, 2016, <https://fluorocouncil.com/Applications/Building-and-Construction.html>. The council also states that there is/was both a US and Canadian mandate to eliminate long-chain PFAS by 2015, in favour of short-chain fluorochemicals which reportedly aren't as harmful. That's difficult to interpret, since "improvement" over such an awful substance doesn't say very much... There is another issue here: companies knowingly endangered people but there are hardly any consequences to their actions. Can we trust new material development to be ethically sound? Or is the prospect of monetary gain much more important for these corporations?

least unassuming can fall prey to the swings of fashion.^[84] This added layer of complexity from a socio-psychological standpoint means that we should consider the *likely* lifespan of a product instead of its maximum lifespan.^[85] When we choose materials, or engineer new ones, we should ask ourselves whether they will have a lasting presence or if they're likely to become a short-lived trend.

We live in an economy that is unlikely to make the most of the high durability of polymers, making them as likely to become waste as another material, and maybe more likely because plastics don't age gracefully. Fernandez makes a similar comment in *Material Architecture*: “the actual lifetime profiles of contemporary buildings are ruled less by material and component durability—a dominant factor in the past and the ‘traditional’ measure of service life—than by a series of intangible forces including aesthetic discrimination, user preferences, market-related fluctuations and evolving social norms for work and living.”^[86]

Since new material inventions tend towards becoming more and more technologically advanced, psychologically they have the effect of moving us further away from a connection to the Earth. The materials don't speak to the place, nor is the origin visually traceable to the source such as the clay in brick, or the wood in structures or finishes.

On a wider (and more long-lasting) social level, the technological materials neither embody history nor memory, and attempt to be impervious to aging. They don't help to connect with past generations. From Pallasma's *The Eyes of the Skin: Architecture and the Senses*:

All matter exists in the continuum of time; the patina of wear adds the enriching experience of time to the materials construction. But the machine-made materials of today – scaleless sheets



Figure 4.3: Fibre-reinforced plastic in the seating at the TMW technical museum, by Querkraft Architects.

84 Bjørn Berge, *The Ecology of Building Materials*, translated by Filip Henley (Oxford: Architectural Press, 2000), p.9.

85 Ibid.

86 John Fernandez, *Material Architecture: Emergent Materials for Innovative Buildings and Ecological Construction* (New York: Architectural Press, 2006), p.37.

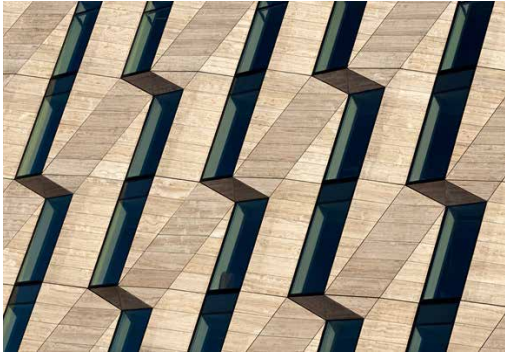


Figure 4.4: *Close-up of Horten Headquarters facade, by 3XN.*



Figure 4.5: *Horten Headquarters facade uses a composite of travertine and fiberglass.*

of glass, enameled metals and synthetic plastics – tend to present their unyielding surfaces to the eye without conveying their material essence or age. Buildings of this technological era usually deliberately aim at ageless perfection, and they do not incorporate the dimension of time, or the unavoidable and mentally significant processes of aging. This fear of the traces of wear and age is related to our fear of death.^[87]

Ecologically and psychologically, there are benefits to staying with the idea of simple materials and exploring their best use. With regard to phasing out toxic and petroleum-based products new materials do and will continue to play an important role. However, phasing in complicated petroleum-based composite materials that can't be recycled and aren't particularly desirable for reuse is less sustainable than what it attempts to replace.

A building like Horten Headquarters by 3XN will be interesting to see age in time. Although it has a composite material facade made up of travertine fused to fiberglass which would be problematic to recycle, the materiality of the composite is such that it ultimately looks like a facade of natural stone. It's possible that this "natural" aesthetic will help it last if the material weathers gracefully. Since the facade doesn't have the look of being technologically advanced, it appeals to biophilia by its close connection to the Earth. At the end of the facade's usefulness, it's possible that the composite material could be reused if it's still serviceable, though the irregular tile geometry might make this a challenging task.

I would summarize the philosophy of new material inventions as the belief that the way towards sustainability lies in technological progress. There is a lot of focus on ecological efficiencies, but unfortunately much less thought for socio-psychological effects and the interdependence of society, psyche, and environment. Looking at interdependencies starts to create a more nuanced set of material sustainability criteria for architects.

87 Juhani Pallasmaa, *The Eyes of the Skin: Architecture and the Senses* (Chichester: Wiley-Academy, 2005), p.31-32.

RENEWABLE (ORGANIC) SOURCES

Unlike new synthetic materials and composites, renewable materials have a close proximity to the Earth, satisfying our innate biophilia (love of living things). It is visually possible to relate exposed wood to its origin as a tree rooted in the ground and being nourished by it and the Sun. As that wood ages, it does so gracefully, building up a patina of marks, scratches, and discolourations that are telling traces of events that have come before. Even refinishing the wood will maintain some of these traces.

However, to embrace renewable materials to the extreme would mean to mandate their sole use, which has a few problems. First, there is conflicting evidence with regard to the role of plants in climate change; the argument is that plant-based renewable materials sequester carbon, and when they are cut down to be used in a building that carbon remains sequestered (as opposed to natural decomposition of the plant matter which would release greenhouse gases back into the atmosphere). The counter-argument is the leaf cover of mature plants may help absorb solar energy so that the ground stays cooler.^[88] If we give up too many mature trees for construction material, this may have negative local and global impacts.

Another issue that should be considered is that not all renewable materials that are on the market are grown locally. This means that a plant like bamboo, although touted for its quick regeneration, may have to be shipped long distances; bamboo shipped from China to North America may contribute more to greenhouse gas emissions due to transport than a renewable resource produced locally. However, if I compare this to the fact that much of iron and steel is shipped globally at various stages of production, then bamboo

connections:
» biophilia



Figure 4.6: *Expanded cork insulation. Cork comes largely from Portugal and is classified as a rapidly renewable material, but its limited supply will never be able to replace plastic insulations in the quantities we use today. However, it might be useful in specialized applications for its fire retardant qualities..*

88 Abby Swann, "How Do Trees Change the Climate?", RealClimate: Climate Science from Climate Scientists, accessed April 25, 2016, <http://www.realclimate.org/index.php/archives/2014/10/how-do-trees-change-the-climate/>; similarly Jennifer Wells, *Complexity and Sustainability* (London: Routledge, 2013), p.249, where reforestation is recommended.



Figure 4.7: *This strawbale construction office by Ingrid Cryns of Soma Earth is uses waste straw from the agriculture industry; it is renewable and local to Southern Ontario. Walls tend to be very thick.*

starts looking quite sustainable by contrast. There's a spectrum as opposed to black and white judgements. The only way to know this spectrum is to understand where your materials come from, what kind of journey they've been on, and what kind of impacts they've had along the way. Different manufacturers may employ different processes, so not all steel, bamboo, or wood is created equal.

A final consideration is that using only renewable organic materials can limit building durability where it has to be in contact with the wet earth at its foundation. As a result, some allowances for non-renewable mineral-based materials such as concrete have to be made. To only judge material on its renewability may leave other concerns unattended; much like following any "perfect" system or "perfect" solution. In wicked complexity, there is no such thing.

LOCAL MATERIALS

The social benefit to using local materials is that they create an architecture that speaks to the specificity of the place and helps reinforce a sense of identity. This is conceptually similar to vernacular architecture which uses locally available materials and skilled labour to construct in a way that's appropriate to the local climate. Climate is one reason why the use of many of the same materials in different parts of the world led to different architectural expressions. Local evolution of craft styles also creates differentiation. So for example, Russian wood construction developed into one kind of style and form, while Chinese wood construction is another style and form altogether.

A concept that's useful in studying architecture of local materials is "vernacular" architecture. In *Discovering the Vernacular Landscape* John Brinckerhoff Jackson has a definition for vernacular landscape which is applicable to the inorganic nature of buildings as it is to the organic nature of greenspaces: the vernacular is "a composition of man-made or man-modified spaces to serve as infrastructure or background for our collective existence." He goes on to say immediately that "if background seems inappropriately modest we should remember that in our modern use of the word it means that which underscores not only our identity and presence, but also our history."^[89] His argument is that the vernacular landscape, one which is "identified with local custom, pragmatic adaptation to circumstances, and unpredictable mobility"^[90] is the basis for our cultural and individual history and identity; so it is with vernacular architecture that comes from local material, skills, and adaptation to climate. That is to say, vernacular architecture is formed by its environmental context as well as socio-psychological factors of skill and ideas of beauty.

connections:

- » vernacular architecture
- » critical regionalism



Figure 4.8: Local materials are often chosen in humanitarian efforts, such as the Earth Home Project which helped villagers in Pakistan rebuild homes after a flood.

89 John Brinckerhoff Jackson, *Discovering the Vernacular Landscape* (New Haven: Yale University Press, 1984), p.8.

90 Ibid., p.xii.



Figure 4.9: *Snobetta's isolated cabin in Norway (1), a cottage on Georgian Bay by CORE architects (2), and a retreat by Patterson Associates (3) all have one thing in common: local materials and difficult to reach sites. Supplementary materials could only be brought in by horseback, boat, and four-wheel drive over a farm track, respectively.*

Similar ideas occur with regard to critical regionalism, which is a more contemporary response to creating an architecture that speaks to regional identity through materiality, style, and environmental response. In *Toward a New Regionalism: Environmental Architecture in the Pacific Northwest*, David Miller proposes exactly this: that regional architecture must be understood from the perspective of climate, construction technologies, and stylistic goals. He goes so far as to precisely reference that soil, topography, and local plant life will all inform regional construction.^[91] It's notable that his representation of this paradigm explicitly includes the psyche: "An environmental architecture provides for humanity's long-term needs, both physical and psychological, using only those resources the earth can sustainably provide."^[92] The well-being of the psyche comes into play as a human need that's addressed through this approach.

Although the locale in which I'm writing, Southern Ontario, is rich with natural resources such as wood, stone, aggregate, and raw material for cement, these are still not the full spectrum of materials that modern construction heavily depends on and which has become the norm. For example, although we have the ingredients for concrete, concrete construction is highly dependent on its steel reinforcing for which we don't have a local source. This means that normative construction either isn't possible if we dedicate ourselves to local materials, or that it would require an imperfect take on local materials that makes allowance for imported additions.

The ecological benefit of local materials is that their proximity significantly reduces the amount of energy required for transportation. However, this assumes that the material can be handled locally at all stages, from harvest to production to finishing, which is a rare scenario due to globalization but not impossible. Once again, it depends on the processes of each manufacturer and their own values and priorities; they may choose to keep everything local if they them-

91 David E. Miller, *Toward a New Regionalism: Environmental Architecture in the Pacific Northwest* (Seattle: University of Washington Press, 2005), p.3.

92 Ibid., p.xv-xvi.

selves value greenhouse gas reductions and if they have pride in the local economy.

Keeping local proximity in mind can advance sustainability if it doesn't solely focus on production from new materials but takes advantage of the waste stream as well. After all, cutting off the energy needed to harvest and process a material in the first place reduces greenhouse gas emissions even further.



Figure 4.10: *The Eggum Tourist Stop by Snobetta uses rock excavated from the site and locally-gathered driftwood.*



Figure 4.11: *Frei Otto pioneered lightweight structures. Some of his designs were derived from studies of soap bubbles. (1) Similar to Buckminster Fuller, Otto's fascination with lightweight structures rose out of a curiosity about structural efficiency, though he recognized that just because you can build such expansive lightweight structures, they may not be needed by society and tend to be temporary. (2)*

DEMATERIALIZATION

Dematerialization is a term that can have several definitions which share the common goal of doing more with less material; that is, the goal is getting more work and value from smaller amounts of material. It is closely related to the economics of material flow, and comes from the realization that infinite material-based economic growth is impossible on a planet with a finite amount of materials. This is different from the artistic meaning of dematerialization, in which there's either an *appearance* of lightness and transparency^[93] or an idea that the value of art lies in its concept, not its material form.^[94]

Since dematerialization tries to achieve sustainable economic function decoupled from physical resources, it includes various notions of material cycling that extend the service of each bit of material—such as recycling, take-back programs, reuse, zero-waste, and industrial ecology. However, it also includes the notion that goods can be designed with less material or “higher intensity of use” of material.^[95] The idea of cycling will be discussed with respect to each specific strategy. The second idea, of using less material, is the more literal definition of dematerialization I'll discuss here.

In *Materials Matter* Kenneth Geiser discusses materials with a focus on products as opposed to architecture, and although he presents the idea of reducing material content in products he also cautions that “If lighter products are less durable or if smaller products are less expensive, this may increase the likelihood that these prod-

93 Adrian Lo, “AD1: Dark Light—Model Photographs,” *Architectural Inter-modalities*, November 29, 2010, accessed April 25, 2016, <https://architecturality.wordpress.com/tag/dematerialization/>.

94 Roula Matar-Perret, “Dematerialisation of Art – Disappearance of Architecture. What Materialities?,” translated by Charles Penwarden, *Critique D'art: The International Review of Contemporary Art Criticism*, no. 41 (Spring/Summer 2013), <https://critiquedart.revues.org/8316?lang=en>. and Elisabeth Schellekens, “Conceptual Art,” *Stanford Encyclopedia of Philosophy*, October 22, 2014, <http://plato.stanford.edu/entries/conceptual-art/>.

95 Kenneth Geiser, *Materials Matter: Toward a Sustainable Materials Policy* (Cambridge, MA: MIT Press, 2001), p.313-318.

ucts will be discarded frequently and lead to the manufacture of more products to serve the same need.”^[96] That is to say, making things lighter may socially and psychologically encourage wastefulness by making them less durable. He gives an example of heavy glass drink containers which used to be the norm and could be used, returned, and re-used; now they have been replaced by lightweight and inexpensive materials designed to be discarded.^[97]

At the building scale, lightweight structures may have a visual appeal, but John Fernandez cautions us in *Material Architecture* that their lightness doesn't reflect the amount of resources that went into them:

For it can be readily demonstrated that the lightness of the finished artifact is little indication, and misleading, of the overall material use (consumption and dissipation) that results from the making of that object. For example, a heavy and massive traditional stone building constructed today would require less material overall, than the same building in aluminum and glass. The reason resides in the dramatic differences in the amounts of material that result as wastes (mine tailing, industrial wastes, fuel expenditures in processing and transportation) between the stone and aluminum and glass.^[98]

Fernandez' caution arises out of a more systemic analysis of the environmental impacts of lightweight buildings, highlighting the importance of looking at material sustainability through a more holistic and interdependent framework.

In buildings, there is another concern with literally emphasizing lightweight efficiency, in stripping down material expenditure to the bare minimum: if a building is subjected to an event it wasn't strictly designed for, it will fail. Structural design is based partly on probabilities of climatic events and loading patterns, but as our climate changes and becomes more uncertain there's an advantage

96 Ibid., p.320.

97 Ibid., p.226.

98 Fernandez, p.51.



Figure 4.12: 2014 Serpentine Pavilion in London, UK



Figure 4.13: Serpentine Pavilion showing thinness of fiberglass enclosure and a continuing fascination with lightness.

in designing more conservatively, with more material, to withstand a greater range of possibilities. Moving forward with an uncertain climate future makes tight tolerances of light weight construction a high risk. The advantages of structural redundancy can be illustrated by the Buffalo snow storm of November 2014: most of the buildings that failed and collapsed due to the storm were flat-roof steel frames, which are generally designed to tight tolerances with little redundancy because steel is considered to be a predictable material. Wood-frame houses on the other hand, which have the advantages of a redundant construction, remained standing.^[99] Wood structures are not designed to similarly tight tolerances as steel because it's considered to be a less predictable material—it can have internal imperfections because it's a natural, not a man-made, material.

Design for durability may be a better strategy than “lightweighting,” but durability does not solely depend on material strength (as we already discussed under “new material inventions”): Extending the useful life of finished products maximizes the amount of value provided during their useful life, reduces the need for new products, and slows the rate at which they are discarded. Some products, like antique furniture, fine art works, or family heirlooms are preserved, indeed, revered, for their age and generations of use. They are often durable pieces that have significant craft energy embedded in them, and their continued use diminishes the need for replacement products and slows the flow of materials.

Part of the importance of this quote is that it not only draws on the ability of physically durable pieces to endure, but also on the value placed on hand-crafted items that helps them to endure. This is a social value, and it contributes to social, not just ecological, sustainability by virtue of keeping an item in use instead of as waste. This is in contrast to lightweighting, which is more synonymous with the technologically-advanced “high-performance” materials discussed in the section on “new material inventions.” High-performance materials ignore psychological relation,

99 Corey Zurell, “Wood as a Building Material” (lecture, Arch 277 - Timber Design, Waterloo, May 8, 2015).

aesthetic grace, and the longevity of their social acceptance when they are designed for durability that's taken to an ageless extreme. Geiser begins to hint that objects can be more socially durable when they have been carefully crafted.^[100]

Jeremy Till suggests that architecture can be dematerialized in a more innovative way when we start to conceive of architects as managers of space, time, and material flows rather than necessarily makers of new things. Michael Speaks and McDonough & Braungart similarly see the architect playing a management role.^[101] Till gives the example of London-based architecture office "00" solving the problem of a crowded school corridor by changing the timing of breaks rather than physical reconstruction. He proposes that this mode of dematerialization helps to move focus away from scarcity towards "using design ingenuity to redefine the project." Redistribution is used to solve the scarcity of circulation space.^[102]

RECYCLING

Recycling—or better yet, recyclability—is often used as an argument for material goods, but it is often an empty promise. A product that's recyclable is only as good as the infrastructure for actually accomplishing the task of recycling it, and in many cases this infrastructure doesn't exist. For example, glass, which is commonly understood as a recyclable material is only recycled when it comes from contain-

100 Geiser, p.320.

101 Jeremy Till, "Scarcity Contra Austerity," *Places Journal*, October 2012, <https://placesjournal.org/article/scarcity-contra-austerity/>; Michael Speaks, "Theory Was Interesting... but Now We Have Work," *Arg: Architectural Research Quarterly* 6, no. 03 (September 2002): , doi:10.1017/S1359135503001714; William McDonough and Michael Braungart, *Cradle to Cradle: Remaking the Way We Make Things* (New York: North Point Press, 2002).

102 Till, "Scarcity Contra Austerity."

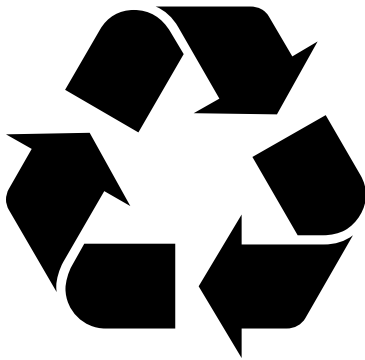


Figure 4.14: *The well-known recycling symbol.*

ers; the flat glass found in buildings is hardly ever recycled.^[103] It is probable that a scheme for recycling plate glass could be developed, but architects have no control over whether it does or does not develop. The creation of recycling facilities is outside the realm of architecture. We have to work with existing industries. However, the LEED program shows us that good waste management practices are achievable in construction, and glass might be the only unresolved recycling challenge: 93% of LEED Canada projects divert half of their waste from landfill, and 76% are diverting three quarters of their waste from landfill.^{[104][105]}

Besides infrastructure and processes, there are many potential obstacles in recycling. The previous section on material inventions discussed the downside to composite materials—it takes more effort to separate them into constituents that can go through the reprocessing of recycling, and sometimes the separation of a composite into its parts is impossible. If the separation isn't "clean" enough, it will compromise the quality of the recycled product. Most materials lose quality when they are reprocessed, even if they're uncontaminated, and this is known as **downcycling**. Plastics are usually downcycled, because their chemical structure gradually becomes weaker. Earth materials such as concrete, stone, and brick are also downcycled rather than recycled because the easiest thing to do with them is to crush them into low-value fill for landscaping, roadwork, and occasionally as aggregate in new concrete (although the acceptance of this practice

103 According to Glass for Europe: "only limited quantities of Construction and Demolition glass are recycled as in most countries there is no standardized system for dismantling and collection." source: "Circular Economy: Recycling of Glass Products," Glass for Europe: Building, Automotive, Solar-energy Glass, accessed April 25, 2016, <http://www.glassforeurope.com/en/issues/recycling-of-glass-products.php>.

104 *LEED Canada for New Construction 1.0 Credit Distribution as of March 31, 2013*, PDF, Canada Green Building Council, March 31, 2013.

105 Toronto Waterfront Waste Diversion page shows that there have been zero tonnes of glass diversion though it's unclear whether there was any glass that needed to be diverted on the projects. ("Waste Diversion," WATERFRONToronto, accessed August 10, 2016, <http://sr.waterfrontoronto.ca/en/environment/pm7wastediversion.asp>.)

is very split among Ontario municipalities,^[106] and recycled aggregate tends to come from roads, not buildings^[107]). Use of recycled concrete aggregate in structural applications is uncommon,^[108] it is more widely accepted for roadwork. Similarly, wood can be made into chips for landscaping or for use in engineered wood products. The materials with the best infrastructure and least loss of quality in recycling are metals, including construction metals such as steel and aluminum.

Complementary to the idea of downcycling is the concept of **upcycling**. The Oxford English Dictionary describes this concept as “the operation or process of reusing waste materials to create a product of higher value or quality; (more generally) the action or process of repurposing or renovating an old or unwanted item to make it more attractive, valuable, etc.”^[109] The focus on heightening value by repurposing or renovation suggests that objects are transformed craft instead of relying on mechanical reprocessing the way that downcycling and true recycling (with no loss of quality) tend to do. The added quality and value of upcycled objects comes from elevating them from trash to usable object. In this sense, upcycling is synonymous with reuse, which is discussed at the end of this chapter. It has less to do with homogenization of materials for recycling, or



Figure 4.15: *Techno Recycled Glass Surfaces* collection from *Architectural Systems*

106 In 2013 Aggregate Recycling Ontario made a case to Peel region to allow recycled aggregate in municipal tenders: Brian Messerschmidt, *Use of Recycled Aggregate in Municipal Infrastructure Construction*, PDF, Aggregate Recycling Ontario, October 10, 2013, <http://www.aggregaterecyclingontario.ca/files/Presentations/Peel%20Region%20-%20pres-oct10.pdf>. Bill 56, or the Aggregate Recycling Promotion Act, 2014 has not yet passed.

107 *Recycled Aggregate Usage by Ontario Municipalities*, PDF, Aggregate Recycling Ontario, December 2011, http://www.aggregaterecyclingontario.ca/files/forum_documents/Survey%20Results%20of%20Recycled%20Aggregate%20Usage%20by%20Ontario%20Municipalities.pdf, p.9, 5 (respectively).

108 L. Butler, J.S. West, and S.L. Tighe, *Quantification of Recycled Concrete Aggregate (RCA) Properties for Usage in Bridges and Pavements: An Ontario Case Study*, PDF, Transportation Association of Canada, 2011, <http://conf.tac-atc.ca/english/annualconference/tac2011/docs/p3/butler.pdf>, p.1.

109 *Oxford English Dictionary*, s.v. “Upcycling,” June 2014, <http://www.oed.com.proxy.lib.uwaterloo.ca/view/Entry/408183?redirectedFrom=upcycling&>.

shredding for downcycling, and relies on design to give it a new purpose. This kind of work is within the realm of architecture, and is an opportunity for architects to contribute to sustainable material use.

Ecologically, recycling, downcycling, and upcycling cut down on the amount of energy required to produce raw material and the amount of ecosystem disruption during extraction. Aluminum is a particular success story of recycling, which is said to be 92% more energy efficient than producing it from raw sources, and that increasing recycling rates by 10% decreases the industry's emissions by 15%.^[110] All forms of recycling also reduce the amount of waste that ends up in landfills, which have both a social and an environmental cost.

Socially, recycling helps us to dematerialize our economy by getting more use out of a single unit of material. Instead of being used once and then disposed of, it can be used at least twice or more, depending on whether it is truly recyclable, or if it has to be downcycled or repurposed. It helps to develop a more sustainable economy. Furthermore, recycling is likely to be done locally or regionally, which provides a few employment opportunities. However, it has to be ensured that the processes used in recycling are ecologically sound, just as with any other kind of manufacturing. Toxicity, operational energy, water conservation, and worker safety should all be monitored.

Psychologically, recycling, downcycling, and upcycling can all have very different effects. Upcycling will be discussed in more detail under the "material re-use" section. Aesthetically, recycling isn't likely to have a psychological influence because when it is optimal it simply turns an old product into a new product of the same material. This does not necessarily render objects "ageless" the way that new hyper-durable material inventions can be ageless. However, nor does it provide tangible feedback of the waste that consumerism creates; in fact, when done effectively it can facilitate consumerism for many cycles with minimal degradation. This has the potential to be both a good and a bad quality: although it is an ecologically beneficial

110 "Aluminum Recycling," The Aluminum Association, accessed August 11, 2016, <http://www.aluminum.org/sustainability/aluminum-recycling>.

process in comparison to new production, it does not help to address the underlying issue of consumerism in material culture. It gives the impression that the problem of waste can be made to go away, to an extent that it produces more wishful thinking than tangible results.^{[111][112]} This will be further addressed in the “Cradle to Cradle” section.

As I’ve mentioned, it is possible to improve the recycling industry, and this also applies to increasing awareness of what is and isn’t currently recyclable. For example, the UK has a good system for communicating both recyclability and extent of recycling on packaging in the country, which I find is both helpful and informative. The labels tell you how each component of the package should be disposed of, and whether it is “widely recycled” or if you have to “check local recycling” to find out if it’s accepted.^[113] The system only increases awareness on food packaging, but in general it helps to reduce public misinformation and wishful thinking with regard to the progress that has been made in waste management.

When it comes to construction materials, recycled materials don’t help to create public awareness on the issues of waste because the waste component is remade new. Labeling programs for public education are not architectural. Third-party building certification and municipal waste diversion requirements provide the impetus for better waste awareness, whereas architecture made of recycled materials doesn’t inherently contribute to awareness.

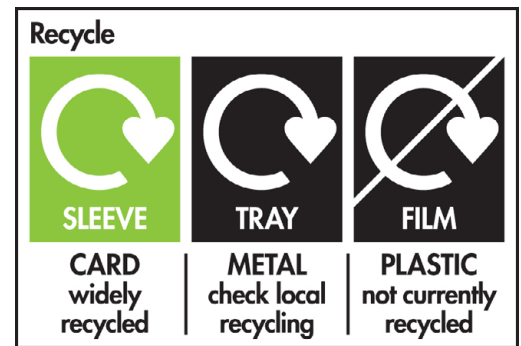


Figure 4.16: An example of the recycling symbols used in the UK.

111 e.g. in Toronto, drink cups are a “contaminant” in recycling bins, and yet people continue to wishfully try to recycle them. The Toronto Star recently did a piece on this: Betsy Powell, “People of Toronto: Stop Putting Takeout Cups in the Blue Bin | Toronto Star,” *Thestar.com*, June 19, 2016, accessed August 11, 2016, <https://www.thestar.com/news/gta/2016/06/19/people-of-toronto-stop-putting-takeout-cups-in-the-blue-bin.html>.

112 The Record reports that not only is curbside glass collection a big expense to taxpayers, but most of it goes into roadwork because the price to have it truly recycled is even higher. Jeff Outhit, “Glass Recycling Could Resume — for a Hefty Fee,” *The Record*, September 12, 2013, , <http://www.therecord.com/news-story/4075027-glass-recycling-could-resume-for-a-hefty-fee/>.

113 “Recycling Symbols Explained,” *Recycle Now*, accessed August 11, 2016, <http://www.recyclenow.com/recycling-knowledge/packaging-symbols-explained>.

CRADLE TO CRADLE

Cradle to Cradle is a well-developed and illustrative example of the idea of cycling materials (thereby dematerializing the economy) by recycling them i.e. reprocessing them to be made into new products. The Cradle to Cradle system as proposed by William McDonough and Michael Braungart is based on dividing the material world into technical and biological nutrients, and on keeping those two streams separate so as to make recycling an easier and more efficient process. Biological nutrients are “recycled” by composting them and letting natural processes turn them to food for new biological growth, whereas technical nutrients must be taken apart, different materials must be sorted, and those individual materials can be mechanically reprocessed into new products. Their idea addresses a major challenge of recycling—that of composite materials which can’t be separated out, making recycling impossible. They also work to develop materials that are safe and nontoxic, with no harmful dyes, processing additives, or material constituents that degrade interior air quality and negatively affect human health. Together, the biological and technical nutrient categories create two closed-loop systems where materials can cycle without loss of quality.



Figure 4.17: Cradle to Cradle Certified Biofoam has the potential to replace expanded polystyrene insulations.

Overall, the Cradle to Cradle proposition is comprehensive with regard to ecological considerations, and addresses barriers that we find in the waste industry by advocating for the design and production of healthier, cleaner products that can be carefully disposed of. There are flaws or caveats to the system that McDonough and Braungart attempt to address, and some that they don’t appear to be aware of. For example, one issue that they address well is the question of correct end-of-life handling, to which they propose to take consumer ownership out of the equation such that the manufacturer leases the product but also has the right to reclaim or switch the product out as long as it still provides the same service. This puts the

end-of-life decision-making in the hands of the service provider, who can channel it appropriately. It also illustrates another side to dematerialization of the economy—it's the service that a product provides that's given priority, not the ownership of the product.

Although the system attempts to streamline recycling, making it both more effective and efficient, there are a few flaws that appear not to be recognized. One is social, another psychological, and the third purely practical.

The social issue with recycling is that it facilitates fast turnover of goods; it does this by making it “ok” to consume things that are recycled or recyclable, overcoming the psychological guilt that can come from acting as a consumer in an ecologically uncertain time. Instead of slowing down material use, it may accelerate it. Braungart and McDonough proudly state as much:

Eco-effectiveness does not call for minimization of material use or prolonged product lifespan. In fact, it celebrates the creative and extravagant application of materials and allows for short product lifespans under the condition that all materials retain their status as productive resources. ... In the context of eco-effectiveness, strategies of reduction and minimization are not even steps in the right direction unless they contribute to the ultimate aim of achieving cyclical material flow systems that maintain quality and productivity over time.^[114]

The essay oversimplifies the issue by stating that “to minimize the volume, velocity and toxicity of the material flow system” is an eco-efficient (as opposed to -effective) technique that is locked into a linear paradigm. It should be obvious that cyclicity and slow overturn aren't mutually exclusive. Ironically, they also equate these methods of efficiency with guilt reduction, implying their eco-effective scheme doesn't play the same role. The authors work hard to differentiate themselves from typical recycling that often reduces the quality of

114 Michael Braungart, William McDonough, Albin Kälin, and Andrew Bollinger, “Cradle-to-Cradle Design: Creating Healthy Emissions - a Strategy for Eco-Effective Product and System Design,” in *Creating Desired Futures - How Design Thinking Innovates Business* (Basel: Birkhäuser, 2010), p.249.

material, but don't seem to see that their strategy is locked onto a more "perfect" version of the same process. Despite describing the downfalls of the recycling industry, they do not see the possibility for the same downfalls within their proposition.

What they call eco-efficiency strategies are also rejected for their "antagonism to economic growth and innovation."^[115] Braungart et al argue that prioritizing the use of less material or longer use of material is harmful to the economy, and that there's another way (his way) to reach environmental sustainability. This is a closed-minded view of the economy. Geiser's review of the economic ties to material use shows a more complex picture, whereby maturing economies tend to go through cycles of decoupling and recoupling from intensive material use, though this trend can vary by material.^[116] Geiser also points out that that the act of recycling (whether downcycled or keeping the integrity of the material) "permits materials to flow frequently and rapidly through many applications in the economy."^[117] From an energy and greenhouse gas emissions perspective, this is detrimental, especially if rates of material use and disposal accelerate, because in our current world (and not in the ideal world that McDonough and Braungart seem to picture) this adds to the problem of climate change; if we had such a thing as abundant, pollutant-free energy, the rate of cycling materials wouldn't be as much of an issue, but we don't have such a source. The ecological concern is that the system could be a driver for consumerism which contributes both to climate change and social inequality. The vision is somewhat utopian and not grounded in the time-sensitive issue of global warming.

The crux of the eco-effectiveness argument is that industry and nature should be able to co-exist and have a positive relationship. Instead of focusing on being less bad, or "no bad," this relationship

115 Ibid., p.269.

116 Geiser, p.309.

117 Ibid., p.317.

should have positive effects.^[118] I agree with this idea but not the suggested solution. The authors seem to think that these positive effects can be summed up by an economy that celebrates the “extravagant application of materials.” However, when I discussed the issues of material culture, I showed that this kind of economy has plenty of socially and psychologically negative effects. Braungart’s essay acknowledges that the “eco-efficiency” he derides is explicitly concerned with a fairer distribution of economic wealth, but does not address how this is translated in “eco-effectiveness.”^[119]

The issue of the utopian vision is also a psychological flaw in the system. The mentality is that materials will be able to cycle perfectly without downgrading or wearing down (again, the authors contradict themselves by saying that zero-emissions is thermodynamically impossible^[120] but imply that it’s reasonable to expect materials not to wear down or dissipate through cycling^[121]). The perfectionism that the system is based on is handed down to the consumer, who may or may not oblige; if they do, it is a burden to them; if they don’t, it is a burden and possible downfall of the system. Perfectionism is akin to utopianism and in psychology it is seen as a cover for vulnerability, and it is not without its psychological downsides.^[122] In *Daring Greatly* Brené Brown defines perfectionism as “a self-destructive and addictive belief system ... simply because perfectionism doesn’t exist. It’s an unattainable goal.”^[123] What kind of vulnerability does this vision attempt to protect us from? For one, the uncertainty of the future, for another the fear that we actually may not be able to continue to rely on an economic model based

118 Braungart et al, “Cradle-to-Cradle Design,” p. 253.

119 Ibid., p.252.

120 Ibid., p.257.

121 Ibid., p.258.

122 Brené Brown, *Daring Greatly: How the Courage to be Vulnerable Transforms the Way We Live, Love, Parent, and Lead* (New York, NY: Avery, 2012), p.128-130.

123 Ibid., p.130. Furthermore, her prescription for combatting perfection: appreciating the beauty of cracks.

in consumerism. Conveniently, Cradle to Cradle promises that we won't have to change, because everything will be perfect. Although McDonough and Braungart criticize efficiency for exhibiting the rebound effect, and rightly so as it is real and goes by another name too—Jevon's Paradox—they are quite happy to fall into accelerated material turnover because they paint it in a rosy light.

Perfectionism and utopianism remind me of what Clarissa Pinkola Estés describes as a soft dream, a dream that mesmerizes while real life dies because real-life problems are not attended to. “Soft dreams under hard conditions are no good, . . . in tough times we must have tough dreams, real dreams, those that, if we will work diligently . . . will come true.”^[124] Perhaps it's time to stop dreaming of a utopia in which technology saves the day while we burn up the rest of our carbon allowance (much like in the story of *The Little Match Girl* that Estés illustrates her point with).

To reiterate, the Cradle to Cradle system offers very good ideas for how new products should be designed and produced in a way that is healthy for people and that allows materials to be cycled at the end of their useful life. However, the promotion of the “extravagant application of materials” and “short product lifespans” is rather extreme and fails to acknowledge the socio-psychological issues of material culture and the fact that we can't afford to celebrate short product lifespans in an energy-scarce economy. Furthermore, I find that the focus on eco-effectiveness vs. -efficiency is incongruous if we stop to consider that the Cradle to Cradle system caters to the perpetuation of an economy based on material turnover instead of asking whether this is an effective kind of economy.

Overall, my criticism lies with socio-psychological considerations, with one possible exception. The Cradle to Cradle system emphasizes cyclicity of materials in a way that seems to ignore earthen materials such as stone and ceramic because they cannot be cycled. However, these materials are durable and globally abundant, which

124 Clarissa Pinkola Estés, *Women Who Run with the Wolves: Myths and Stories of the Wild Woman Archetype* (New York: Ballantine Books, 1992), p.319.

are qualities left behind by the system's repeated emphasis on enabling short product lifespans. An overemphasis on cycling makes it an exclusive rather than a holistic system. I haven't found that Cradle to Cradle acknowledges that it is also a part of a larger system, rather than it's presented as the ultimate solution.

INDUSTRIAL ECOLOGY

Industrial ecology is closely linked to dematerialization (Geiser tells us that dematerialization rose out of the field of industrial ecology^[125]). In itself, it focuses on "tracking material flows, reducing material wastes, and creating opportunities for more intensive use of materials during their life cycle."^[126] As such, it includes the practice and belief that waste from one industry can become the raw material for another industry. Industrial ecology is applicable to all materials, including manmade chemicals, though I am mostly interested in how it relates to architecture.

Industrial ecology is also linked to the idea of zero waste, which looks at material systems holistically and includes both production and disposal considerations. It too proposes that waste from one industry can become raw material for another.^[127]

Industrial ecology is a way of looking at industrial processes systemically, and uses the ecology of living systems as an analogy for industrial relationships between resource extraction, processing, and consumption.^[128] It embraces the complexity of material flows and is open to multiple interpretations instead of presenting one "perfect" system and rejecting other system solutions the way that Cradle to Cradle specifically seems to do. Industrial ecology implies that waste materials from other industries could be incorporated into archi-

connections:

- » industrial metabolism
- » zero waste

125 Geiser, p.16.

126 Ibid., p.13.

127 Ibid., p.317-18.

128 Fernandez, p.58, 300.



Figure 4.18: *Sheep wool insulation from Sheep Wool Insulation Ltd.*

texture, as long as they meet health and safety criteria and there is a designer willing to integrate them.

Using waste from other industries can imply recycling or re-using materials directly, but also using them as fuel in the production process. As such, not all applications of industrial ecology are made equal; the distinctions of these different processes are discussed in their respective sections.

In architecture, industrial ecology can be exemplified in the use of waste straw for strawbale construction, waste wool from sheep-rearing as insulation, and even waste carpet as an experimental wall construction (by Rural Studio).

Similar to the issue with Cradle to Cradle and recycling more generally, industrial ecology and other “waste as food” concepts can create the perception that waste is not problematic. To this effect, concrete manufacturers have expressed some concern that they don’t want to promote the use of fly ash as a “green” substitute for cement in the long term as it’s a byproduct of coal-burning. They fear that a demand for fly ash could create the perception that the concrete industry supports coal-powered electricity generation.^[129] Burning coal to produce energy releases a lot of particulates into the air, as well as carbon emissions, thereby reducing people’s health, incurring high healthcare costs, and contributing to climate change. Ontario recently closed all of its coal-burning power plants based on these reasons.^[130]



Figure 4.19: *Lucy Carpet House by Rural Studio uses stacked worn carpet tiles for the walls.*

129 Wayne Trusty, *Sustainable Building: A Materials Perspective*, PDF, CMHC, p.11.

130 Derek Leahy, “Ontario’s Electricity Is Officially Coal Free,” DeSmog Canada, April 19, 2014, accessed August 11, 2016, <http://www.desmog.ca/2014/04/17/ontario-s-electricity-officially-coal-free>.

DESIGN FOR DISASSEMBLY

Buildings can be specially designed to be disassembled at the end of their useful life instead of being demolished by conventional means of undifferentiated destruction. As implied in the name, design for disassembly is concerned with the ability to take a building (or other material product) apart at the end of its useful life, by planning for its deconstruction at the design stage. Geiser sums up the characteristic strategies of design for disassembly quite well: “The products of such design processes often exhibit a low number of constituent materials, a high degree of removable components, and an assembly process dependent on reversible snaps, slides, screws, and clamps.”^[131] All of these strategies will make the final object simpler to decompose into re-usable and recyclable parts.

The benefit of design for disassembly is that it makes the task of reclaiming materials to be re-used or recycled significantly easier. It also helps to retain the integrity of the materials by virtue of their disassembly as opposed to homogenization in a waste heap. However, design for disassembly, as the name implies, is focused on *designing* for eventual disassembly and re-use, which puts an emphasis on the ecological benefit the project will have at the end of its life. This is a potential obstacle, which is that as time passes the intent of original design may be lost and there is no guarantee that a building designed this way isn't simply demolished. There may be ways to remedy this, but for now it lies outside the control of the architect to make sure that a building designed for disassembly is really disassembled. In this way, the ecological benefit may be lost. The exception to this is short-term installations such as those designed by Shigeru Ban. On a small timescale, Ban is able to ensure that the take-down of his installations goes as intended; he also makes an effort to use materials that are recycled or re-used in the first place.

connections:

- » design for deconstruction



Figure 4.20: *Paper Church* by Shigeru Ban was a response to Kobe earthquake in 1995. After ten years of service, it was disassembled. Ban has similarly designed structures for disassembly when he knew they would be temporary, such as for exhibitions.

131 Geiser, p.315.

Design for disassembly combined with the use of reclaimed materials can make a powerful combination by simultaneously showing how materials can be reconfigured in new construction as well as making future reconfiguration easier; the Mountain Equipment Co-op store in Ottawa does exactly this.^[132] Currently, buildings can be difficult to deconstruct if they use fasteners like nails or welds. This helps to illustrate how desirable design for deconstruction is, and how much time it could save at the deconstruction stage of a project. If this helps deconstruction become a norm, buildings that are designed for deconstruction will be a happy discovery instead of a forgotten dream. However, I would urge that we don't use the lack of buildings designed for disassembly as an excuse not to engage in deconstruction and reclamation of materials for reuse. Engaging in difficult deconstruction processes helps to highlight the benefits of design for disassembly.

ADAPTIVE RE-USE



Figure 4.21: *University of Waterloo School of Architecture, Cambridge, Ontario was converted from a textile mill.*

Adaptive re-use is the re-use of entire buildings for new tenants and new functions. It eliminates the need to deal with large quantities of building materials as “waste” in the first place and to find an appropriate stream for them. It is an effective strategy for slowing down the rate of flow of building materials because it raises the question of whether anything new is needed or whether adaptation and redistribution can be the solution to a need. It also has the psychological and social benefit of providing a sense of stable identity to the urban fabric. Buildings in historic city centers have been adapted for re-use for decades if not centuries, to the benefit of the city and citizens as a whole.

¹³² Vince Catalli and Maria Williams, “Designing for Disassembly,” *Canadian Architect*, January 1, 2001, accessed August 11, 2016, <https://www.canadianarchitect.com/features/designing-for-disassembly/>.

However, not every structure may be worth saving or possible to save, and it's possible that a retrofit could use more energy than constructing a new building. In an article discussing embodied energy, Martin Holladay comes to the conclusion that "it sometimes makes perfect sense (and it is good for the environment) to bulldoze an old, inefficient building and replace it with a new, energy-efficient building."^[133]

Furthermore, there is an innate need to create as a means of self-expression and psychological fulfillment, and so it's reasonable to believe that we will continue to have a condition whereby new construction and the demolition of old construction continue to take place. In that case, we should have a strategy in place to make the most of those activities. The re-use of materials is the next logical option after adaptive re-use has been considered.

Valuing both the stability of repurposed buildings and the need for creation of new buildings may seem contradictory, but it shows the complexity of material issues and the need to accommodate both strategies rather than trying to decide on the best one—they both have their place and purpose. For example, Wang Shu points out that although places like China may suffer from the loss of memory and history because of rapid development, European cities may also suffer when development is not allowed to occur in the name of preservation.^[134] Neither extreme is socio-psychologically positive.



Figure 4.22: *Dovecote Studio* by *Haworth Tompkins Architects*.

133 Martin Holladay, "All About Embodied Energy," GreenBuildingAdvisor, November 15, 2013, <http://www.greenbuildingadvisor.com/blogs/dept/musings/all-about-embodied-energy>.

134 Anna Tweeddale, "Wang Shu: 'Memory Is Deeper than Symbols'," Australian Design Review, November 15, 2012, accessed July 06, 2016, <https://www.australiandesignreview.com/features/26177-wang-shu-memory-is-deeper-than-symbols>.

connections:
» upcycling



Figure 4.23: *Concept design by Shigeru Ban to build relief shelters in Nepal from building rubble.*

MATERIAL RE-USE

Material re-use is the act of taking previously used materials and using them directly, or with minimal refinishing, in new construction. It's an approach that presents effective ways to respond to the issues of material sustainability.

The ecological benefit of material re-use is that it doesn't take significant mechanical energy to be put to use again, as compared to recycling. In this way it can play a bigger role in reducing greenhouse gas emissions. It also slows down natural resource depletion, although it is arguable that this issue isn't as pressing for most construction materials as that of carbon emissions. When doing an ecological comparison between re-use and production of any kind of new material, there is both a savings in energy that equates to reduction in greenhouse gas emissions and less ecosystem destruction at the extraction site. This begins to touch on a psychological benefit of re-use, which is the easing of solastagia—the pain associated with having your ecological home degraded.

Material re-use has the highest impact on greenhouse gas emissions when it can be done locally. That is to say, when materials can come from nearby demolition projects.^[135] In this way, it can overcome one of the weaknesses of purely “local” architecture which limits its material palette to such an extent that building durability may suffer and the project may not be able to include any globally innovative techniques that address aspects of sustainability other than transport distance and sense of local identity. It is possible to get the best of both global and local material flows by reusing materials, and since the source is still local it can be interpreted as an expanded definition of “local architecture.” It can contribute to a new vernacular that stays true to the definition proposed by Jackson—“identified with local custom, pragmatic adaptation, and unpredictably mobil-

135 Liselott Roth, *Reuse of Construction Materials: Environmental Performance and Assessment Methodology*, PhD diss., Linköpings Universitet, 2005, p.60.

ity”^[136]—that is more encompassing than the more common association with “local techniques, local materials, and local climate” but without “stylistic sophistication.”^[137] These qualities don’t have to be mutually exclusive.

The strength of this kind of local or vernacular architecture is that it will be able to absorb the global nature of contemporary material flows, and benefit by them. For example, it does not reject steel on the grounds that it cannot be naturally sourced in Southern Ontario. Once a material arrives here it can be absorbed into a contemporary vernacular driven by the need to adapt to restraints on emissions. Just as original vernacular architecture operated under a scarcity of locally available materials, material re-use addresses the scarcity of greenhouse gas emissions that we can afford to release; it addresses a constructed scarcity which nevertheless has very real consequences. It’s very important that material re-use is an effort that doesn’t dictate a total cessation of global flows; although such an action would unarguably reduce greenhouse gas emissions it would also be an extreme decision that would impose such a massive change that it could be politically and economically catastrophic. Material re-use comes from a mindset that change needs to happen, but that it shouldn’t be extreme because it would create a different kind of crisis. In this way, it also helps to keep with “local custom” by continuing to have some buildings constructed of steel, or some building components made of steel—not least of all rebar.

However, a contemporary vernacular would also differ from the common definition because it does not have to be limited to local techniques or be without stylistic sophistication. As long as global communication is possible, spread of technique is also possible; the only thing limiting it is finding a willing craftsperson to take it on. Similarly, if an architect is willing to spend time composing the building thoughtfully it does not have to lack in aesthetics. This last



Figure 4.24: *Salvaged Ring* by a21 Studio in Vietnam is built with many scraps of wood from a local carpenter.

136 Jackson, *Discovering the Vernacular Landscape*, p.xii.

137 *Ibid.*, p.85.



Figure 4.25: *MEC Ottawa designed by architects Linda Chapman and Christopher Simmonds working with Vince Catalli and Derek Badger of by dEsign consultants. The project uses material reclaimed and reused in-situ.*

point, and the ensuing challenges, will be discussed in more detail further on.

Reuse is not automatically ecologically-friendly. In terms of energy expenditure, locally-sourced reclaimed materials can have bigger savings of carbon emissions than those sourced from further away. Furthermore, older materials may contain hazardous compounds, such as lead or asbestos, that require caution in dismantling and don't make good candidates for reuse in new structures.

Psychologically, I speculate that a building made of reclaimed, aged materials helps us to acknowledge the passing of time and to accept aging as a natural and possibly graceful process. Furthermore, the challenging work of putting reclaimed material to new use has a craft-like quality that fosters a healthier relationship to materials via materiality instead of consumption. Craft-like work can be fulfilling, engaging, and help to form individual identity as well as community.^[138]

Socially, the use of locally-sourced materials helps to create new economic opportunities and to sidestep engagement in ethically-challenging outsourcing of cheap work and ecological degradation to developing countries.

MATERIAL APPROACHES - CONCLUSIONS

Having reviewed the various approaches to material sustainability we can identify several positions that it's possible to take: local or global distribution; natural or artificially-made materials; renewable or non-renewable; disposable or durable lifespan; linear or cyclical material flow; fast or slow material flow; crafted or machined; skilled or skill-less. These dimensions of material sustainability can contribute to ecological, psychological, and social sustainability, or they can detract from them. To consider material sustainability means to

¹³⁸ Matthew B. Crawford, *The Case for Working with Your Hands: Or Why Office Work Is Bad for Us and Fixing Things Feels Good* (London: Viking, 2010).

holistically look at the bigger picture and identify factors for evaluation that affect each of the three spheres, and there are a lot of factors to juggle.

One thing that became clear by reviewing different approaches to material sustainability is that it's nearly impossible to make generalizations about whether they are "good" or "bad." Most approaches can manifest architecture with high or low embodied energy, high or low toxicity, high or low durability, etc. What is possible to understand or critique in a general way is the philosophy of any one of these approaches, such as the penchant for new material innovations to be equated with the idea that technology is the key to saving our environment, or the repeated assertion in *Cradle to Cradle* that its recycling scheme can be executed without degrading material quality.

To put it another way, studying the different philosophies of material sustainability was useful for understanding problem areas in material production and use, since literature on different approaches highlights different problems. These problem areas can be translated into a list of indicators. Although I've come across literature that does define sets of indicators for material sustainability, most focus only on ecological impacts. I have yet to find sources that form their list of indicators from a holistic viewpoint that encompasses culture and psyche.

This research enabled me to combine discussions of materiality in architecture with the ecological concerns of materials. In the course of doing the research I was specifically paying attention to a few questions that I felt would help to address issues I identified in material culture: which approach(es) can have the most immediate impact on reducing greenhouse gas emissions without jeopardizing other indicators of environmental sustainability? Which approach(es) allow architects to be actively involved as solution-makers? Which approach(es) satisfy individual psychological needs while helping to move away from materialism? (e.g. Does the materiality of this

approach satisfy biophilia?) Which approach(es) engage people and create work, as opposed to mechanizing or industrializing it?

Below I've summarized some of these indicators.

Indicators

Ecological

- » embodied energy
- » impact on operational energy (e.g. concrete acts as thermal mass, but is naturally non-insulating which could be a problem)
- » renewability
- » toxicology
- » impact on biodiversity/ecosystems (sustainable resource management vs. “opportunistic depletions”)
- » creation of solid waste
- » impact on water (quantity of use/recapture/treatment of used water/release back in what state)
- » comfort and health
- » durability (performance in time)
- » reusability
- » recyclability^[139]

Socio-psychological

- » affordability^[140]
- » potential to involve local labour or help local labour train in a new skill (build local skill to create sense of pride in the trade)
- » fair employment, fair trade^[141] (ie. not exploiting people to get our goods at a price that we like, nor exploiting the environment to hide away the garbage, sometimes toxic, that we create)

139 “Sustainability Opportunities,” Canadian Architect, accessed August 11, 2016, https://www.canadianarchitect.com/asf/perspectives_sustainability/sustainability_opportunities/sustainability_opportunities.htm.

140 Ibid.

141 “One Planet Living: The 10 Principles,” Bioregional, accessed August 11, 2016, <http://www.bioregional.com/oneplanetliving/>. (with regard to equity and local economy)

- » encourage social connections
- » provide tangible feedback that brings to light commentary on material issues
- » social durability (beauty vs trend)
- » allow for creation, identity formation, display of mastery (after skill building)
- » acknowledge time passes (existentialism)
- » encourage productive activity (meaningful work)
- » build cultural myth / story, like Hollis says is the “ultimate source of authority”^[142]

142 Edward Hollis, *The Secret Lives of Buildings: From the Ruins of the Parthenon to the Vegas Strip in Thirteen Stories* (New York: Metropolitan Books, 2009), p.40.

5 MATERIAL STUDIES

*Studying steel, glass, brick, concrete, wood, and extruded/
expanded polystyrene insulation.*

A study of different approaches to material sustainability showed that it isn't possible to generalize their effectiveness because each has the capacity to be executed well and with net positive effects, just as it can be executed poorly and with net negative effects. Instead, the study helped pinpoint indicators of ecological, social, and psychological sustainability by cross-examining the literature on different approaches to gain a wider perspective.

In the course of looking at different material approaches, I started to gather some material-specific knowledge. In this section I look at several common building materials to understand where they come from, how they're manufactured, and what can happen to them after the life of a building is deemed to be over. Although I identified a number of environmental indicators in the previous section, in this section I focus on understanding the industrial flow of the material and the options for recycling, reusing, or composting that material at the end of its life. The environmental impacts of producing these materials are discussed only briefly in the context of embodied energy because I began to focus on analyzing how materials fit into a cyclical paradigm, or a "circular economy."

RECYCLING CASE STUDY: STEEL

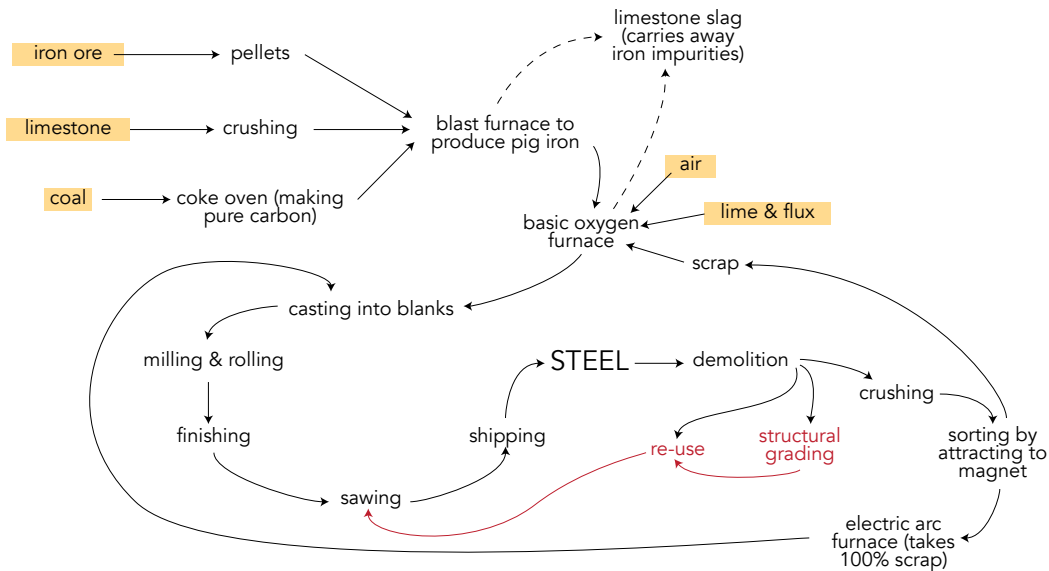


Figure 5.1: Life-cycle diagram for steel.

Steel production is a very energy intensive process. Perhaps because of this, there is a lot of incentive to collect and recycle as much of it as possible and recycling facilities are common. It is touted as the most recycled material in general.^[143] The quality of the metal doesn't significantly decrease—it can be recycled many times.

Most structural steel comes from recycled metal,^[144] and although this is good it must also be considered that if steel demand rises to meet demand for green buildings, then more steel will inevitably have to be produced from its basic ingredients in an energy intensive way. Demand drives production, which is another danger of trying to pick one “right” material for sustainable architecture.

143 “Steel Is the World’s Most Recycled Material,” Steel Works: The Online Resource for Steel, accessed August 23, 2016, <http://www.steel.org/sustainability/steel-recycling.aspx>.

144 Edward Allen and Joseph Iano, *Fundamentals of Building Construction: Materials and Methods* (Hoboken, NJ: J. Wiley & Sons, 2004), p.374.



Figure 5.2: *Third Wave Kiosk by Tony Hobba Architects in Australia reuses steel piles.*



Figure 5.3: *“Reycloop” kitchen sink building by Superuse Studio in Amsterdam is an installation that reuses old steel sinks.*



Figure 5.4: *“Wikado” playground by Superuse Studio in the Netherlands reuses parts of aircraft to make a playground.*

RECYCLING CASE STUDY: GLASS

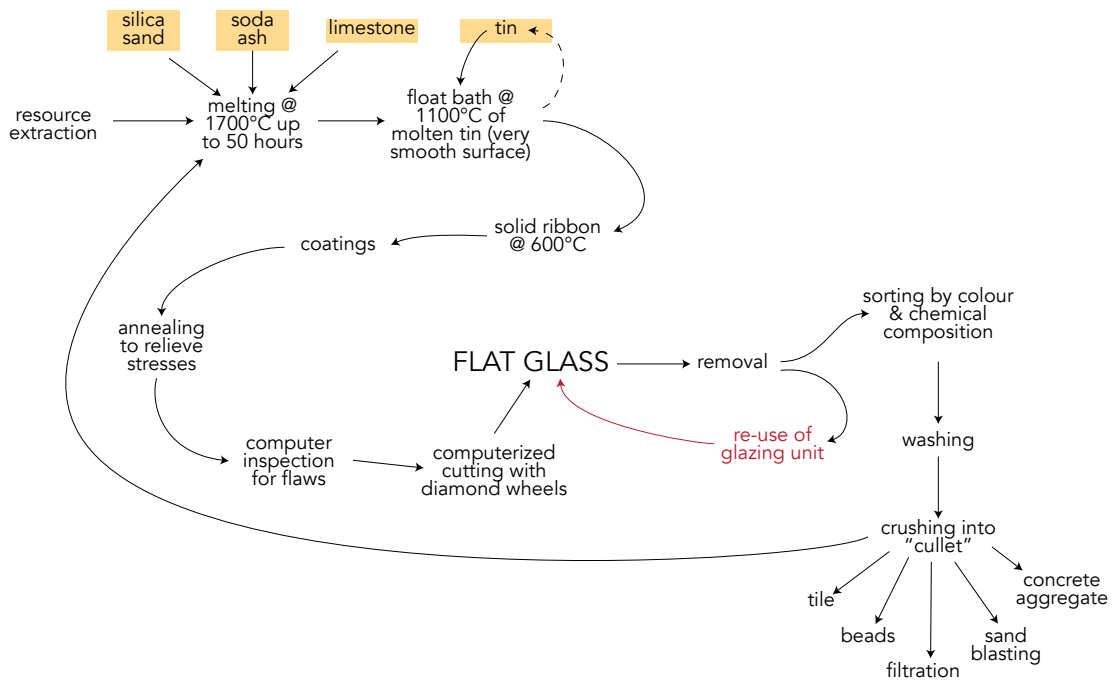


Figure 5.5: Life-cycle diagram for flat glass.

Glass is produced by melting down silica sand, soda ash, and limestone at high temperatures, using a lot of energy. However, glass is highly recyclable and its quality doesn't degrade in the process.^[145] Used glass is crushed into "cullet" and is usually added to the sand, ash, and limestone mixture. It has a much lower melting point than the minerals, and it takes less energy to recycle it than to make it from scratch. However, due to some complexity of sorting different colours and compositions of glass, and cleaning it to make sure absolutely no contamination remains, there are few plants that recycle glass. Only one—NexCycle in Guelph—appears to serve all of Ontario. As well, the flat glass used in buildings has very little recycling, partly since glazing units must be disassembled.^[146]

145 "Glass Is Infinitely Recyclable," British Glass, accessed August 23, 2016, <http://www.britglass.org.uk/infinitely-recyclable>.

146 "Recycling of End-of-life Building Glass," European Online Resource Efficiency Platform Interactive Library RSS, accessed August 23, 2016, <http://blogs.ec.europa.eu/orep/recycling-of-end-of-life-building-glass/>. and *Recycling of End-of-life Building Glass*, PDF, June 2013.



Figure 5.6: *House in the Garden* by Cunningham Architects uses recycled glass chunks to make a privacy screen.



Figure 5.7: *Glass Chapel/Mason's Bend Community Center* by Rural Studio in Hale, Alabama reuses windshields to create a semi-enclosed space.



Figure 5.8: *Wat Pa Maha Chedio Kaew* temple in Sisaket, Thailand reuses consumer glass bottles as bricks.

LOCAL MATERIAL CASE STUDY: BRICK

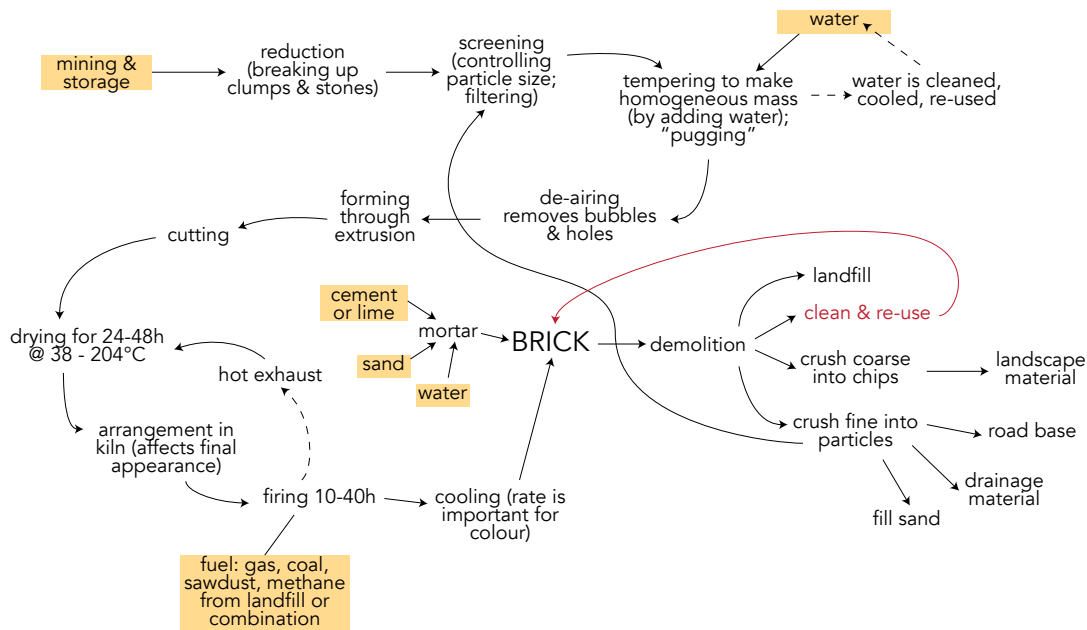


Figure 5.9: Life-cycle diagram for brick.

Brick is a fairly low-impact building material as its constituent materials are abundantly available. It takes a bit more energy to produce than concrete, however it also has more potential for reclamation and reuse. The mortar in older construction is weaker, making old bricks easier to reclaim and re-use in new construction; old bricks are said to be harder than new ones. This process can only really be done once or twice, since disassembling a wall and cleaning off the mortar wears down the brick.^[147] Otherwise, brick can also be turned into rubble for similar purposes as concrete rubble (roadwork and landscaping).^[148]

The look of reclaimed brick in construction produces a variegation in texture and colour, giving a look of patina even to new construction.

147 "Reclaiming Bricks," Diyfixit, accessed August 23, 2016, <http://www.diyfixit.co.uk/building/reclaiming-bricks.html>.

148 "Bricks," Business Recycling: Making Recycling at Work Easy, accessed August 23, 2016, <http://businessrecycling.com.au/recycle/bricks>.



Figure 5.10: *Pavilion 4 by HMA Architects & Designers in Shanghai, China reuses brick.*

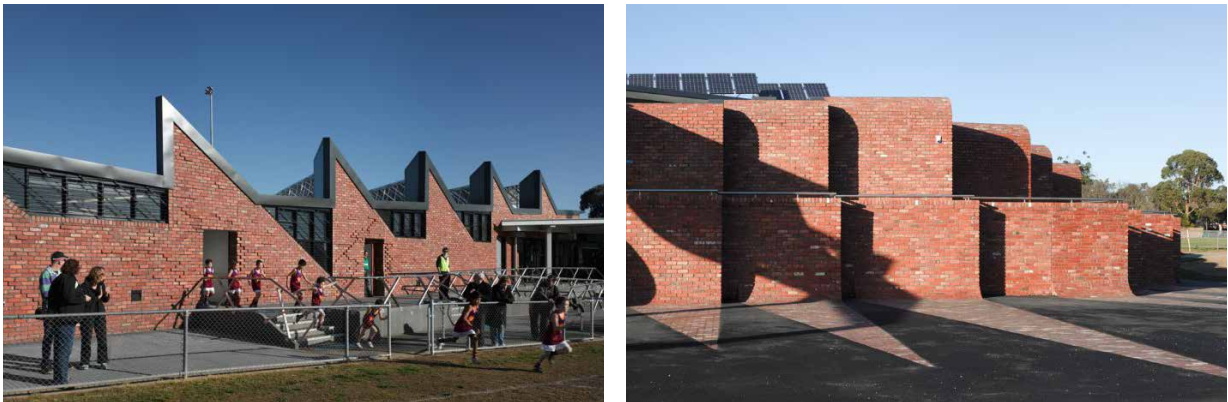


Figure 5.11: *Templestowe Football Pavilion by Phooley Architects in Melbourne, Australia reuses brick.*

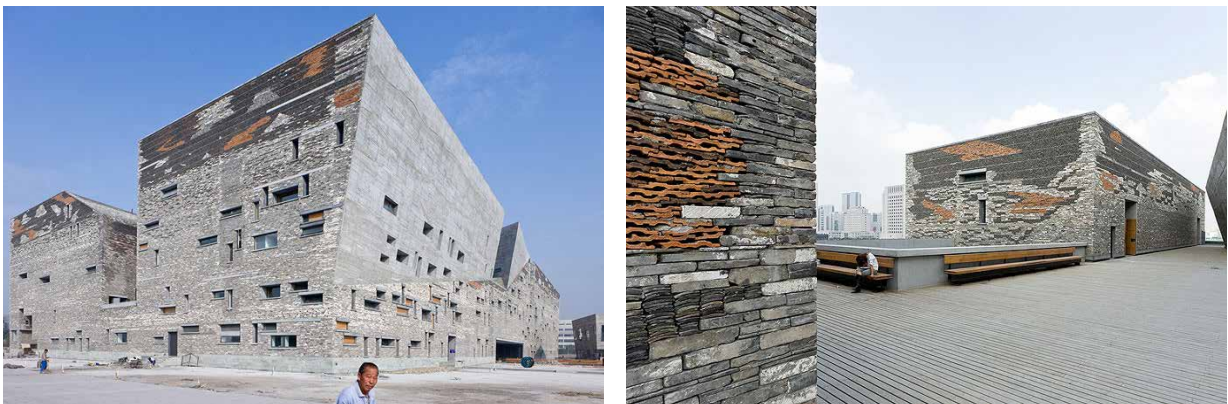


Figure 5.12: *Ningbo Historic Museum by Wang Shu, Amateur Architecture Studio in Ningbo, China reuses stone, brick, and clay tiles.*

LOCAL MATERIAL CASE STUDY: CONCRETE

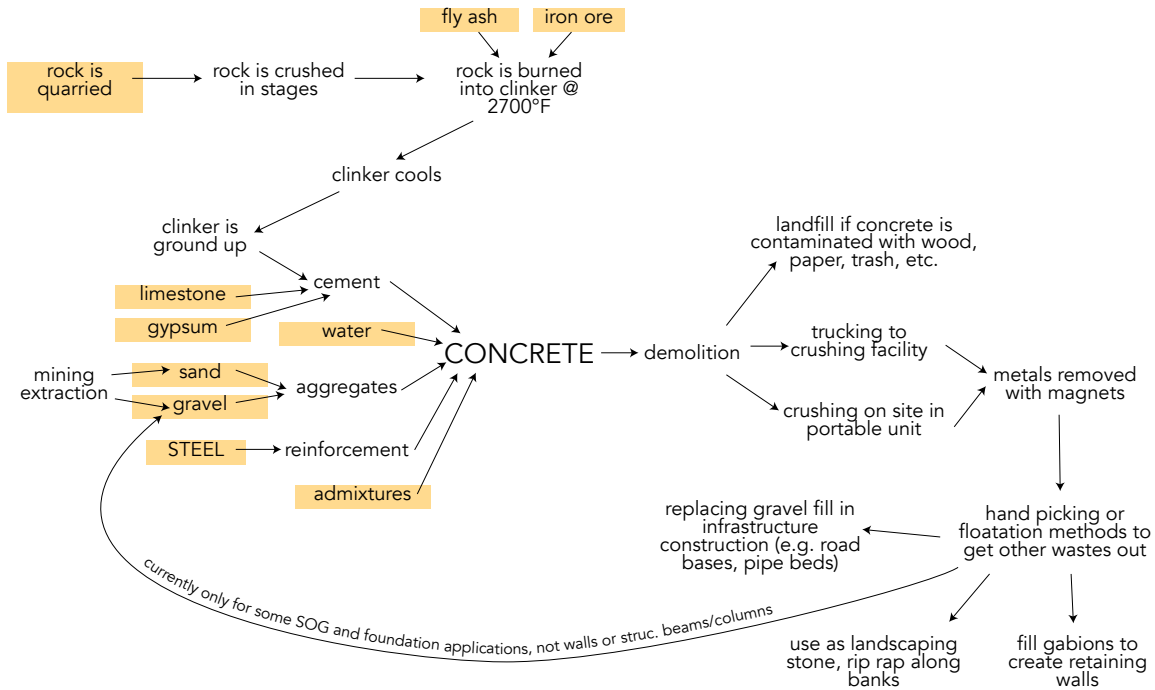


Figure 5.13: Life-cycle diagram for concrete.

The most intensive part of producing concrete is the production of the cement that acts as binder for the mixture. Quarried rock is burned at high temperatures and then ground down into a paste to produce the cement. It is estimated that this process contributes about 5% of *all* global CO₂ emissions.^[149] However, more recently there has been growing consideration for the fact that concrete carbonates during its lifetime, meaning that it absorbs CO₂ at the surface.^[150]

After the life of the building is over, concrete can be demolished, and if it is uncontaminated by other materials such as wood or paper, it can be crushed on site or trucked to a crushing facility to be repurposed. My preliminary search suggests that concrete is

149 Madeleine Rubenstein, "Emissions from the Cement Industry," State of the Planet: Earth Institute, Columbia University, accessed August 23, 2016, <http://blogs.ei.columbia.edu/2012/05/09/emissions-from-the-cement-industry/>.

150 "Recycled Aggregates," PCA: America's Cement Manufacturers, accessed August 23, 2016, <http://www.cement.org/for-concrete-books-learning/concrete-technology/concrete-design-production/recycled-aggregates>.

most often downcycled into rubble for fills, gravel beds, and retention structures.^[151] There is a precedent for incorporating the rubble as aggregate into new concrete construction, but this is limited due to attitudinal barriers towards reusing materials.

Looking at an earthen material such as concrete helped me understand that some materials don't fit very well into a cyclical economy. This did not indicate to me that they should not be used, but rather made me think that a material like concrete embodies durability and is antithetical to consumerism by nature of not being recyclable.

151 "Markets for Recycled Concrete Aggregate," CDRA: Construction & Demolition Recycling Association, accessed August 23, 2016, <http://www.cdrecycling.org/end-markets>.



Figure 5.14: *SOS Children's Village Community Center by Studio Gang in Chicago, 2008; the team used leftover readymix concrete from condominium construction sites at the end of each day to build up the exterior walls; the concrete was donated.*



Figure 5.15: *Hanil Visitors Center & Guest House by BCHO Architects uses gabion baskets filled with crushed (therefore "downcycled") concrete.*

RENEWABLE MATERIAL CASE STUDY: WOOD

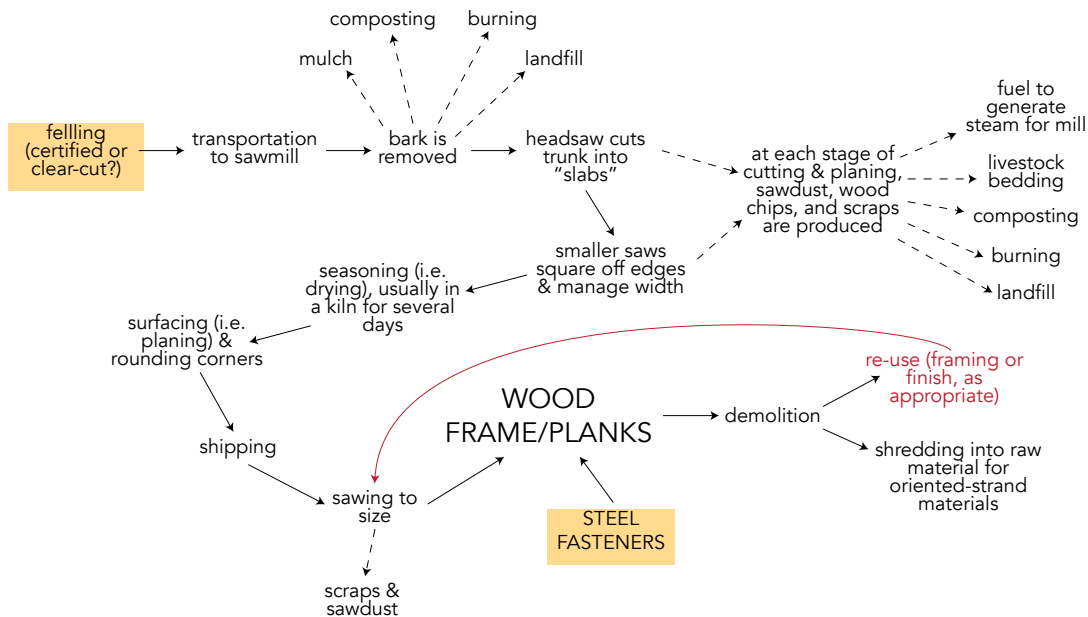


Figure 5.16: Life-cycle diagram for wood.

Wood has very low embodied energy, especially considering its structural capabilities (measured by its strength-to-weight ratio).

Wood can be downcyclable, re-usable, and renewable, but not perfectly recyclable. A plank of wood can be recycled once by shredding it to make the raw material for engineered wood products (together with various adhesives). The promise of wood is that it is biodegradable (though adhesives are not) and renewable - given sun and water it will grow. However, as discussed in the section on "renewable materials," there is conflicting evidence about the role of plants in global warming. Although wood has a low embodied energy and sequesters carbon, wood as a living plant may help to reduce global warming effects.



Figure 5.17: *Villa Welpeloo* by Superuse Studio in Enschede, The Netherlands reuses wood from cable reels.



Figure 5.18: *Kaap Skil Maritime and Beachcombers' Museum* by Mecanoo in Oudeschild, The Netherlands uses reclaimed wood as a screen over a glass facade.



Figure 5.19: *House* by Timeless Material Co. in Ontario reuses wood trusses from a much older structure.

RECYCLING CASE STUDY: EXTRUDED & EXPANDED POLYSTYRENE

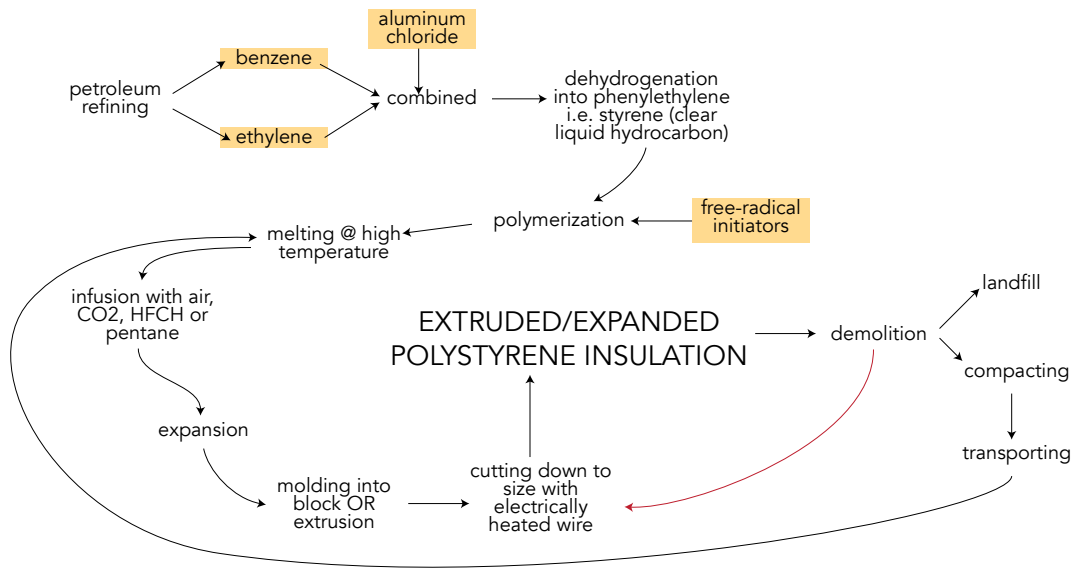


Figure 5.20: Life-cycle diagram for extruded and expanded polystyrene.

While it is possible to recycle insulation, in practice it isn't often done because its bulk needs to be compacted down before it becomes profitable to transport it to a recycling facility and process it. [152] However, it can be successfully reclaimed and used in new projects. [153]

152 "Polystyrene (PS)," PlasticsEurope, accessed August 23, 2016, <http://www.plasticseurope.org/what-is-plastic/types-of-plastics-11148/polystyrene.aspx>.

153 "Using Recycled Rigid Foam," GreenBuildingAdvisor.com, May 2013, accessed August 30, 2016, <http://www.greenbuildingadvisor.com/community/forum/green-products-and-materials/27463/using-recycled-rigid-foam>.



Figure 5.21: *Compacted XPS insulation.*



Figure 5.22: *Reclaimed 5" EPS sheets for sale through Craigslist. Buffalo listing. Accessed August 30, 2016.*

Material Studies—Conclusions

It became apparent that no one material is ideal across all indicators, and that choosing one material over another is complex in itself. Moreover, not all material of one type has the same provenance. Although studying materials this way helps gain a general understanding, a finer level of specificity based on a specific manufacturer and a specific provenance is the final determining factor of what may be called more or less sustainable. A couple of imperatives based on studying approaches and material flows starts to emerge, however. For example, since embodied energy is determined by the amount of energy required for extraction, transportation, manufacturing, and delivery to site, there are benefits to using materials that are found locally, are reused or recycled from a previous use, and use minimal energy for reprocessing. At the same time, materials harvested and finished in a developed country (such as our Canada) face more stringent requirements for ethical treatment of workers and the environment. As discussed in the section on local materials, these also have the advantage of being able to speak to a local identity. In this way, it became important to me to explore ways of waste diversion from today's construction industry; of minimizing ecosystem impacts such as carbon emissions; of working locally; and by the agency of a practicing architect. Of the various material philosophies and flows, material reuse stood out as an approach that meets these criteria, thereby addressing both the cultural question of how materiality can play into sustainable architecture, and the ecological question of how architecture can be practiced with respect for the environment. It's important to note that reclaimed materials must still pass specific requirements for performance and non-toxicity to be accepted for this use, otherwise other waste streams must be considered.

I found that looking at production and disposal of construction materials as an abstracted process left out some important considerations with regard to spatial execution. The spatial aspect of material processes is important because of the highly globalized

nature of today's economy. For example, the production and disposal processes for steel can be understood abstractly in terms of mining and refining steps, but a more nuanced picture emerges if the process is followed spatially. China imports overwhelming quantities of iron ore from all over the world, processes it, and then exports the resulting steel back to the world.^[154] Still, China does not process *all* iron ore. Therefore, there may be better/worse options if you start looking at individual manufacturers. When looking at recycling and reuse of steel, instead of production from raw materials, it tends to be more local.^[155]

This better/worse quality is present in other material production and disposal industries, which is probably why most researchers who attempt to pinpoint the environmental impacts of materials do so by looking at specific products, specific companies, and specific production processes.^[156] This is also a possible reason why life cycle assessments for materials are said not to be very accurate—they are not spatially specific enough.

154 Adveith Nair, "ANALYSIS - New Iron Ore Pricing System Seen Boosting Dry Bulk," Reuters India, April 14, 2010, <http://in.reuters.com/article/idINIndia-47669720100413>.

155 Allen and Iano, *Fundamentals of Building Construction*, p.374.

156 for example, in Andrew Walker-Morison, "A Material Difference: Sustainability beyond Symbolism and the Development of Ecospecifier," in *Imaging Sustainability*, ed. Helen Lewis and Chris Ryan (Melbourne: RMIT University Press, 2006), p.41-43.

Figure 5.23: Iron ore production by country (2011)

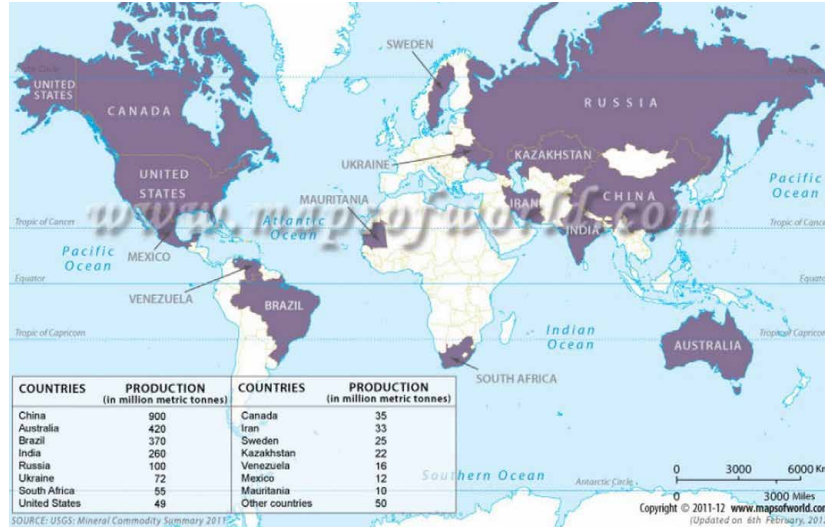


Figure 5.24: China's iron ore imports 2009

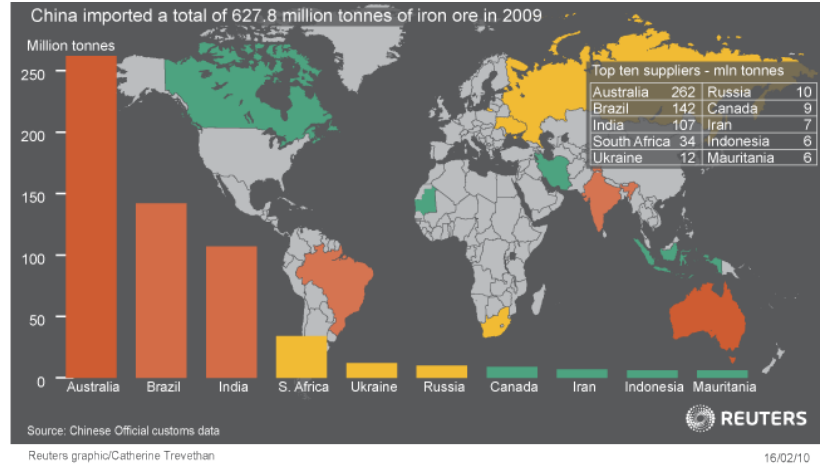
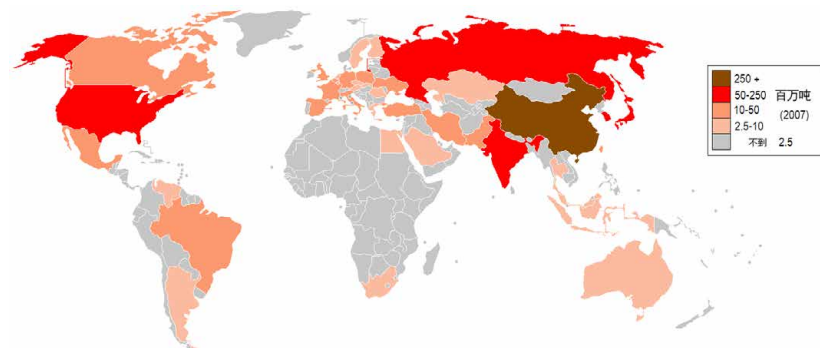


Figure 5.25: Steel production by country (2007; millions of tons)



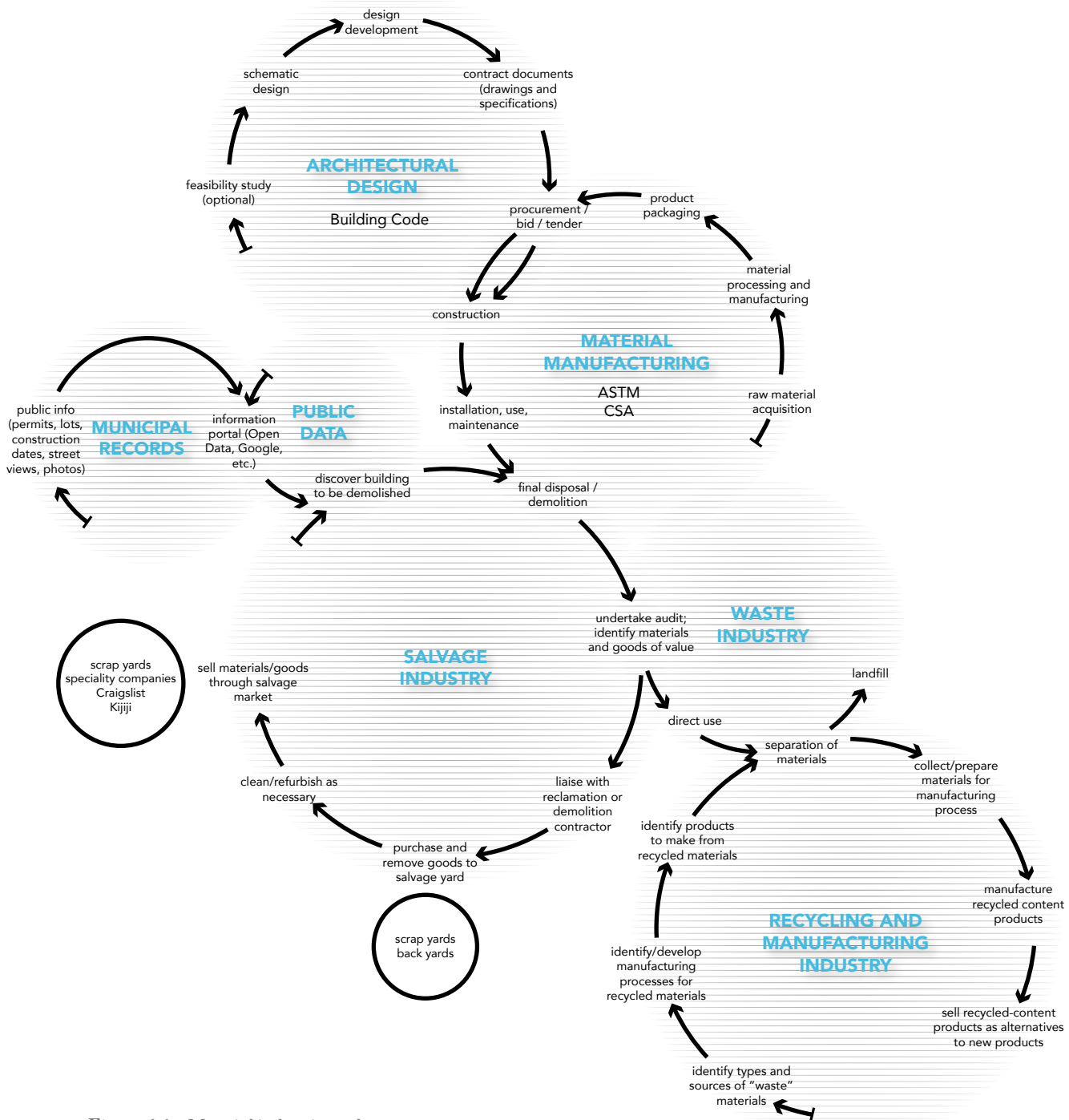


Figure 6.1: Material industries and points of their overlap.

6 MATERIAL INDUSTRIES

Material re-use holarchy
Material re-use actors

I have looked at material sustainability from the perspective of different “approaches” or ethos, as well as by looking at several common building materials. Another way to better understand it is by analyzing how various material industries are related and governed, and how they are run. In this section I do just that by identifying governing structures, industries, and end users and studying how materials flow through the different systems.

Actors in the system have three types:

- » sites of material provenance and deposit (spatial)
- » business organizations (socio-economic; act on material, create spatial links)
- » policing bodies that govern either industries or settlement areas (at the level of municipalities, provinces, and countries)

The previous section helped to understand relationships between material industries by looking at how individual materials are made and disposed of. The advantage of this approach is that it provides detailed knowledge about how a specific material is dealt with, and leads to a discovery of specific issues that can then be addressed

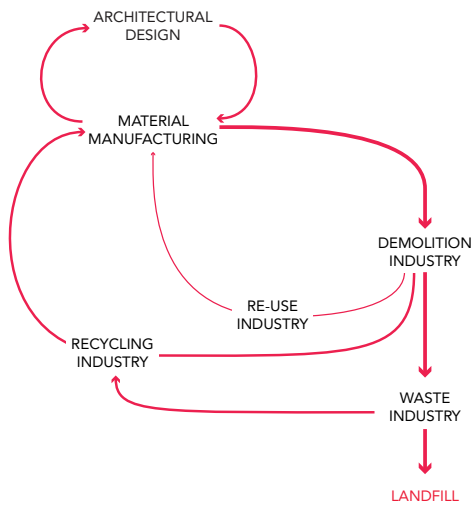


Figure 6.2: *Simplified diagram of material cycling.*

in policy. However, I felt that an abstract understanding of material processes should be combined with an understanding of the material industries that produce them.

I concluded the material studies by alluding to the fact that in-depth evaluation (particularly of environmental sustainability indicators) is only possible by studying specific manufacturers of materials, and their spatially-specific practices. Similarly in this section a review of literature on material industries is used to understand their general inter-relationships, and industries are mapped in a local—Southern Ontario—context to understand them spatially. However, I will note that not all maps are complete. In my research I found that constructing maps of some industries is not within my scope at this time. For example, using a public source of information such as YellowPages fails to bring up a particularly useful listing of recycling services^[157] for the construction sector; the glass recycler I found, NexCycle, is not categorized,^[158] and other businesses, such as recycled concrete aggregate plants don't show up.^[159] This kind of specialized knowledge requires further academic or professional research to understand the individual industry players.

157 Recycling services on YellowPages: <http://www.yellowpages.ca/search/si/1/Recycling+Services/ontario>

158 NexCycle search results: <http://www.yellowpages.ca/search/si/1/nexcycle/ontario> (uncategorized as of July 27, 2016)

159 Aggregate Recycling Ontario: http://www.aggregaterecyclingontario.ca/interactive_map.html

Material re-use actors:

POLICING

Standards development organizations
Building codes, bylaws

INDUSTRIES

New material manufacturing
Demolition industry
Recycling and manufacturing
Rubbish removal
Solid waste facilities
Salvage industry

DESIGNERS/USERS

Architectural practices
Salvage/deconstruction/green building consultants

Standards

I found it important to know how material quality and use are governed, in order to understand the process by which they get a seal of approval for use in buildings. Standards are made by expert stakeholders for a variety of products, including construction materials. Their creation is overseen by a standards development organization, which can be international (like ASTM and UL) or national (like CSA and ULC). Standards are generally followed voluntarily. In order for standards to become a legally binding requirement, they have to be referenced in legislation such as the Building Code. This means that any product labeled with a mandatory standard has to be tested and certified by a conformity assessor before it can be sold for use, such as for construction. Conformity assessors must be accredited by the SCC (Standards Council of Canada) for work in Canada.^[160]

Still, how does a standard get made? Creating a new standard can be a long process, but it starts with an application which gets rigorously reviewed by a standards development organization (ASTM, CSA, ULC, etc. not sure which organization is most appropriate to which kind of application).^[161] It's unclear who is responsible for finding the funding for creating a new standard, but CSA will prepare a cost estimate. However, part of the requirement for a standard is that it provide value for the stakeholders; that is, it should show that it will improve an aspect of the industry. Furthermore, CSA states that "an in-depth evaluation may not be required

160 "Frequently Asked Questions: Standards-related Questions." Standards Council of Canada. Accessed April 26, 2016. <https://www.scc.ca/en/help/faqs>.

161 "How Standards Are Developed." CSA Group. Accessed April 26, 2016. <http://www.csagroup.org/services/codes-and-standards/standards-development/how-standards-are-developed/>.

... where the beneficial effects clearly exceed cost.”^[162] Societal as well as economic benefits are considered.^[163]

CSA oversees standards for many industries, including construction and building materials: “CSA Group is your leading testing & certification and standard solutions provider for construction-related safety & performance requirements for Canada. Our services for building materials cover a range of products, including roof vents, flashing, siding and other components.”^[164]

One standard can cover a lot of factors. For example, CSA-O86 is the standard for “Engineering Design in Wood” and covers everything from basic sizing to design requirements for specific applications of wood.^[165]

162 CSA Group. *CSA Directives and Guidelines Governing Standardization, Part 2: Development Process*. Report no. CSA-SDP-2.2-14. 2014. http://d1lbt4ns9xine0.cloudfront.net/csa_core/ccurl-zip/292/494/SDP_2-2_Part_2_Development-process-2014.pdf. p.9

163 *Ibid.*, p.10.

164 "Building Materials." CSA Group. Accessed April 26, 2016. <http://www.csagroup.org/industries/construction-buildings-infrastructure/building-materials/>.

165 Canadian Standards Association, *CAN/CSA-O86-01 Engineering Design in Wood*, January 2003.

Regulatory Bodies

Regulatory bodies that govern settlement areas determine socially-agreed boundaries, such as municipal outlines, census tracts, land use zoning, and lot divisions. Some of these levels of regulation govern the types of construction and construction processes that are permitted in an area e.g. the Ontario Building Code, and City of Toronto bylaws. In order to construct or demolish a "building," permits have to be obtained, and the procedure has to be carried out in compliance with safety and building code regulations. In turn, these regulatory bodies are potential sources of information about the buildings that may be encountered on a demolition site. This information can be useful in trying to create closed-loop material cycles, because it can be studied to understand the city as a material "mine" for future reuse and recycling. The various sub-levels of governance yield different information about construction patterns, especially if studied historically.

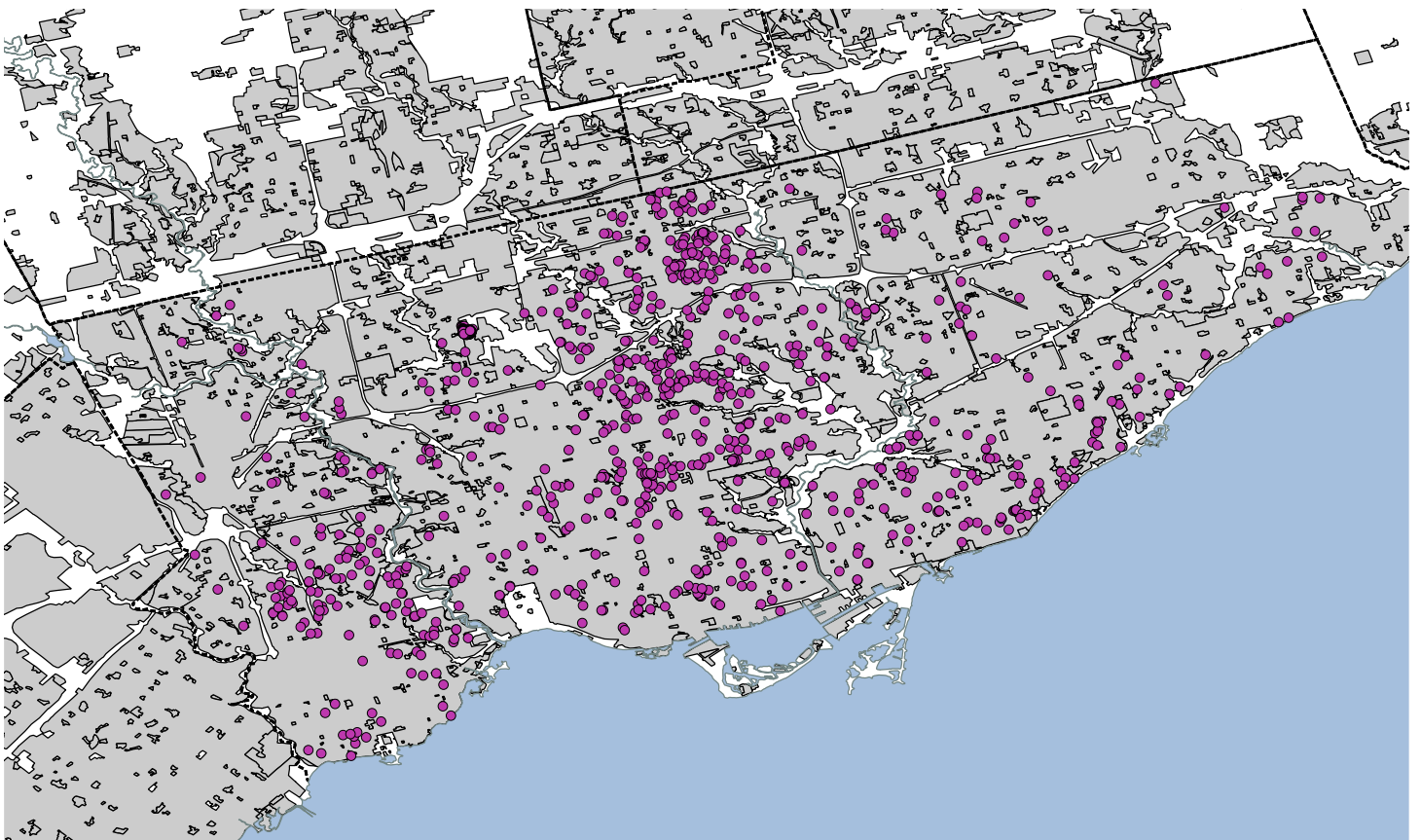
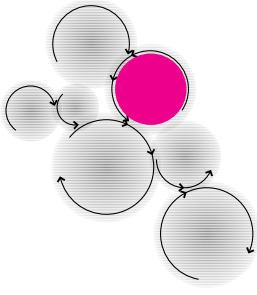


Figure 6.3: Active demo permits 2014



New Material Manufacturing

New material manufacturing starts with the mining/raw material extraction, and can go through several industries or manufacturers before it gets to the manufacturer that produces a building material from it. In the course of this process a material can travel extensively around the world.

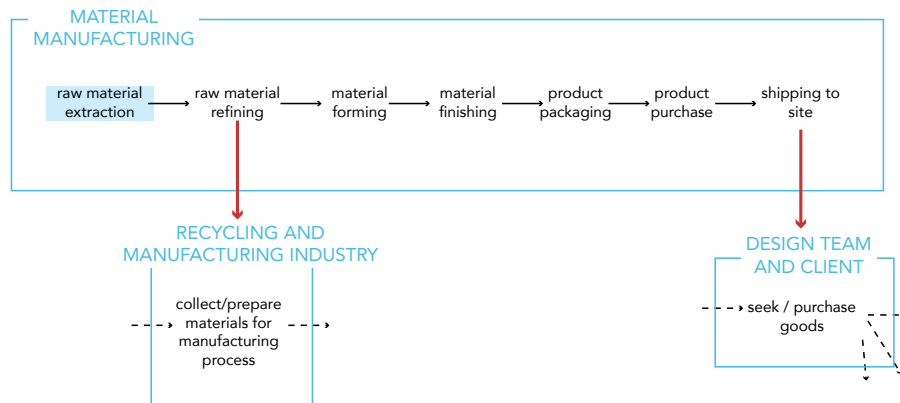


Figure 6.4: *New material manufacturing industry in/out flow diagram with other industries.*



Figure 6.5: Iron ore mine (raw material extraction), iron pellets (refining), forming steel.

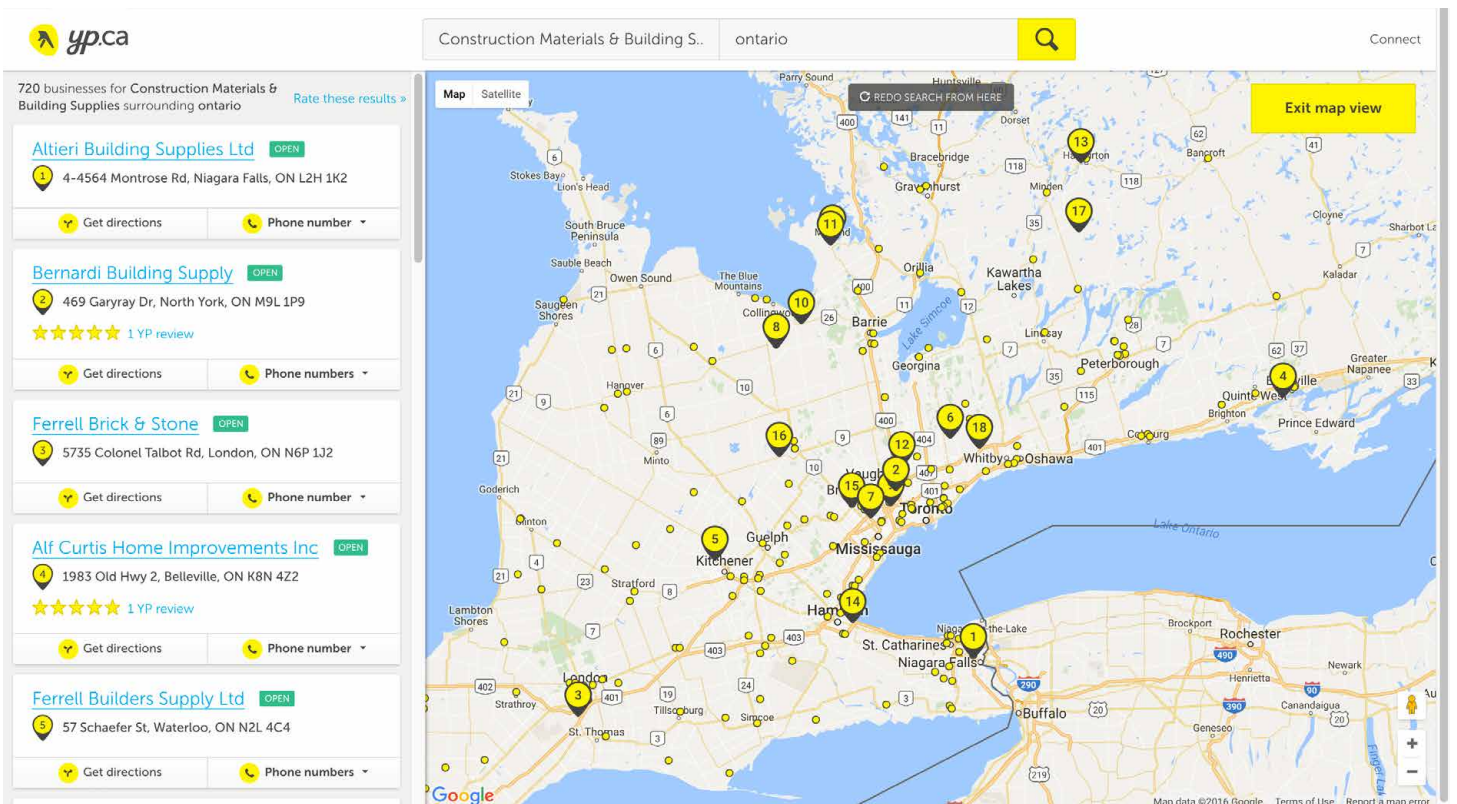
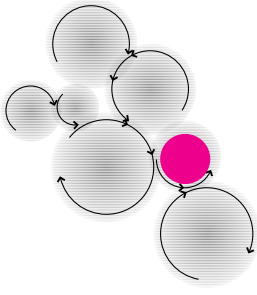


Figure 6.6: Construction materials and building supplies on YellowPages.

Demolition Industry



Demolition companies can have offices and warehouse/storage facilities, but work out of demolition sites to remove material. Different modes of demolition are possible, depending on the decisions about what will happen with the material. Approaches include “smash and bury,” “smash” and sort into recyclables, soft strip valuables and demolish, or full deconstruction with the intent of re-use. The term for the latter is deconstruction contractors.

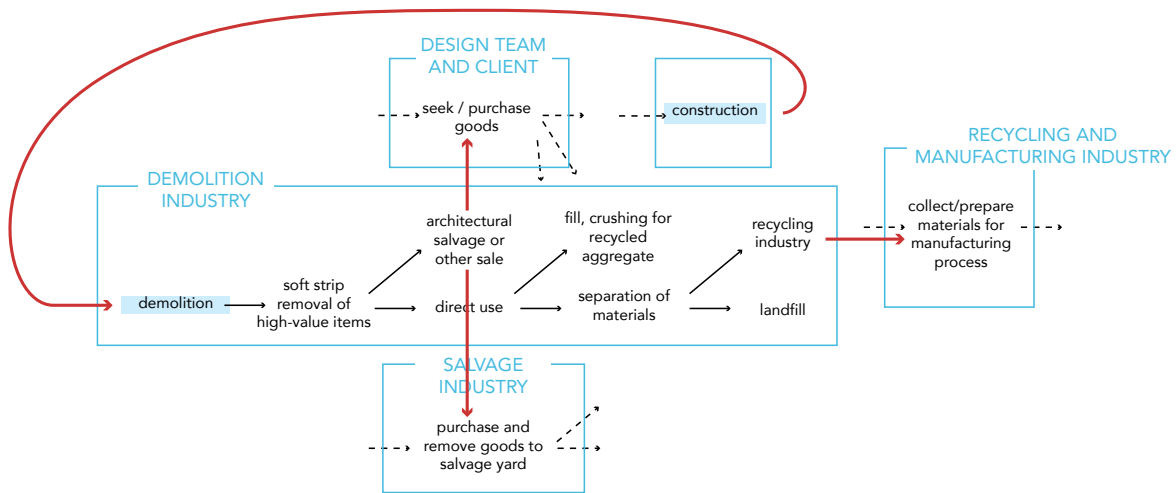


Figure 6.7: Demolition industry in/out flow diagram with other industries.



Figure 6.8: "Business as usual" demolition, material sorting on-site, deconstruction and stockpiling of materials.

162 businesses for Demolition Contractors surrounding ontario

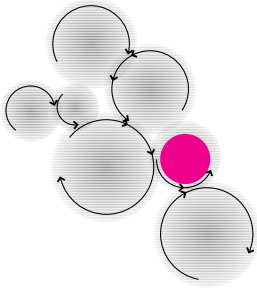
Rate these results

- Lanmar Demolition**
1 627 Main St E, Hamilton, ON L8M 1J5 Get directions
905-524-2740
- Royal Crest Demolition**
2 52 Golders Green Ave, Scarborough, ON M1C 3P6 Get directions
647-558-2465
- Romano Demolition**
3 8633 Jane St, Concord, ON L4K 2M6 Get directions
905-669-2323
- Bel-Air Excavating & Grading Ltd**
4 Cambridge RR 4 Stn Galt, Cambridge, ON N1R 5S5 Get directions
519-623-7101 | 1-800-558-4672
- Cardi Construction Limited**
5 600 Nebo Rd RR 2, Hannon, ON L0R 1P0 Get directions
905-560-3122

Map | Satellite

Map data ©2015 Google Terms of Use Report a map error

Figure 6.9: Demolition contractor listings category on YellowPages



Rubbish Removal

Solid waste companies have offices and storage/warehouse facilities, and liaison between sites of waste generation and disposal i.e. landfills. Unsorted waste is collected from construction sites in large bins and transported to landfills. Rubbish removal services can vary—some simply signify garbage collection while others specialize in environmentally-friendly removal.



Figure 6.10: Waste collection from a construction/demolition site

623 businesses for Rubbish Removal surrounding ontario

Rate these results

- North Kawartha Disposal**
1 4209 Hwy 28 RR 4, Lakefield, ON K0L 2H0 [Get directions](#)
705-768-4783
- Romano Disposal Services Inc**
2 8633 Jane St, Concord, ON L4K 2M6 [Get directions](#)
905-669-2323
- Must Go Junk Removal**
3 141 Baldwin St, Newcastle, ON L1B 1H1 [Get directions](#)
289-685-6878
★★★★★ 1 YellowPages review
- Como Disposal**
4 4 Grand Ave, Etobicoke, ON M8Y 2Y5 [Get directions](#)
437-889-2608
- J Romano Disposal Services Inc**
5 8633 Jane St, Concord, ON L4K 2M6 [Get directions](#)
905-669-2323
★★★★★ 1 YellowPages review

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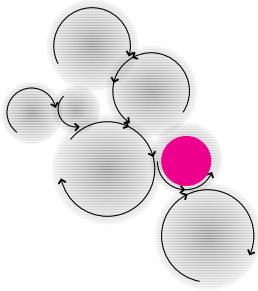
Redo search from here

Reduce map

Map data ©2015 Google Terms of Use Report a map error

Figure 6.11: Rubbish removal listings category on YellowPages

Solid Waste Facilities



It is estimated that up to 40% of all waste in landfills comes from the construction industry. Landfills have to be fairly sophisticated to prevent leachate from going into the ground and contaminating soil and water, as well as allowing methane to exhaust to reduce the risk of explosion as garbage decomposes. Some landfills have innovated to use bioreactors and/or incinerators to deal with leachate and methane and burning garbage to generate energy, respectively. However, burning garbage is controversial: it can smell bad and it releases toxins and greenhouse gases into the atmosphere.

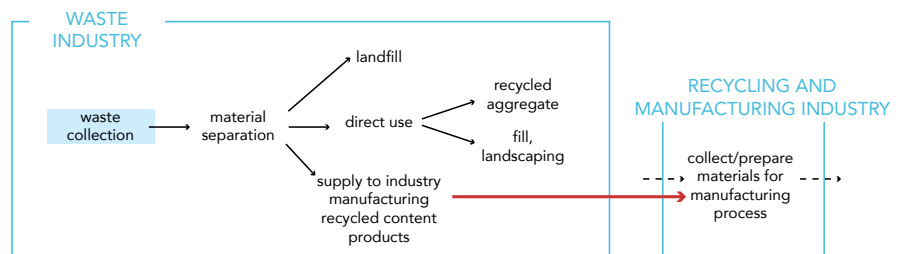


Figure 6.12: Waste industry in/out flow diagram with other industries



Figure 6.13: *A landfill with a bioreactor, typical landfill site.*

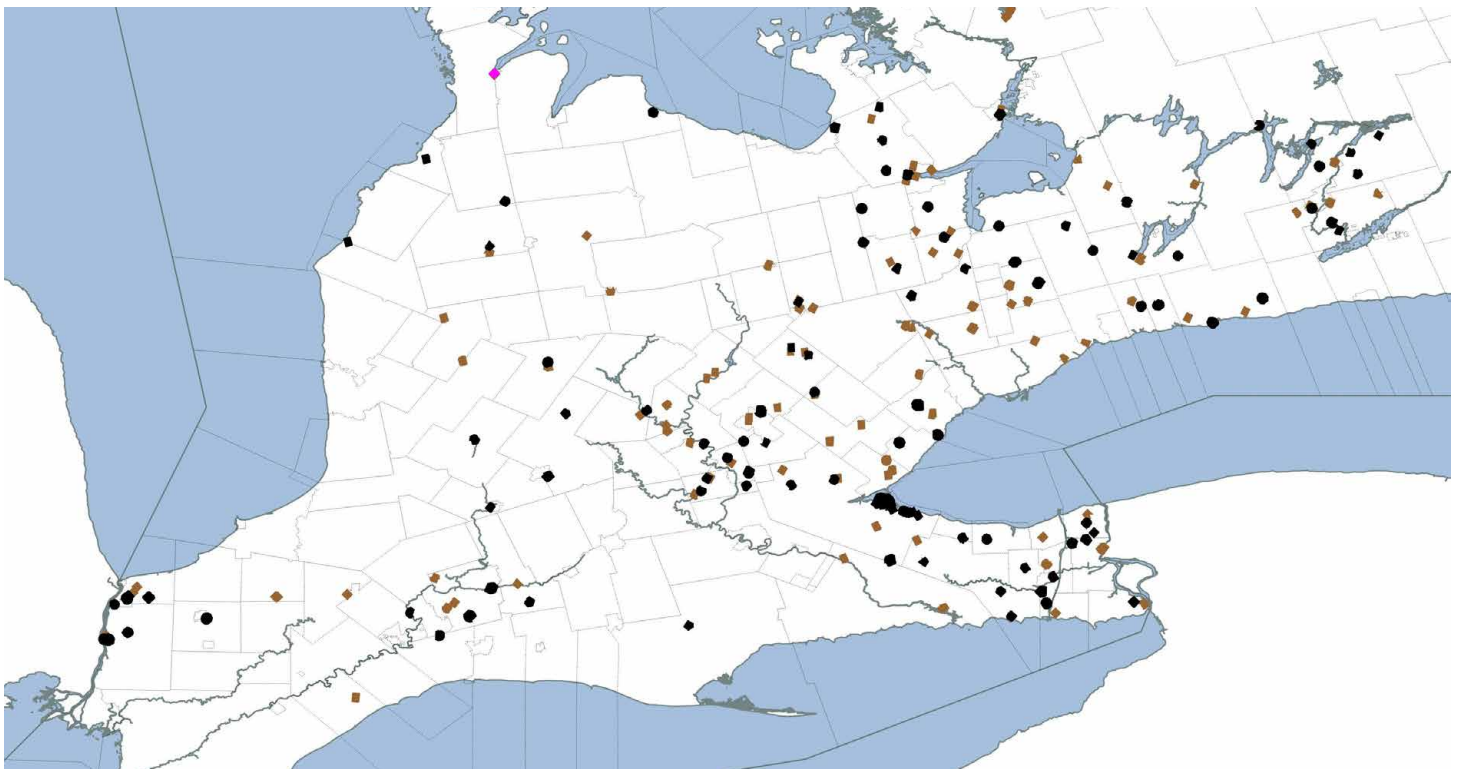
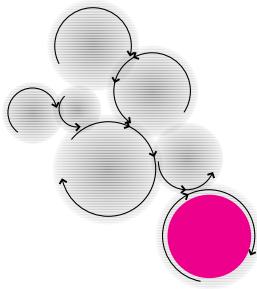


Figure 6.14: *Solid waste facilities and lumber mills*



Recycling and Manufacturing

Recycling happens at recycling plants. They sort and package items to be sent to manufacturers who work with them. There is an industry devoted solely to manufacturing new products from post-consumer products. Sometimes this may be done by a manufacturer who also works with virgin materials, so it is more difficult to identify sites specific to post-consumer manufacturing.

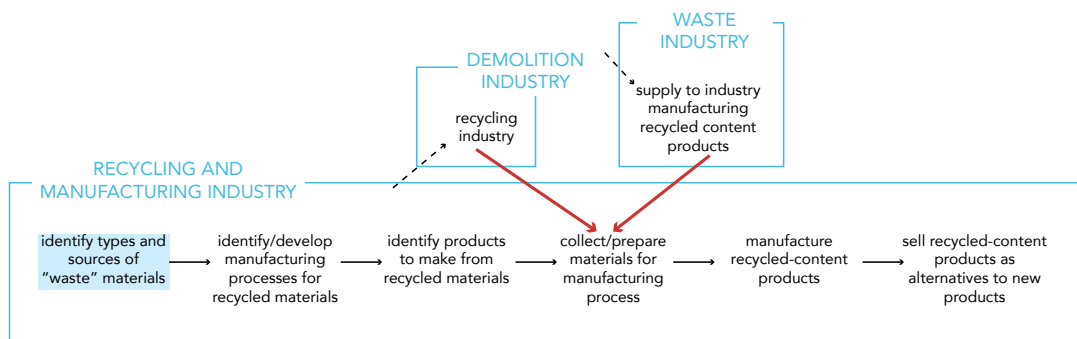


Figure 6.15: *Recycling industry in/out flow diagram with other industries*



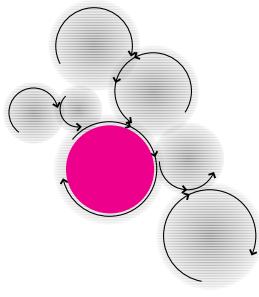
Figure 6.16: Recyclables after delivery, sorting being done manually, sorted and banded recyclables ready to be sent to a manufacturer.

361 businesses for Recycling Services surrounding Toronto, ON

Rate these results

- Electronic Distributors International Inc**
1 15 Progress Dr, Orillia, ON L3V 6H1 [Get directions](#)
705-327-8691
- Guaranteed Services**
2 94 Finlay Mill Rd, Midhurst, ON L0L 1X1 [Get directions](#)
705-252-9301
- Curran Recycling Ltd**
3 526 McGregor Sdrd, Sarnia, ON N7T 7H5 [Get directions](#)
519-332-0849
- Try Recycling**
4 21463 Clarke, London, ON N0M 1C0 [Get directions](#)
519-457-1566
★★★★★ 1 YellowPages review
- Huronia Auto Wreckers & Recycling Ltd**
5 9325 Beachwood Rd, Collingwood, ON L9Y 0X2 [Get directions](#)
705-302-2326

Figure 6.17: Recycling service listings in the YellowPages



Salvage Industry

The salvage industry operates from “used building material depots” as well as through decentralized means via printed and digital classifieds. This mix of centralized and decentralized market is unique to this industry because it doesn’t require much equipment and therefore doesn’t have to rely on economies of scale as much as large production facilities do.^[166]

Also: reuse supplier, reuse broker.

166 There is some new interest in decentralized recycling, but the equipment is new and it’s uncertain whether such an industry will flourish. Kickstarter example: <https://www.kickstarter.com/projects/83900559/mull-rings-dice-and-more> and another example: <http://preciousplastic.com/>

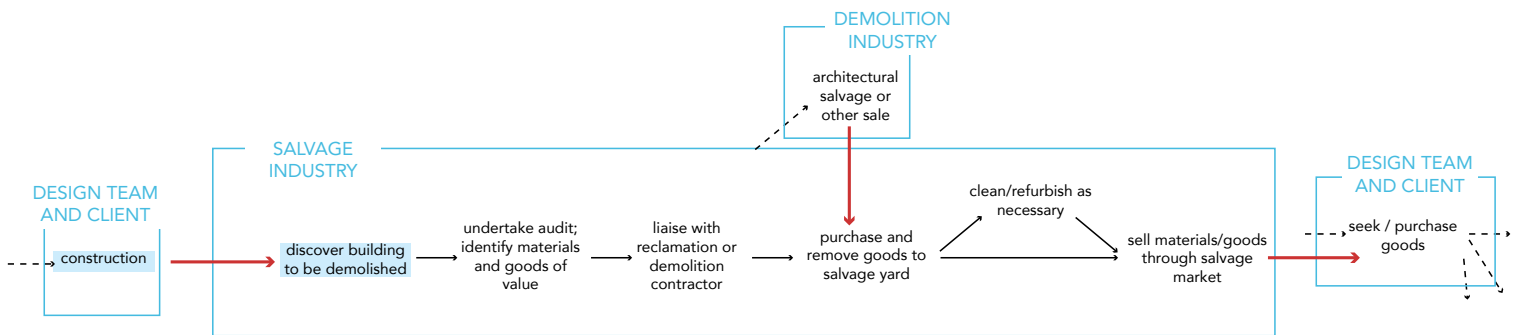


Figure 6.18: Salvage industry in/out flow diagram with other industries



Figure 6.19: *Examples of reclaimed building material depots.*

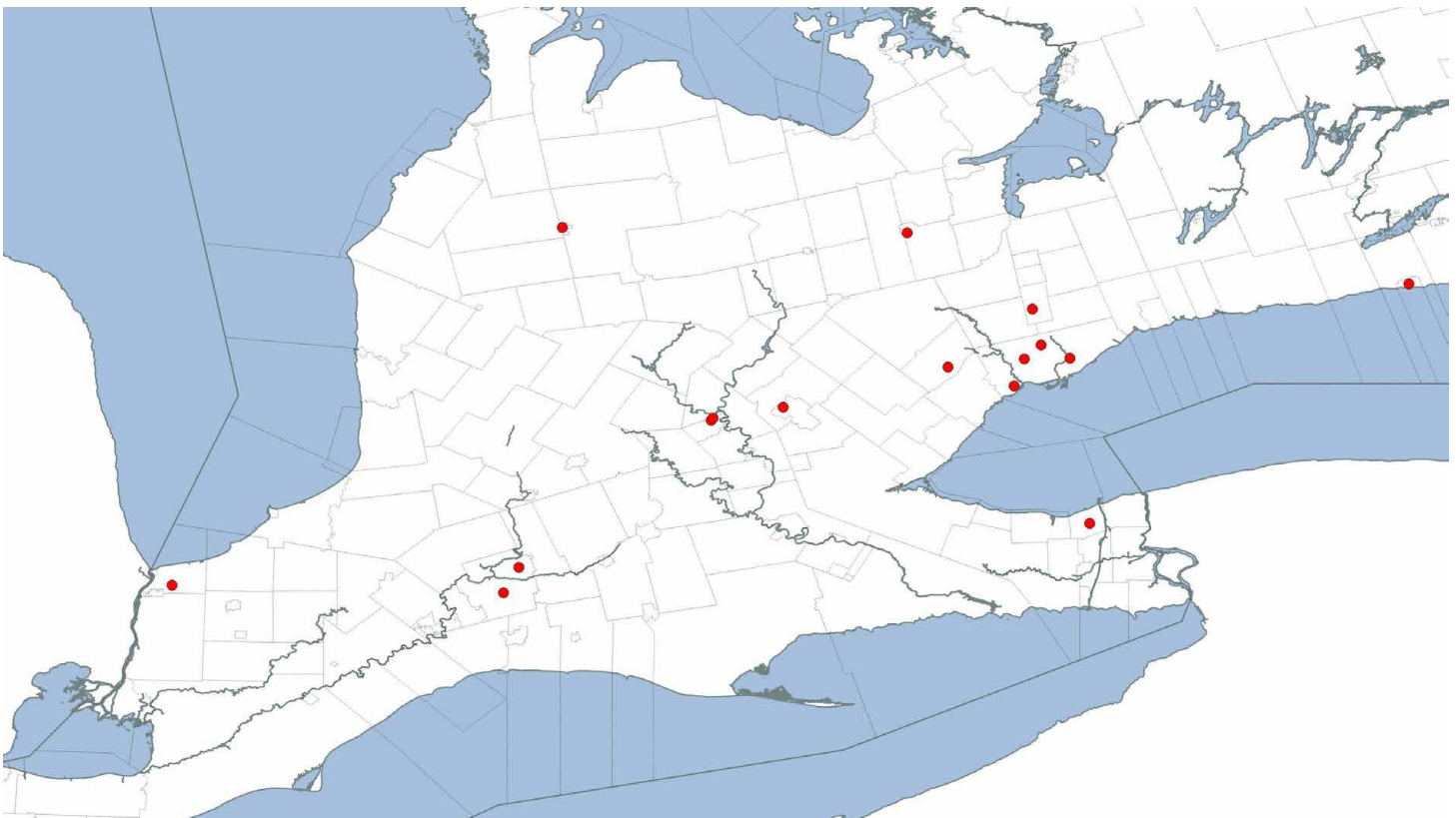
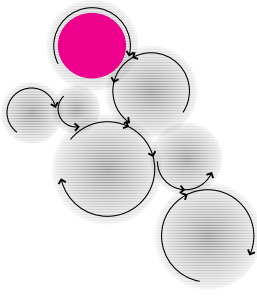


Figure 6.20: *Used building material listings category on YellowPages*

Architecture Practices



Architects play a large role in deciding the kind of materials that are used to construct a building. The form of a building influences decisions about structural material (for example, by its ability to span large distances, or allow for large openings, or perform well in cantilevers, etc.). Next, interior and exterior finishes are chosen based on the tone/atmosphere that the architect and client want to convey, and the product's performance including maintenance requirements.

Architects are the driving force behind material use but are far-removed from hands-on reality of them except for periodic project review during construction. The typical process for architectural design starts with schematic design that sets in place the general structural design and cost of the project. In a way, material requirements are determined from the beginning of the design unless there's very compelling reason to change them later in the process, because a change in structure can require changes of the whole design. This model doesn't question material availability or provenance except by cost and its effect on the project budget. The materials become predetermined parameter.

Materials can come from virgin sources, they can be made of recycled material, or they can be reclaimed to be used in new construction. The reclamation stream is distinct from the others because it cannot be produced "on demand." It requires a willingness to work with whatever is currently available.

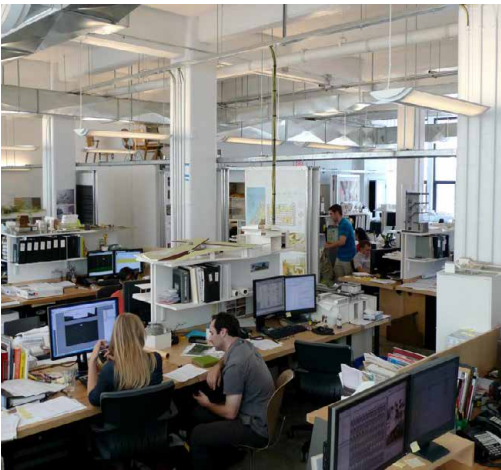


Figure 6.21: *Architecture office.*

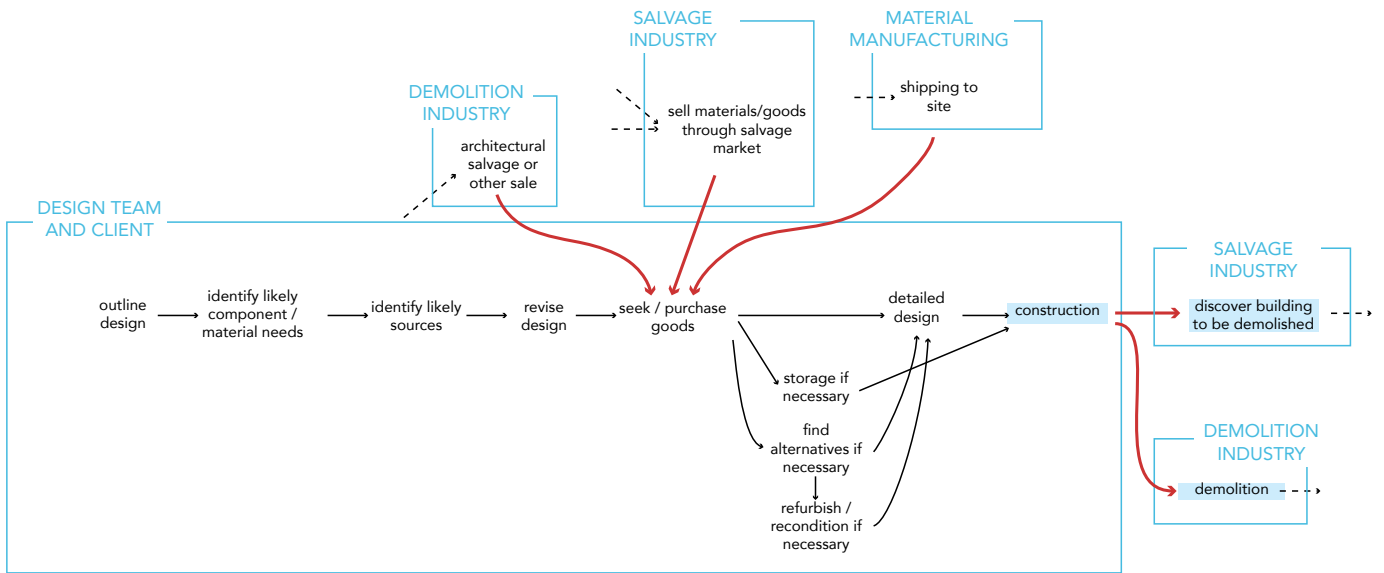


Figure 6.22: Architecture industry in/out flow diagram with other industries

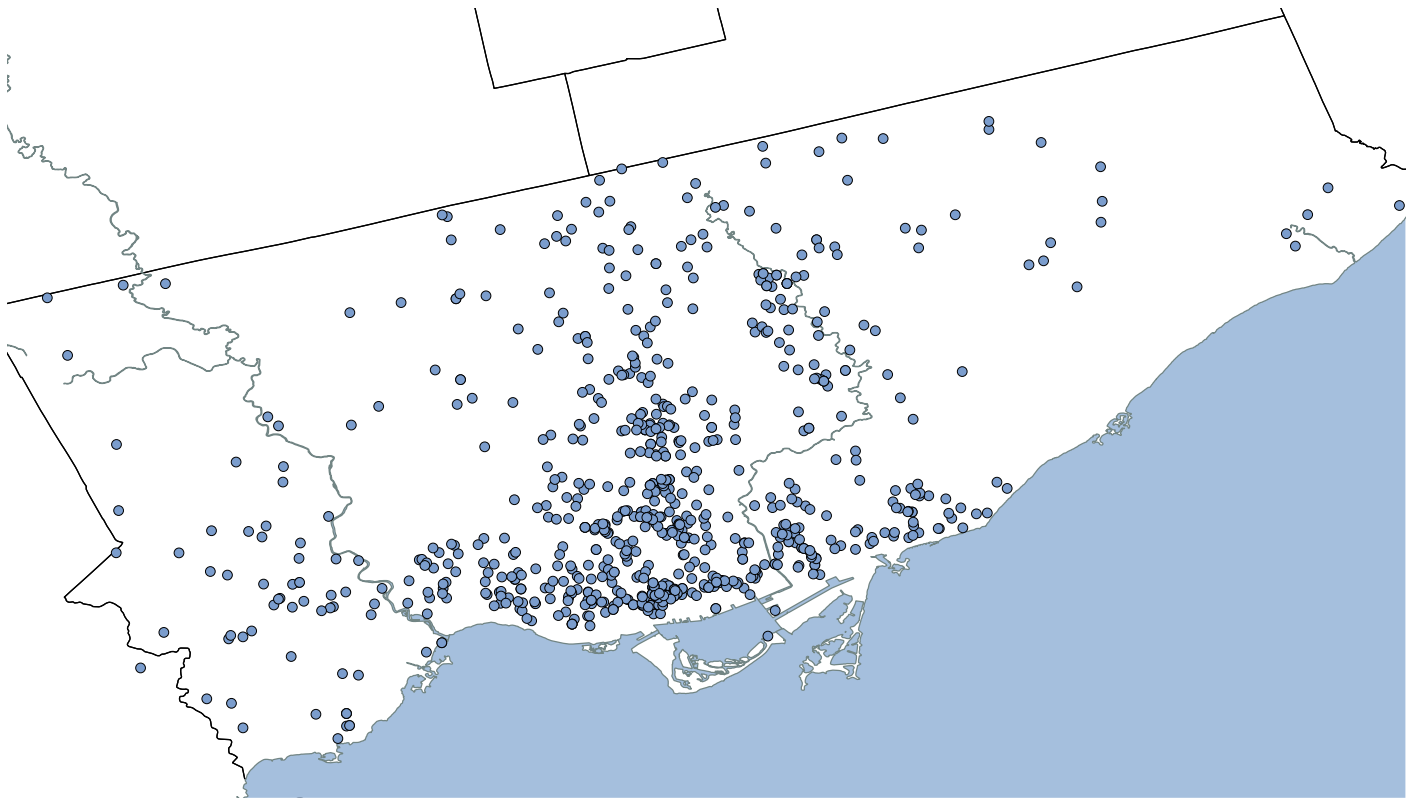
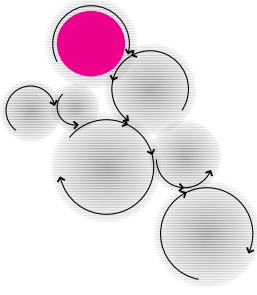


Figure 6.23: Architecture practices found through OAA listing



Green Building Consultants

There are consultants who have expertise in material sustainability and can help implement various approaches such as adaptive re-use, material re-use, recycled-content materials, or renewable materials. They might call themselves green building consultants or sustainability consultants. There are also consultants who are even further specialized, such as deconstruction and reuse consultants. All of these types of consultants can play a role in creating a material sustainability strategy for a specific project. Their knowledge can be particularly useful in evaluating the environmental impacts and installed performance of various products, which are crucial factors to be aware of.

Material Industries - Conclusions

The research into different material industries helps to understand the actors that interact with materials from new production to the waste stream. The choice of industries reflects my growing focus on the waste stream, as well as an interest in governance structures and the place of the designer.

7 MATERIAL SUSTAINABILITY CONCLUSIONS

Findings

When I began to identify issues of material culture, several priorities for evaluating material sustainability rose to the forefront. Based on current events, I decided I specifically wanted to address the environmental, psychological, and social problems created by our consumerist culture. For example, I was looking for approaches and materials that could help to address the urgent need to reduce greenhouse gas emissions, that fell within architectural agency, and that might have a net-positive socio-psychological effect.

Studying material approaches, materials, and material industries in tandem helped to broaden the critical perspective on the use of any one approach. I started to understand how they are related, as well as their strengths and weaknesses. I drew on systems/complexity science as a framework to make this analysis, and to help me understand why a diversity of approaches can be an advantage and not an impediment.

I discovered a few recurring challenges while delving into material systems. For example, my study of new material inventions led me to discover examples of how poorly ethical issues can be handled in private-sector product development, and gave me a sense that “free markets” really can’t be trusted to find the best long-term

solutions because they have no imperative to disclose every production process. In recent years especially, there is more awareness about the unethical measures that often go forward in the name of cost-cutting. All things being equal, people may be happy to choose a product of reasonable quality at a lower price, but as the tradeoffs in environmental quality and social equity become clear the “free market” self-regulates when people start to base their buying decisions on the fairness of the production. This is to say, for free markets to work as intended—to find the best solution, and not just in the short term—they would have to be 100% ethical or at least 100% transparent, which they clearly are not. Although I started to realize this while studying fluoropolymers, relatively new materials, the issue is not limited to new material production but is embedded in our economic structure, arguably rendering it socially unsustainable.

Environmentally, I repeatedly came across the notion that the economy is also dependent on growth through the production of material goods, which is impossible on a physically finite planet. In this light, I became interested in concepts of economic dematerialization, which propose that we need ways to make better use of material goods rather than consuming them once and then sending them to a landfill.

Dematerialization through materiality

Moving away from materialism and consumerism does not necessarily mean that we can't derive any enjoyment from novelty, as novelty can be achieved without buying or producing new things. Rearranging furniture, planting a new streetscape, and repurposing building components in a new context are all low-impact ways of having novelty. However, it's also important to realize that novelty is not fulfilling in the long-term because it simply wears off, and this is not always a bad thing. For example, a sense of a stable urban canvas can have a grounding quality that allows multiple social structures to establish themselves and develop in various scales of time. Stability

can create an enduring sense of social and personal identity, which contributes to human well-being.

A better approach to long-term psychic fulfillment is in engaging with the material world more directly through the acts of making and fixing things as suggested by Matthew Crawford in *The Case for Working with Your Hands*, rather than through the pursuit of novelty. His book indicates that making and fixing will boost feelings of competence and autonomy, and give a sense of purpose by working toward a goal. Crawford suggests that working creatively with materials in a hands-on way brings fulfillment not from the thing itself but from tactile engagement and confidence that comes with skill-development.^[167] Material approaches that encourage making, fixing, and skill-building are thus seen as more psychologically sustainable than those that seek to reduce the need for skill and ingenuity.

The slow food, slow fashion, and slow architecture movements are responses to problems of consumerism and its partner, disposability. They share in common a focus on well-crafted, high-quality products as opposed to quickly-produced cheap and disposable products. We are less likely to toss the things which are made custom for us, which are made for us by loved ones, which are made by someone famous, and which are made by ourselves. These items, which speak variously to our identity, history, memory, status, or skill tend to endure, implying that there is value in craft and the stories it tells. Until we socially accept durability and start to take care of our things by embracing maintenance and refurbishment as a material approach, a durable product isn't seen to have significantly higher value, and this is unfortunate.

Since continuous growth is impossible, the economy has to be decoupled from material turnover. One way to start to decouple it is to prolong the life of a material as an economic good, by recycling

167 Matthew B. Crawford, *The Case for Working with Your Hands: Or Why Office Work Is Bad for Us and Fixing Things Feels Good* (London: Viking, 2010).

it or reusing it multiple times, which can at the same time have environmental benefits compared to raw extraction.

I found that the concept of dematerialization is similar to that of a “circular economy,” but at the same time I took issue with the idea proposed in a circular system such as Cradle to Cradle. I find that overall it celebrates fast material turnover too much, because it is fast turnover that has helped to get us into an unsustainable situation in the first place. Furthermore, the system doesn’t acknowledge that some degradation and dissipation of material necessarily occurs in reprocessing because there are no lossless manufacturing processes in the world. Perhaps this loss happens at a slow rate, and perhaps I’m beginning to split hairs on pushing the issue, but the point remains that in the very long term even a good recycling scheme can’t make materials last forever, so we should think about ways the economy doesn’t have to rely on constant turnover of new things. This is another one of the reasons I more fully support “slow” culture—such as slow food, slow fashion, and slow architecture.

Time / Urgency

Some approaches seem to fail to respond to current needs, such as lowering global CO₂ emissions. For example, as mentioned, Cradle to Cradle celebrates material overturn without acknowledging that the more material consumption there is, the more energy is spent on recycling processes. Our energy sources may shift in time to make this approach viable but the current situation demands a reduction in overall energy needs while we work toward increasing the capacity of renewable energy sources.

Another approach, such as design for disassembly is a bit too much focused on the energy benefits that could be reaped in an indeterminate number of years. I am more interested in an approach that can work to reduce environmental impacts starting today, such as material reuse. I fully see the benefit of design for disassembly, but it’s orientation towards the future made me wonder in what ways we

can work with today's existing problems and imperfect construction methods.

Recycling might also be considered future-oriented until certain types of materials actually start to be recycled, such as flat glass from buildings. "Recyclability" doesn't do anything to curb waste until recycling facilities exist and collection procedures are in place to channel waste towards them. The idea of "recyclability" might exacerbate problems of waste because it creates the perception that we already have a circular economy, and that we are good at giving waste a new life.^[168]

Finally, products that are designed for high durability rely on the assumption that society will repair, fix, or reuse them whereas a current issue of material culture is that objects are seen as disposable. Durable materials may aid environmental sustainability, but if they aren't socially and psychologically durable then they are likely to become a waste product. It may be safer to assume that the majority of items will fall out of fashion at some point, so it is better to design them to fit into a circular economy rather than maximum physical durability.

Cyclicity / Durability

Embracing recycling or Cradle to Cradle to an extreme overemphasizes cycling of materials as a virtue. I am trying to communicate that we have to find a balance between the idea of cyclicity and durability, instead of going to an extreme on either one. Every round of cycling "technical nutrients" will degrade materials and even the natural processes of "biological nutrients" are limited by the rate of

168 an example of how much people *think* something is recyclable: Betsy Powell, "People of Toronto: Stop Putting Takeout Cups in the Blue Bin | Toronto Star," Thestar.com, June 19, 2016, accessed August 11, 2016, <https://www.thestar.com/news/gta/2016/06/19/people-of-toronto-stop-putting-takeout-cups-in-the-blue-bin.html>.

cycling made possible by nature.^[169] As mentioned, the problem with designing for maximum physical durability is that the social durability of the object might render it useless before it breaks down.

Complexity

In general, going to an extreme of any approach is a failure to consider the nuanced complexity of multiple environmental, social, and psychological needs. For example, even renewable/natural materials sound like positive qualities, but can also be dangerous because they don't necessarily mean non-toxic, low emissions, or ethical sourcing. Similarly, an over-emphasis on using low mass of materials for architecture is too narrowly focused on finished products to understand materials wasted during processing, emissions released, and the role of redundancy in increasing resilience. I've attempted to be conscious of material approaches that act to reduce the guilt of consumerism without necessarily having the positive impacts that they imply.

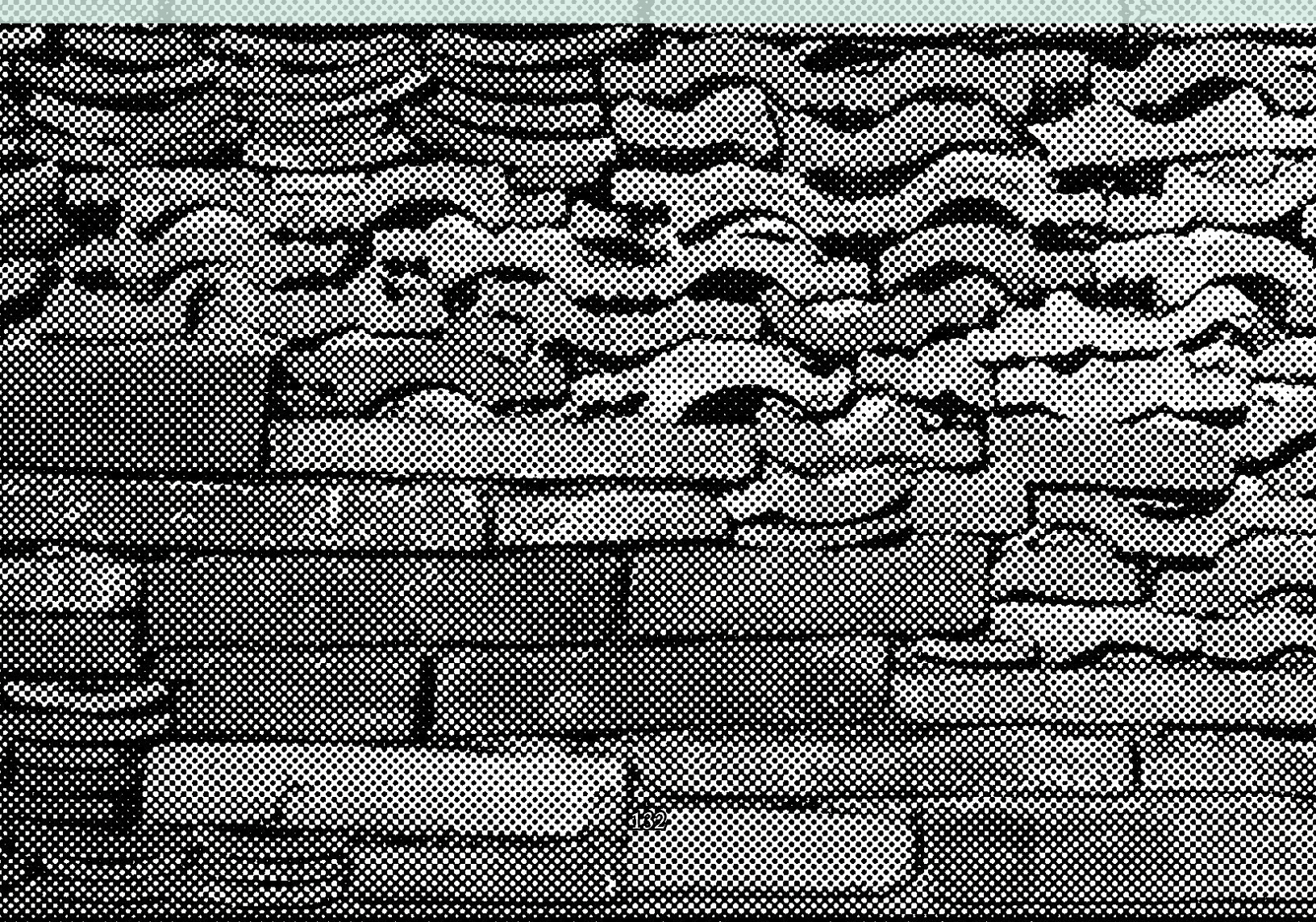
Materiality

I've identified materiality as an important issue in assessing material sustainability for architecture. Materiality can communicate issues of material culture to increase awareness, and it can also increase (or decrease) cultural durability. A sense of materiality is missing from some approaches like recycling because it melts things down to get things that are new again. Architectural aesthetic has the potential to start to change cultural norms by visibly shifting away from materialism to materiality.

In line with materiality is an idea about craftsmanship. A construction industry that focuses on building faster and cheaper via standardization leaves less room for craftsmanship on site; more of the craftsmanship is likely to happen in manufacturing instead of

¹⁶⁹ you could increase the rate of biodegradation by industrial processing, but this has the caveat of using more energy inputs

construction. Since I've identified that craft can form the basis for a more sustainable human relationship to the material world, I am unwilling to make industrialization a priority if it comes at the cost of job and skill-building opportunities. Industrialization has helped us increase the quality of life for people in some ways, but now threatens quality of life in other ways (such as environmental pollution and growing social inequality). As a result, I find that there has to be a balance between craft and industrialization, with craft currently having a resurgence.





PART 3 : MATERIAL RE-USE

Figure 8.1: (previous spread) Detail of material prototype by Wang Shu and Amateur Architecture Studio.



Figure 8.2: Omega Center for Sustainable Living by BNIM Architects in Rhinebeck, NY “uses cypress salvaged from mushroom farms, beech reclaimed from former factories, and planks from the 2009 inauguration platform of President Barack Obama.” (source: http://www.architectmagazine.com/technology/recycling-building-materials_o?o=1)

8 MATERIAL RE-USE

An underrepresented approach

I became interested in exploring material re-use as a material sustainability strategy because I found it to be an underrepresented approach that architects, specifically, have the power to implement, and which can adequately address the environmental, psychological, and social problems in material culture.

Although material re-use should ideally be the first waste diversion tactic to be considered at the end of a building's life, it is largely overlooked. The current architectural market paints an informative picture: LEED statistics show that material re-use credits have a low uptake, even in the highest level of certification (Platinum), and out of 784 architecture practices listed in Toronto by the OAA only 39 specialize in "reuse" (about 5%),^[170] which is more likely to refer to adaptive reuse than material reuse.

Under the LEED Canada program, only 9% of Platinum level projects (the highest level of certification) got the 5% Resource Reuse credit (MRc3.1) and only 4% of Platinum projects got the 10% Resource Reuse credit (MRc3.2). The credits for building reuse



Figure 8.3: *Omega Center exterior.*

¹⁷⁰ <http://www.oaa.on.ca/discover%20an%20architect> searched using "Toronto," "Reuse," and "Practice" as search parameters. Accessed July 27, 2016.

Material Reuse	LEED Canada NC 1.0		LEED NC 2.1 (US)		LEED NC 2.2 (US)		LEED NC 2009 (US)	
	# of projects	% of projects	# of projects	% of projects	# of projects	% of projects	# of projects	% of projects
All registered projects - 5% reuse	16	3% of 523	26	1.8% of 1451	227	2.4% of 9274	96	0.08% of 10913
All registered projects - 10% reuse	10	2% of 523	12	0.82% of 1451	129	1.3% of 9274	unknown	unknown
Platinum projects - 5% reuse	2	9% of 23	9	12.8% of 70	65	18.8% of 346	24	10.9% of 221
Platinum projects - 10% reuse	1	4% of 23	5	7.1% of 70	40	11.6 % of 346	unknown	unknown

Figure 8.4: Table showing number of projects meeting the Material Reuse credits in the LEED program in the US.

and rapidly renewable materials were similarly under 10%.^[171] In the United States, the percentage of projects meeting 5% reuse at the Platinum level was 19% and for 10% it was 11.6%.^[172] However, only 2.4% of all registered projects met the lower credit, on par with Canadian statistics. Although these statistics are only taken from one certification system, LEED, it is notable that this is the most widely-used system in the building market right now. Material re-use is

171 LEED Canada for New Construction 1.0 Credit Distribution as of March 31, 2013, PDF, Canada Green Building Council, March 31, 2013.

172 Calculated using GBIG advanced search, using LEED NC 2.2 (which has the highest number of projects that used reclaimed materials).

also included in the Living Building Challenge^[173] but only fairly recently.

Material re-use finds a middle ground between local and global material flows, as described. In general, as I hope I have explained in previous sections on approaches to material sustainability, the middle ground is essential in dealing with complex systems in order to ensure that no *single* metric is used to define sustainability at the cost of all other metrics. The more you push to an extreme on one metric, the more others are likely to suffer as a result. So in this case if you go to extremes to be “local” then durability and non-material aspects of sustainability may suffer. If you go to extremes to use renewable materials you may neglect to consider transport energy or the other roles that plants (and animals) play in a global ecology. If you take the route of dematerialization in the sense of lightweighting you might end up with a collapsed building under conditions of climate change, neglect the embodied energy of the materials, or inadvertently create a building that seems more disposable because of its light weight and scant quantities of material. If you care only for ageless durability you can end up neglecting all three of psychology, society, and ecology in the process. If you consider only how perfect a system can be you can create psychological oppression. If you consider only cyclicity you may psychologically encourage consumerism, and disregard the immediate problem of greenhouse gas emissions to which recycling contributes. If you design only for the eventual payback of a solution you may likewise ignore the immediacy of the carbon emissions problem.

In general, any solution that makes material sustainability seem easily solvable or purports to provide “the” ultimate solution is



Figure 8.5: *The Aptos retreat by CCS Architecture in San Francisco uses reclaimed barn wood as cladding.*

173 The Living Building Challenge started stipulating material re-use in version 3.0: “All Projects must feature at least one salvaged material per 500 square meters of gross building area or be an adaptive reuse of an existing structure.” Prior versions focused on landfill diversion which included stripping a building of re-usable components. (*Living Building Challenge 3.0*, PDF, International Living Future Institute, 2014, p.48; and *Living Building Challenge 2.1*, PDF, International Living Building Institute, May 2012, p.33.)



Figure 8.6: *The Ilma Grove house by Andrew Maynard Architects in Northcote, Australia, uses reclaimed brick.*

likely missing the complexity of holistic sustainability. Solutions that embrace extremes inherently seem to have this downfall.

There is a balance to strike between transience and permanence, or its counterpart light weight and heaviness. Between ascetic scarcity measures and self-indulgent dreams of abundance is the idea of having, and being happy with, enough. Between unruly, anarchic chaos and totalitarian, utopian order is a mix that creates resilience. Between learning from the frugality of the past and planning for paybacks in the future there is the state of things as they are today which should be addressed. Between cyclicity and linearity there is an imperfect loop that recognizes the fact that nothing lasts forever and that thermodynamically we tend toward dissipation, but we can certainly make the most of what we have instead of squandering it.

As mentioned in the section on “material re-use” earlier, the connection to a mindset similar to vernacular architecture is interesting to me because of its close association with craft and craftsmen as opposed to architecture and capital “A” Architects. The fact that material re-use requires a craftsmanlike mindset aligns with my own longstanding practice of a variety of crafts. I will explore this mindset and its alignment with principles of complexity, imperfection, and meaningful work in case studies of material re-use projects. I believe craft enables us to interact with the material world in a thoughtful, conscious way that ultimately makes our architecture psychologically and socially sustainable, as well as ecologically. I believe it brings the same qualities to architecture as Jackson describes in vernacular landscape: “the beauty that we see in the vernacular landscape in the image of our common humanity, hard work, stubborn hope, and mutual forbearance striving to be love. I believe that a landscape which makes these qualities manifest is one that can be called beautiful.”^[174] Architecture which manifests these qualities is also beautiful, and these qualities shine through on projects that recognize

174 John Brinckerhoff Jackson, *Discovering the Vernacular Landscape* (New Haven: Yale University Press, 1984), p.xii.

the complexity of addressing sustainability in order to fulfill human needs.

This section looks at material re-use through case studies and a personal experience in trying to use reclaimed materials. After identifying that sourcing of materials is a persistent challenge in case study projects, I propose a schematic design for a web-based material sourcing tool that helps to find materials and tracks how availability fluctuates in time.



Figure 8.7: *Sanctum by Theater Gates in Bristol, UK is built from reclaimed elements such as wood siding, bricks, doors, and windows.*

9 RE-USE CASE STUDIES

*Studio Gang
Theaster Gates
Wang Shu*

I looked at several buildings that use reclaimed materials to understand the opportunities and challenges of reclaiming and reusing materials. I was able to find benefits / how material re-use can help address interdependent issues of material culture and found out specific challenges to using reclaimed materials in practice. The formal aspects of reclaimed architecture made me reflect on what it “says,” or what kind of philosophy it embodies. I find that it shares a philosophy with several craftforms, many of them Japanese.

Studio Gang - SOS Children's Center and Ford Calumet Center



Figure 9.1: *Main facades of the SOS Children's Center by Studio Gang.*

Studio Gang has two examples that are pertinent to the study of reclaimed materials and processes. The first, the SOS Children's Center is built largely from donated building materials to work within the project's humble budget. The second, the Ford Calumet Center is a design proposal for an Environmental Center inspired by the idea of a nest that could be built from locally gathered cast-off materials; it remains unbuilt. Both projects had a non-typical design and material procurement process that had to adapt to materials found at hand and required the architecture team to actively seek out all of the materials. This is quite unusual for an architectural project delivery, which is typically accomplished by choosing materials from catalogues and samples and specifying the necessary quantity. In both cases, the quantity that could be obtained of any one material was largely uncertain, especially at the beginning of the material search, and it was up to the architect, not a supplier, to come up with the necessary quantity.

The SOS Children's Center located in Chicago was commissioned by SOS Children's Villages, an international non-profit organization started after World War II to help orphaned children.^[175] The Children's Center acts as a communal space for the Chicago Children's Village, which also includes housing for children and the Village mothers. The project had to work with limited funding, so the building site was obtained by donation from the City of Chicago. Similarly, Studio Gang looked to obtain construction materials by donation; the project had to contend with especially high material prices because the same year the center was built Hurricane Katrina caused a spike in construction supply prices.^[176]

175 "History," SOS Children's Villages International, accessed August 23, 2016, <http://www.sos-childrensvillages.org/who-we-are/about-sos/history>.

176 Jeanne Gang, *Reveal: Studio Gang Architects* (New York, NY: Princeton Architectural Press, 2011), p.185.

The process of working with donated materials presented similar challenges as working with reclaimed materials. In fact, the materials may be considered to be reclaimed because they “included anything builders had on hand or in surplus,”^[177] which is to say materials that might otherwise go unused despite being new. One challenge was that expected or desired donations did not always come in. The other challenge was that it was up to the architects to solicit materials, keep track of how much was available, and find a suitable application for them. Jeanne Gang describes the process:

Typically, a design becomes more definitive as the last details are specified. Designing buildings that rely on donations ... requires parts to remain in flux until the end in order to make use of products and services as they materialize. A large donation might result in a change for a major building component, even if the donation is made during construction. At minimum, changes at this scale and this late in the building process can cause a monumental headache for the architect; worse yet, they can mean uncoordinated systems, substituted inferior products, loss of energy efficiency, and reduction of the building’s quality and life cycle – essentially, the loss of design control. ... Instead of losing control, we invented a system to manage the flow of donations.^[178]

In an essay titled “The Cook, the Prospector, the Nomad and Their Architect,” Gang likens the design and procurement processes to cooking and prospecting. The cook has the task of working with a limited palette of materials based on seasonal availability, while the prospector has to be able to personally seek out material “deposits” for a project.

To maintain control and flexibility in the project, the team conceived of the building as a “flexible set of placeholder elements.”^[179] Starting with a base design for the Children’s Center,

177 Ibid.

178 Ibid., p.185-189.

179 Jeanne Gang, “The Cook, the Prospector, the Nomad and Their Architect,” in *Re-inventing Construction*, ed. Andreas Ruby and Ilka Ruby (Berlin: Ruby Press, 2010), p.165.

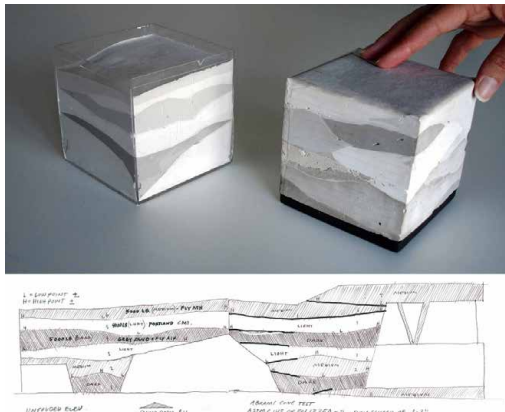


Figure 9.2: Concept model and sketch of concrete striation layout.

each part of the building was treated like a variable in a system with neighbours connected by a network of aesthetic and practical decisions.^[180] This allowed an openness to change and recalibration in the design process, so that, for example, when a donation of steel became available, a stair that had been intended to be concrete was reconfigured. That design decision created an opportunity to use the deep section of the donated steel as a light cavity, so the architects sought and secured a donation for translucent polycarbonate. This process of working with reclaimed materials required a balance of “top-down” aesthetic decisions that ensured cohesion and a “bottom-up” method of working from a material palette determined by availability.

Studio Gang’s process relied on a combination of design ingenuity and flexibility which was made possible by the use of digital architectural tools to test out and analyze a variety of possible material combinations^[181] and, not least, the craft knowledge of the architects and subcontractors. The facade of the children’s centre was developed in collaboration with the project’s concrete contractor, Adjustable Forms Inc. The contractor’s material knowledge was crucial in achieving the desired look. The slump of the concrete had to be carefully controlled to create a wavy look between the different layers of concrete. The team worked through several planning meetings and material prototypes, ultimately using the elevator shaft of the building as a full-size mockup of the stratified coloured concrete.

Partly because of the intensity of the process, achieving the desired look for the concrete facade had a positive effect on the subcontractor’s morale and sense of skill:

Most of the work that we do is structural concrete that gets covered up in pre-cast, glass curtain/window wall, drywall partition, or painted with an acrylic coating and is never seen. ... The building showcases [our workers’] knowledge of their material to the extreme and shows a new way concrete can be utilized; they

180 Gang, *Reveal*, p.189.

181 Ibid.

are all proud that their work can be showcased for such a good cause.^[182]

In this way, the process of constructing the walls, which began from a donation of leftover concrete from condo projects in downtown Chicago,^[183] became a way for the concrete workers to innovate, show and hone their skills. The successful construction instilled a sense of pride in completing a meaningful job well.

The building communicates an alternative to the traditional design process. It embodies an aesthetic that comes from working in a way resembling the complexity and adaptation found in biological processes. Instead of literally translating nature into architecture by using an aesthetic of biomorphic abstraction, the aesthetic is inspired by biological processes. This is an important development in how sustainable architecture is represented because it speaks to restructured processes and it challenges the fact that change is seen as negative in that process. As Gang says, “architecture must be able to use change or be ruled by it.”^[184] Similarly with sustainable architecture, instead of focusing on how sustainability measures will impact architecture, we should be asking how architectural processes can have a positive impact on sustainability.^[185]

Gang further addresses challenges of prospecting for reclaimed construction materials in discussing the design for the Ford Calumet Environmental Center in Calumet, Illinois (southeast of Chicago). The idea was to use locally sourced reclaimed materials from remnant structures of Chicago’s steel mill industry.^[186] The logic of the structure is that “form follow availability”^[187] which is to say



Figure 9.3: *Striated concrete test on elevator shaft, wall after two pours, (1) and the finished wall. (2)*

182 Ibid., p.208.

183 Ibid., p.189-195.

184 Ibid., p.195.

185 A. P. Fawcett, “Twenty-twenty vision,” *Journal of Southeast Asian Architecture*, 3(1, 1998): 68. via Terry J. Williamson, Antony Radford, and Helen Bennetts, *Understanding Sustainable Architecture* (New York: Spon Press, 2003), p.4.

186 Gang, *Reveal*, p.38.

187 Ibid., p.35.

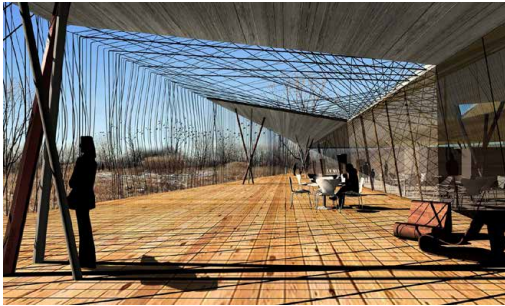


Figure 9.4: *Rendering of the partially enclosed space at the Ford Calumet Center.*



Figure 9.5: *An example of some of the materials that end up at a recycling plant in South Chicago, and which could be reclaimed for construction.*

the architectural process flips from having design dictate the materials, to materials dictating the design. Despite the abundance of waste material generated by the building industry, it can still be a major challenge to procure reclaimed materials. It's a process that requires dedication by visiting, or conferring with, salvage yard and demolition site crews. Gang comments that this process is much more involved than ordering new materials, "with a simple point-and-click from a desktop," from catalogs of manufacturers.^[188] Standardization of building products has its benefits, such as predictability, ease of use, and warranties of performance. However, these same qualities of ease and predictability have made globalized interchange a rising environmental threat due to the energy expended in transportation, and the ability to send raw materials for processing to developing areas of the world with fewer environmental regulations. Reusing materials is a local act that speaks to global consequences, and it's partly its non-standard nature that makes local sourcing desirable.

The Ford Calumet Center and the SOS Children's Center show that the switch from an architectural process that takes material availability for granted to one that is entirely based on material availability is a challenge. Instead of leaving material sourcing to the end of the design process, the ability to procure certain materials becomes enmeshed with the process of designing the architectural form. The sourcing of materials must begin at the start of the project, at least to gain an understanding of what might be available in the area, in what quantity, condition, and at what cost.

The projects show the need to balance a top-down and bottom-up process through a craft-like, collaborative approach. They highlight the benefits and frustrations that go into a challenging project which ultimately brings a sense of pride and competence to the team.

188 Ibid.



Figure 9.6: *Rendering of Ford Calumet Environmental Center design.*

Theaster Gates - Dorchester Projects



Figure 9.7: *Before and after photos of the Archive House.*

Theaster Gates is an artist who decided to buy a property in a dilapidated neighbourhood of south Chicago when he got a position as an arts programmer at the University of Chicago in 2006. The location was close to work and the social problems of the neighbourhood intrigued him. He decided to stay and become part of the community, to see if he could make it more beautiful.^[189]

Gates cites the impetus to participate in community development to be a spur of the moment feeling fuelled partly by a frustration with developers. It bothered him that although they had the most power to change a place, they didn't understand what it needs.^[190] He decided to exercise his own agency and take a risk on creating creative space for the community by transforming a two-storey house into a library and archive. The library is made of up books from a now-closed art and architecture bookshop, while the archive comprises thousands of slides from the art department at the University of Chicago. The space aims to encourage people to “access and use them for research, contemplation and performance material – enhancing both the edifying and creative function of a library while enabling an empowered sense of ownership for the community”^[191]

The Dorchester Projects are an exploration of what it means to work in a post-industrial world with a shrinking industrial economy by means of salvage and community involvement. Gates believes that this work can be used a “model for greater cultural and socioeco-

189 Ben Austen, “Chicago’s Opportunity Artist,” *The New York Times Magazine*, December 20, 2013, accessed July 06, 2016, http://www.nytimes.com/2013/12/22/magazine/chicagos-opportunity-artist.html?_r=0.

190 Tim Adams, “Chicago Artist Theaster Gates: I’m Hoping Swiss Bankers Will Bail out My Flooded South Side Bank in the Name of Art” *The Guardian*, May 03, 2015, accessed July 06, 2016, <https://www.theguardian.com/artanddesign/2015/may/03/theaster-gates-artist-chicago-dorchester-projects>.

191 Theaster Gates, “Dorchester Projects Library and Archive,” *Theaster Gates*, accessed August 23, 2016, http://theastergates.com/section/193928_Dorchester_Projects_Library_and_Archive.html.

conomic renewal”^[192] in contrast to a more conventional revitalization process used by developers which uses artists to raise a neighbourhood’s value but ultimately prices the artists out of the neighbourhood.^[193] Instead, Gates works to create a lasting community culture.

Not only are the library and archive materials salvaged from being wasted, the buildings use reclaimed materials on the exterior and interior. The Archive House uses timbers from old Chicago factories on the interiors and barnwood on the exteriors. Gates feels that “using old materials has added to the quality of the space,”^[194] though he doesn’t elaborate in exactly what way. Other writing hints that the poetry of the aesthetic execution of the projects lies in the fact that it stands in as a metaphor for “always, always finding use for what seems discarded or broken or abandoned, make do and mend at the scale of the object and also at the scale of the city.”^[195] Gates is not only mending old buildings and building materials to make them useable again, he is also mending the community by doing so. The aesthetic of his built work and its public nature communicates his social commitment and provides a hopeful vision for his neighbourhood. Materiality is used to express how community problems might be solved through cooperation, collaboration, fixing, mending, and what Gates calls “radical hospitality.”^[196]

Gates’ background as a potter and artist has had a profound influence on his choice to create the Dorchester Projects in this way. It has taught him that “how you centre a pot matters” and “the willingness to elevate super-modest things.”^[197] As a potter, he says he

192 Theaster Gates, “Dorchester Projects,” Theaster Gates, accessed July 06, 2016, http://theastergates.com/section/117693_Dorchester_Projects.html.

193 Adams, “Chicago Artist Theaster Gates.”

194 Smart Museum of Art, “Theaster Gates: Dorchester Projects,” Vimeo, February 14, 2012, <https://vimeo.com/36813608>. via “Feast: Radical Hospitality in Contemporary Art,” Smart Museum of Art, February 2012, <http://smartmuseum.uchicago.edu/exhibitions/feast/>.

195 Adams, “Chicago Artist Theaster Gates.”

196 Gates, “Dorchester Projects.”

197 Adams, “Chicago Artist Theaster Gates.”



Figure 9.8: *Books on shelves built of reclaimed material inside the Archive House.*



Figure 9.9: *Interior of the Archive House.*



Figure 9.10: *A “soul food dinner” being held at the Archive House.*

is well versed in the practice of making things out of nothing, out of mere shapeless lumps, and of learning whatever he needs to know to get a project completed.^[198] The art critic Christian Viveros-Faune suggests that Gates’ work gives contemporary art “something it’s been sorely lacking: purpose,”^[199] by working in a place that needs the benefits of cultural work but can’t afford it. In Gates’ work, art is “spirituality in paint-spattered jeans.”^[200]

The project has been successful at bringing people together to make things well: “We believe in the things that we make.”^[201] The visibility of this message in Gates’ work contributes to the social and psychological sustainability of the neighbourhood.

198 Theaster Gates, “How to Revive a Neighborhood: With Imagination, Beauty and Art,” TED: Ideas worth Spreading, March 2015, accessed July 06, 2016, https://www.ted.com/talks/theaster_gates_how_to_revive_a_neighborhood_with_imagination_beauty_and_art.

199 Christian Viveros-Fauné, “Theaster Gates,” *Art Review*, no. 56 (January/February 2012): 71.

200 Ibid.

201 Adams, “Chicago Artist Theaster Gates.”

Wang Shu - Ningbo Museum

Wang Shu's work communicates the social and psychological challenges presented by the large-scale reconstruction happening in China. People wanting a higher quality of life believe that they might get it by moving to cities, which has spurred the demolition of many villages as major cities expand. Wang sees that the problem with this reconstruction is that it replaces villages that speak to memory, tradition, and history with an imported architecture that lacks these connections to place.^[202] He feels that if he didn't make an effort to address it, "Chinese architecture would be throttled in the empty talk and chicanery of architects and museums."^[203]

The aim of Wang's work is not to exclude modernity, but to find an inclusive balance with tradition in order to make new development meaningful. In the Ningbo Museum he uses reclaimed tiles and bricks from the rubble of razed villages in a contemporary way that has meaningful connections to traditional technique and aesthetic. The walls use wapan construction, a traditional and long-practiced technique used to quickly reconstruct walls after natural disasters such as typhoons.^[204] This construction technique is combined with a decidedly modern form which nevertheless speaks to a balanced human-environmental relationship. The building is likened to a carved mountain, an artificial recreation of a natural form that tries to satisfy the biophilic desire to be closer to nature; human presence is not excluded in this image, which is "carved" to include cave-like entrances: "Decisive, sharp cuts and the layered facade represent



Figure 9.11: *One of the Ningbo Museum facades, showing "carved" form.*

202 Anna Tweeddale, "Wang Shu: "Memory Is Deeper than Symbols", "Australian Design Review, November 15, 2012, accessed July 06, 2016, <https://www.australiandesignreview.com/features/26177-wang-shu-memory-is-deeper-than-symbols>.

203 Alex Pasternack, "Chinese History Museum Literally Recycled From History," TreeHugger, July 7, 2009, <http://www.treehugger.com/sustainable-product-design/chinese-history-museum-literally-recycled-from-history.html>.

204 Ibid.

man's footprint on the building/mountain, either as relics or as the new manifestation of a vital city structure."^[205]

As in other projects where material was reclaimed, craftsmanship played a large role in putting them back together into a new architectural composition. The team faced the challenge of putting together as many as 80 different types and sizes of bricks. This is a challenge that Wang Shu had encountered on an earlier project, the Tengtou Pavilion at the Shanghai Expo, and it was overcome by making about 20 prototypes. By contrast, Wang notes that his office doesn't spend as much time and effort testing out formal design models—the office's work is much more focused on material experimentation to realize their projects. Furthermore, making the prototypes is crucial for proving to a client that reclaimed materials can look good. Nevertheless, the team didn't have full control over placement of the individual tiles on the expansive facade of the museum. Lines that were supposed to be straight ended up curved, and Wang decided on the philosophy of letting such imperfection go in favour of "letting nature take its course."^[206] The craftsmen working on the project respected this decision.^[207]

The result is that the museum draws some repeat visitors because the walls of the museum illicit memories and feelings of being home in their own family courtyards.^[208] Wang comments that being able to connect to memories is "deeper than symbols. The symbol is just about a concept, but memory is different. It can touch people and also touch very private feelings, very small things, in time."^[209] He equates the use of symbols with commercialization of the very

205 Till Wöhler, "Ningbo Museum by Pritzker Prize Winner Wang Shu," *The Architectural Review*, March 1, 2010, accessed July 06, 2016, <http://www.architectural-review.com/ningbo-museum-by-pritzker-prize-winner-wang-shu/5218020.article>.

206 Ibid.

207 Ibid.

208 Tweeddale, "Wang Shu."

209 Ibid.

idea of tradition, without any of the emotional and reminiscent connection. This is part of the reason why it's important to “connect past experience to new things”^[210] in his work, to bring China into the modern world without losing the meaningfulness and sense of identity found in tradition.

In these ways, the materiality of the Ningbo Museum addresses social and psychological sustainability at the same time that its form and execution shows a respect for the environment.



Figure 9.12: *Examples of tile combinations on the Ningbo Museum facade. (1, 2, and 3).*

210 Ibid.

Conclusion

Ecologically, material re-use reduces the amount of building materials that enter the waste stream. Within the waste-reduction mantra of “reduce, reuse, recycle,” material reuse remains the least discussed and understood methodology. The social and psychological impacts of material reuse in architecture may be even more significant than its ecological impacts. Socially, material reuse isn’t as reliant on the globalized production of goods that exploits human and environmental well-being in developing countries. Instead, it makes it possible to create more local jobs wherever buildings are slated for demolition. Psychologically, material reuse provides a challenge in construction, which nonetheless tests designers’ and tradespeople’s ingenuity in a way that increases collaboration and pride in the finished work; it allows skillful knowledge of material craft to shine. Furthermore, an architecture of material reuse is a tangible cultural commentary on our relationship with the material world, which currently leans towards capitalist consumerism in North America and continues to undermine ecological, social, and psychological sustainability.

What emerges from the study of projects using reclaimed materials is a particular philosophy where the imperfect and unexpected can be beautiful, and the broken can be repaired. This philosophy can be found in several other craft forms, such as shibori tie-dyeing, boro, sashiko repair, kintsugi, visible mending, and even quilting. The philosophy of wabi-sabi or shibui can be used to describe the quality of these buildings and craft forms. A particularly evocative definition by philosopher Okakura Tenshin is that wabi-sabi is “a cult founded on the adoration of the beautiful among the sordid facts of everyday existence. . . . It is essentially a worship of the imperfect, as it is a tender attempt to accomplish something possible in this impossible thing we know as life.”^[211]

211 Rumiko Handa, *Allure of the Incomplete, Imperfect, and Impermanent: Designing and Appreciating Architecture as Nature* (New York: Routledge, 2015), p.12.

In *The Secret Lives of Buildings* Edward Hollis suggests that, in general, Western architecture is obsessed with both perfection and permanence whereas other places, such as Japan, are less concerned with either and are able to celebrate both imperfection and impermanence or transience. The thesis of the book seems to be that the beauty of historic buildings doesn't come from the unyielding will of their maker but from their ability to shapeshift. Despite the expectations of the designer, people will adapt space to fit their reality as they see fit. Hollis tries to get across that perfect architecture is a myth, and that it goes through many transmutations, so perhaps we should start accepting it as such. Hollis also draws a parallel to the oral tradition in storytelling, whereby stories are adapted, and change, from one telling to the next, resulting in multiple versions of the same plot: "If a story is not written down, the only script that exists for the next performance is the previous telling."^[212]

This is an understanding that is crucial but still missing in sustainable architecture, and may be the reason that we tend to tell the same stories and keep repeating the same building mistakes, especially when it comes to occupant behaviour; the life of the building is taken for granted—that it will function as intended (and it is intended to be perfect). Future evidence tends to be ignored. I am specifically thinking of the narrative used for passive solar heat gain, which is repeatedly used, and is repeatedly shown not to function as intended in case study after case study; however, it continues to be perpetuated. Should we accept this as an imperfection and move on? Or would it be wise to "write down the story" by reflecting back on our expectations and the reasons why they didn't come to fruition? I tend to align with the latter, since ignoring evidence in favour of telling the same story is too convenient, and seems to show our inability to face up to the imperfect facts of life with a willingness to integrate them into design. Ignorance (or simply ignoring) isn't the same as acceptance. Attempts to ignore unpredictability and complexity, in-

212 Edward Hollis, *The Secret Lives of Buildings: From the Ruins of the Parthenon to the Vegas Strip in Thirteen Stories* (New York: Metropolitan Books, 2009), p.11.

stead of working with them, create architecture that isn't sustainable because lessons aren't learned and adapted.

The three buildings that I've discussed in this chapter are just a few examples of how the aesthetic expression of material reuse can help people to adapt culturally and environmentally towards a more sustainable society. They have also helped to uncover the opportunities for meaningful work in a craft-dependent, participatory process that material re-use requires. Finally, they have a common aim to increase cultural durability.

However, they also show repeated evidence of the uncertainties and difficulties in working with reclaimed materials. Some of these challenges were managed by engaging contractors and tradespeople to help achieve the desired goal. The question of material procurement, on the other hand, remains open-ended. It requires creativity, hard work, and personally reaching out to potential suppliers, making it an intensive process. This led me to look at sourcing more closely in the next section of the thesis.

At a school lecture:

Audience member: “At what point do you want to run away from and leave [something] so ugly, what is essentially a collection of left-over garbage that is portrayed as modern art? When do you want to escape that to find something that’s more rational?”

Aaron Betsky: “Well, I actually find that everything that I showed you I find beautiful, so, you know, beauty is in the eye of the beholder. I think that ... there is a rationale to the way things are assembled that might have a deeper logic, both aesthetic and physical, than the making of grids. ... You can find a rationale that does not come down to the abstraction and value engineering of all the pieces of the building into the fewest forms possible. ... Just to be clear, I’m not saying that things that are bad are good, or something like that, I’m just saying ‘Could you make an architecture ... where you say ok, [x] is a reality, it’s a horrible thing — what do you with it, how can you handle it?’ ... Your work as an architect is to look at everything that architects often don’t look at, everything that I saw between downtown Toronto [and] here, and figure out what to do *with* it. So don’t run away from it, don’t *pray* to it, but figure out what you can do *with* it.”

*from “Hunting and Gathering: Tactical Urbanism, Collage Architecture”
question period.*

University of Waterloo School of Architecture, February 26, 2015^[213]

213 UWSAlectures, “Aaron Betsky Q&A,” YouTube, April 04, 2016, accessed May 17, 2016, https://www.youtube.com/watch?v=_JLCD5YSwaQ

10 GETTING INVOLVED IN RE-USE

While I was researching the reclaimed materials industry for my thesis I decided that I wanted to make something tangible because it would help me experience the process of reclamation instead of purely speculating on it. I enjoy making things, and usually find that the process makes for an interesting story because it is never as straightforward as one would initially hope. For a long time I didn't know what I should make, and I considered building a wall section as a test to see whether I could find all the required reclaimed components. I also considered "building" something digitally from materials that I "prospected" online. However, that summer my mom asked me if I would help with designing a deck that my dad was going to build. I told her I would do it if I could tie it into my thesis on reclaimed materials.

The project was a good one because despite its simplicity it was still very much a real project. There was a client with very specific opinions, and a budget which was mandated by the cost of new materials.



Figure 10.1: Deck site with proposed boundaries (white) and telephone line (orange)

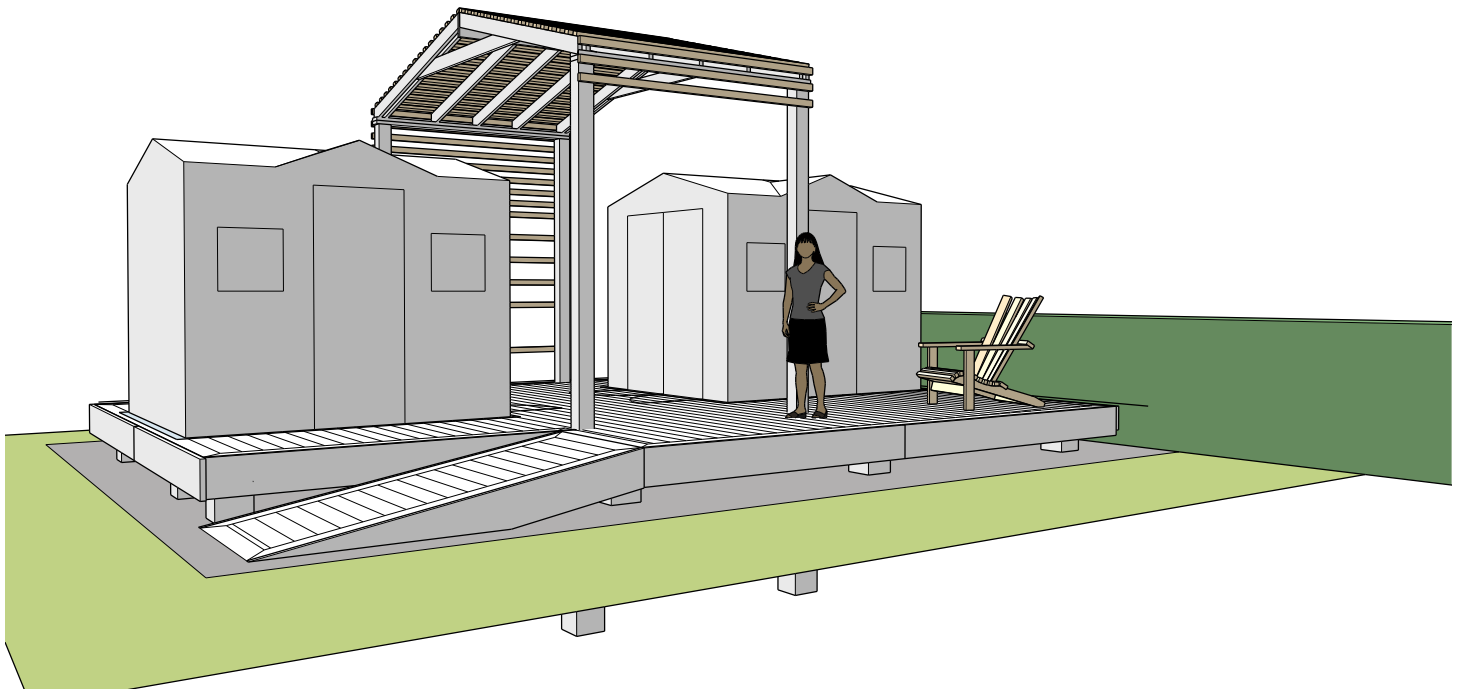


Figure 10.2: Proposed deck design; perspective

THE DESIGN

Coming up with the design, I tried to be conscious of the different reclaimed materials I might actually find on the market. I did a few load calculations and used the Wood Design Manual to choose several different options for the supporting structure, such as built-up beams as well as timber beams. I made sure to compare different species and note down whether I would want to size up or size down depending on what I might find. I also brainstormed different options for the foundation of the deck.

In particular, John Straube and I had a conversation about the likelihood of finding some of the materials I was considering, and the viability of the different options I had come up with. Based on that discussion I went looking for the options: either DekBlok or medium sized stones for the foundations, and either pressure treated, cedar, or both for the structure and surface of the deck. We came up with the minimum size of beams and joists I should look for, with the understanding that I might want to size up a little to make up for the fact that the reclaimed material doesn't come with a structural grading. Overall, I aimed to know my options and to be open to variations.

SEARCHING FOR THE MATERIALS

I wasn't sure where I would be able to find the materials for the deck at first. Trying to get them directly from demolition sites was an option that I had explored, but not a good one given the tight timeline for the project—the deck would have to be built before the beginning of winter, and I had to juggle other obligations. I did a short survey of the reclaimed materials industry in Southern Ontario and found very few resources for building from reclaimed material,



Figure 10.3: *The Timeless Material Company main building*

some of them digital classifieds and others private businesses.^[214] When I also searched the Yellow Pages I found a category of listings under “used building materials” which included most of the previous sources and a notable presence of Habitat for Humanity ReStore locations. Overall, the sources can be divided into two types: those that have a centralized stockyard and those that don’t; the latter being digital classifieds, with materials gathered and stored at an individual’s whim.

I visited both a ReStore in Guelph and The Timeless Material Company in Waterloo to find out what they carry and whether it would be useful to the deck project. I found that ReStore had very little in the way of building materials, and the stock seemed to be there purely by chance. For example, there were two pallet’s worth of shingles, but only a few pieces of wood, most of which were trim.^[215] On the other hand, it had furniture and appliances that had presumably been donated—based on ReStore’s mode of work as stated on their website^[216]—as well as inexpensive windows, doors, and hardware. Their website states that they accept donations and will remove pieces from demolition sites by invitation—meaning that if you give them a call they will come and do the work of taking it out of the building. ReStore (and Habitat for Humanity) is a volunteer-run organization.

The Timeless Material Company is closely affiliated with Kieswetter Demolition, and reclaims materials from the demolition sites they work on. They have first choice of items from any project

214 SalvoWeb: <http://www.salvoweb.com/canada/ontario/antique-and-reclaimed-materials/directory.html> ; Kijiji: <http://www.kijiji.ca/b-home-renovation/ontario/reclaimed-wood/k0c72719004> (reclaimed wood page); Untiqued - Historical Reclaimed Wood: <http://www.untiqued.com/>; The Timeless Material Company: <http://www.timelessmaterials.com/>; Historic Lumber: <http://www.historiclumber.ca/>; Legacy Vintage: <http://legacyvintage.ca/>; Circle Rock Inc. Reclaimed Wood: <http://www.circlerockinc.com/about.htm>; leftover.ca: <http://www.leftover.ca/>

215 It’s worth noting that this only reflects what I saw on a day in September 2015.

216 “Donate to the ReStore,” Habitat for Humanity Wellington Dufferin Guelph, accessed April 25, 2016, <http://habitatwdg.ca/restore/donate-to-the-restore/>.



Figure 10.4: *Reclaimed masonry block and wood; possible material choices for deck*

that they work on, and pick their projects based partly on the materials they can reclaim. Their demolition team knows what is on the site, and their knowledge of the construction trade means that they know the potential resale value of what they're looking at. They have an entirely different business model from ReStore, and seem to cater to a very different client. For one thing, they stock much more raw material such as dimension lumber, and they offer much more in the way of custom refinishing of those materials into finished products such as floors and furniture. The sources of the items have a story—you can buy the pine from Mitchell Church (exact location is unknown to me) and use it for a new floor, or buy refinished sections of the glulam from the burned-down St. Jacob's Market building for a countertop. Other components in their stockyard also seem to tell a story, like the gable-shaped bit of woodwork that looks like it could've at one point held windowpanes in an Anglican church. Walking through Timeless Materials feels like walking through a well-considered collection. They even stock paint that fits the same aesthetic and mood—Farrow & Ball: "132 superior quality and environmentally conscious paint colours."

When I looked at the digital classifieds side of the reclaimed materials industry I found yet another scene: there was no reclaimed wood to be found, though Kieswetter Demolition advertises on Kijiji under the "reclaimed wood" search-term. Their website states that they specialize in "Used Construction Materials and Building Supplies" which makes sense because of their very close affiliation with the Timeless Material Company. What I did find in terms of reclaimed materials on Kijiji was brick that had been reclaimed and cleaned off by hand. Craigslist has listings for reclaimed wood furniture, but no listings for other reclaimed materials at all. Leftover.ca purports to offer the "best deals on post construction leftovers and more..." but is disappointing because it doesn't seem active and has very few listings—new listings seem to come up at a rate of less than one per day (as of August 2016).

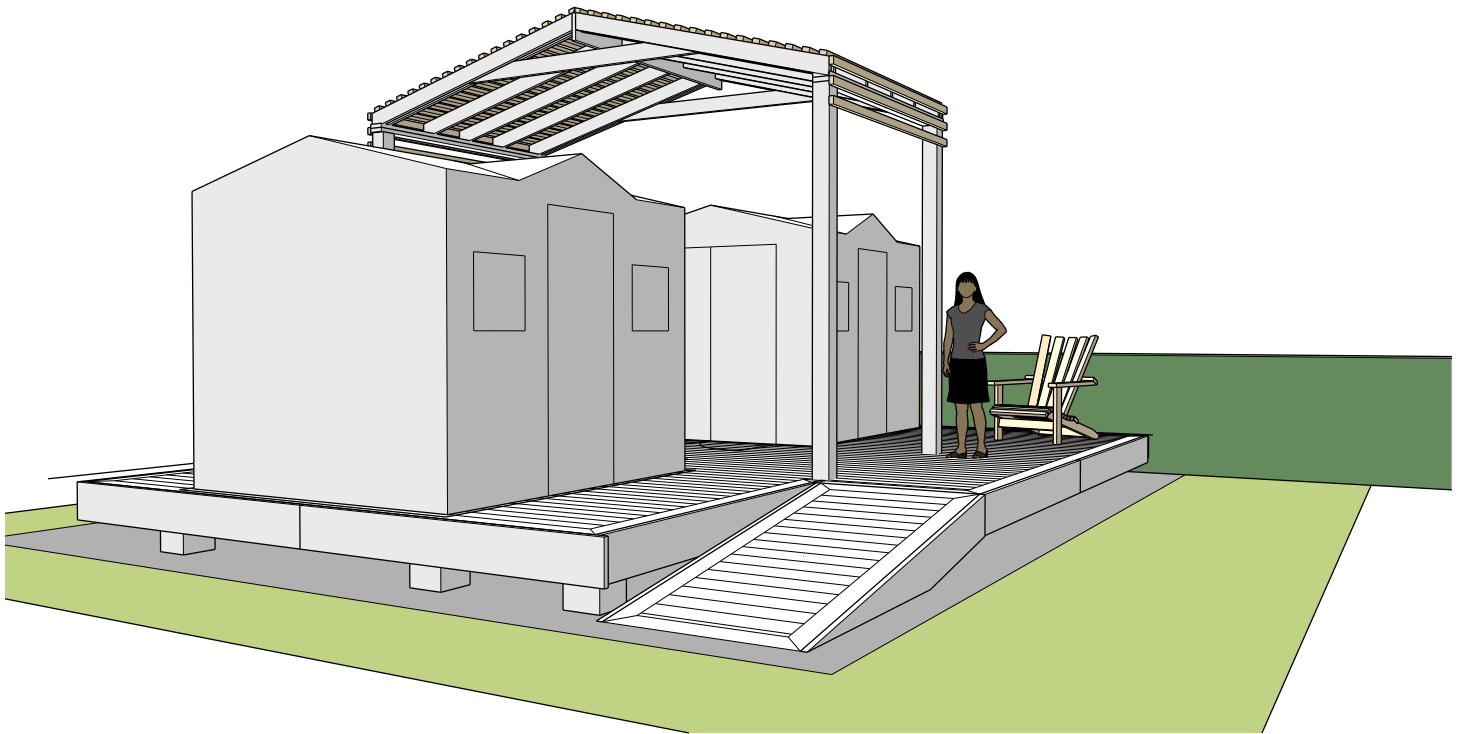


Figure 10.5: *Another perspective view of the deck design*

PICKING AN OPTION

From my initial search, the best option to pursue seemed to be Timeless Materials. My first visit to Timeless Materials in the summer of 2015 was purely to get a better understanding of what they stock, and how much of it. I was looking for a potential source for deck materials and I felt like I had found it. On my second visit I brought in the designs for the deck and requested a cost quote. I had already priced out the deck using the Home Depot website, and knew that it would cost about \$2500 if constructed from new materials like pressure treated boards for the structure and cedar for the deck surface.

On that second visit I met with a sales associate who walked through my design with me, and the price that I was quoted that day was more like a furniture price rather than a building material price; the deck would come in costing about \$8000. I took the opportunity to briefly discuss the difference in price between the reclaimed materials Timeless is selling and the new materials from a store such as Home Depot. The salesperson explained that the process of getting material from a demolition site to the point of sale has several steps. Instead of the usual demolition process which knocks everything down into an indistinguishable heap, the materials have to be carefully removed by hand which requires both extra time in terms of demolition and extra staff labour which must be paid for. The materials are then transported to the Timeless Materials stockyard at 305 Northfield Dr. East, Waterloo, the ownership/lease of which also has a cost. Then the materials are identified (by species and treatment in the case of wood) and sorted in the yard. This matched the process of reclamation described in literature on reclamation.^[217]

At Timeless, the staff notes what kind and how much of a material is available, and starts to bring some of it into the show-

217 such as Robert H. Falk and Brad Guy, *Unbuilding: Salvaging the Architectural Treasures of Unwanted Houses* (Newtown, CT: Taunton Press, 2007); and William Addis, *Building with Reclaimed Components and Materials: A Design Handbook for Reuse and Recycling* (London: Earthscan, 2006).

rooms as samples, and into the basement of the showroom so its moisture content can come down to the level found in building interiors. On the main floor, samples are used to market and sell some stock as finished goods like floors and reclaimed wood furniture, and in this case the work of refinishing or woodworking becomes part of the price of the product. Alternatively, you can choose to have the material “ripped” to the desired size, also at a price, or buy the material as-is.

In the case of the materials that I needed for the deck I was actually fairly lucky because Timeless Materials happened to have a fair amount of pressure treated wood at the time of my inquiry (October 2015). However, one thing that did drive up the cost of the materials that I needed was the fact that even though the deck would work efficiently with 2”x8” members, Timeless Materials only had 2”x12” members in stock. Although this wouldn’t be a problem structurally because I could keep the design the same and simply build it with more redundancy, it did add to the cost since larger members cost more, no matter whether they are new or reclaimed. So although the availability of pressure treated material worked in my favour and the project would be feasible, it would still be more expensive than buying new materials. When I requested an official quote the cost came back about \$5000—less than the first quote but significantly more costly than buying new material. As a result, the deck did not go ahead with reclaimed materials—it made more sense for my family to use new materials.

Almost a year later, in August of 2016, I decided to go back to Timeless and do a more thorough interview about the company and the material reclamation industry in Southern Ontario, in order to confirm what I learned on my informal visits and to learn more. I met with Jay Murdoch and Will Currie, and we discussed several different themes. What follows is a summary, and the transcript of the interview can be found in Appendix A.

Building a deck out of reclaimed materials

I asked Will and Jay what they thought of building a deck out of reclaimed material, and they came to the conclusion that in my case they would probably have to recommend that I use new material, for two reasons. For one, pressure treated lumber and cedar are both newer materials to come onto the market, and they don't usually get used structurally. Because of this, Timeless doesn't get an abundance of either material since they don't come across it as often.^[218] Will and Jay also didn't want to recommend reclaimed materials in my case because the reclaimed wood, which has aged already, is better suited to indoor use for its weathered beauty and its unique look, rather than an outdoor use in our climate which would make it deteriorate much faster than new material. Despite the fact that the cost of the material is high because of the labour that has gone into reclaiming it, it is unlikely that it would perform well in the exterior application I wanted it for. Although the purist in me wanted to use reclaimed materials for their positive environmental impact, the craftsperson in me began to recognize that the material sold at Timeless has a lot of aesthetic potential, and a lot of work has gone into obtaining it, which would be lost on the deck project.

This further served to confirm the decision to go ahead with building the deck from new materials. However, it was interesting that we came to this conclusion through the course of the interview since many of the buildings I've looked at which use reclaimed materials (both wood and others) place them on the exterior.^[219] It makes it probable that there are further nuances to the decision: it isn't "wrong" to use aged material on the exterior as long as the client finds the projected performance acceptable; it matters a lot how the materials are reclaimed and how "saleable" they are, two factors that

218 At the time of my cost estimates in 2015 there were both types of material available, and even an influx of pressure treated, which meant that the price I was getting might already have been a best case scenario.

219 such as the Omega Center by BNIM Architects, Gates' Dorchester Projects, and Wang Shu's Ningbo Museum

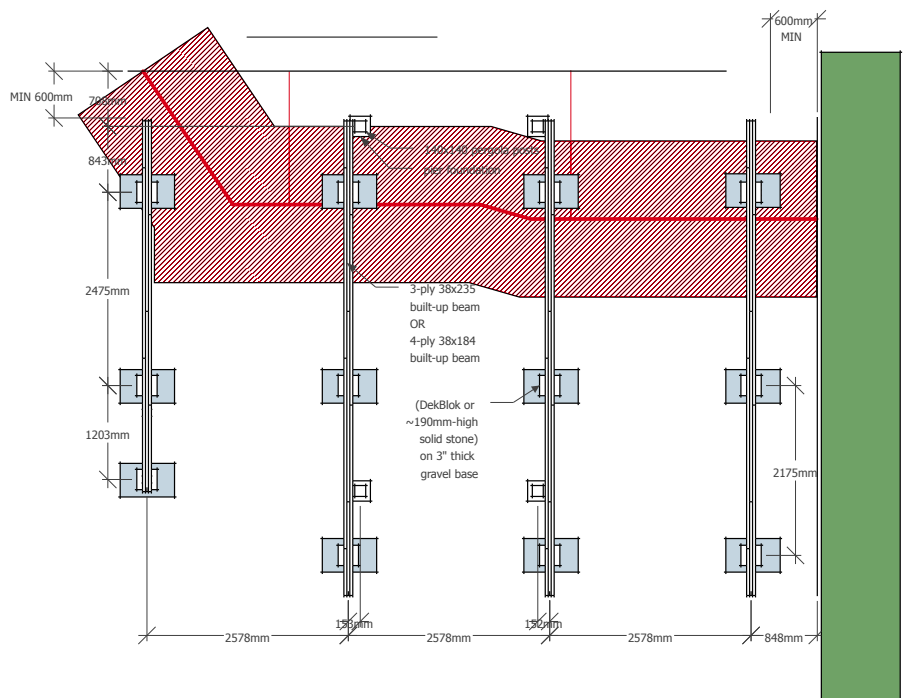


Figure 10.6: Foundation plan with telephone wire shown.

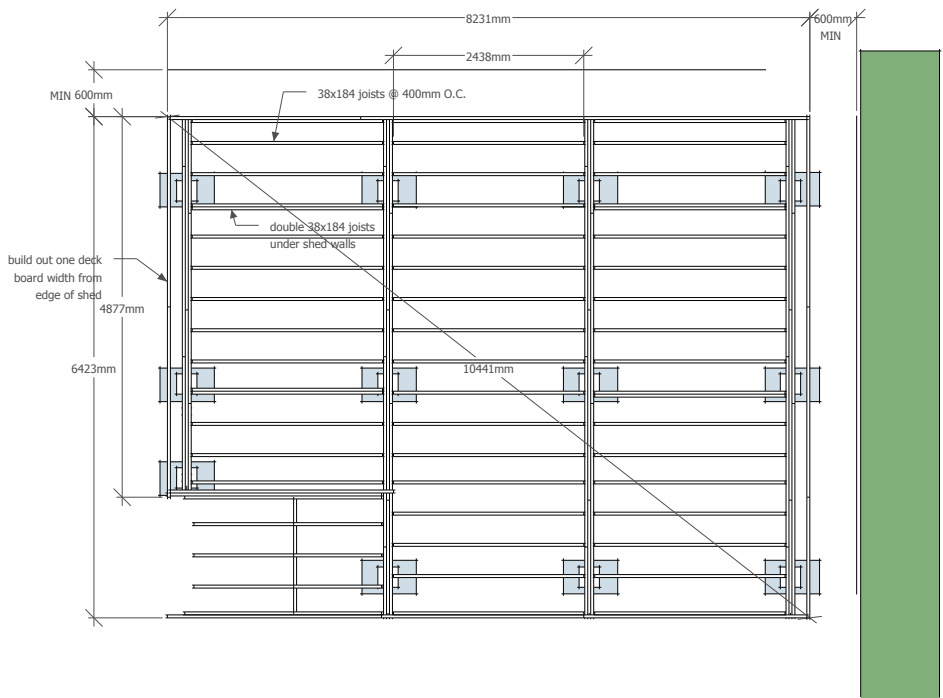


Figure 10.7: Deck framing plan.

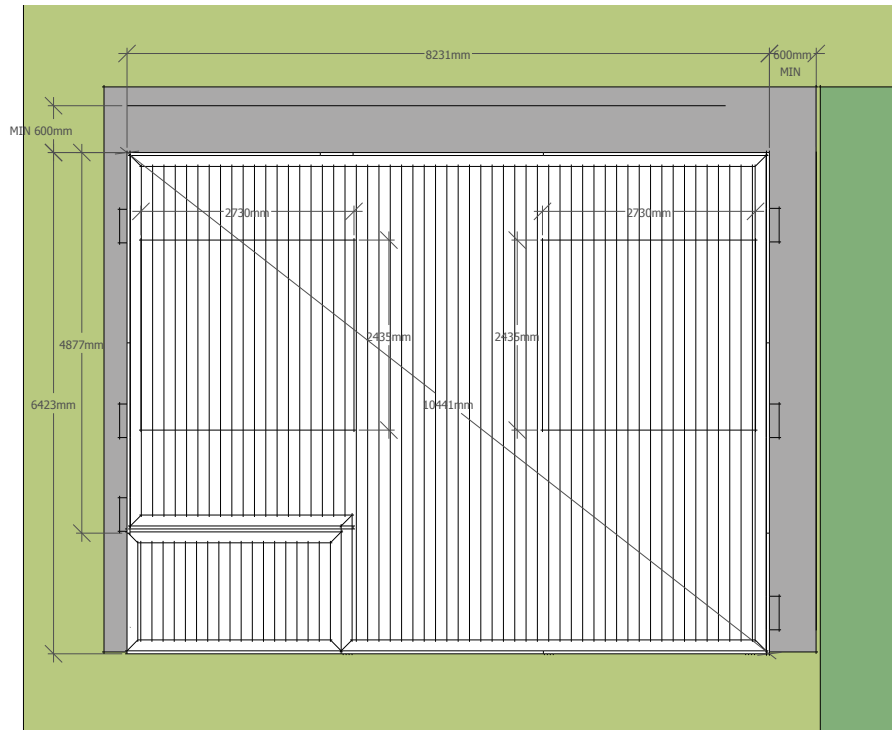


Figure 10.8: Plan view of the decking.

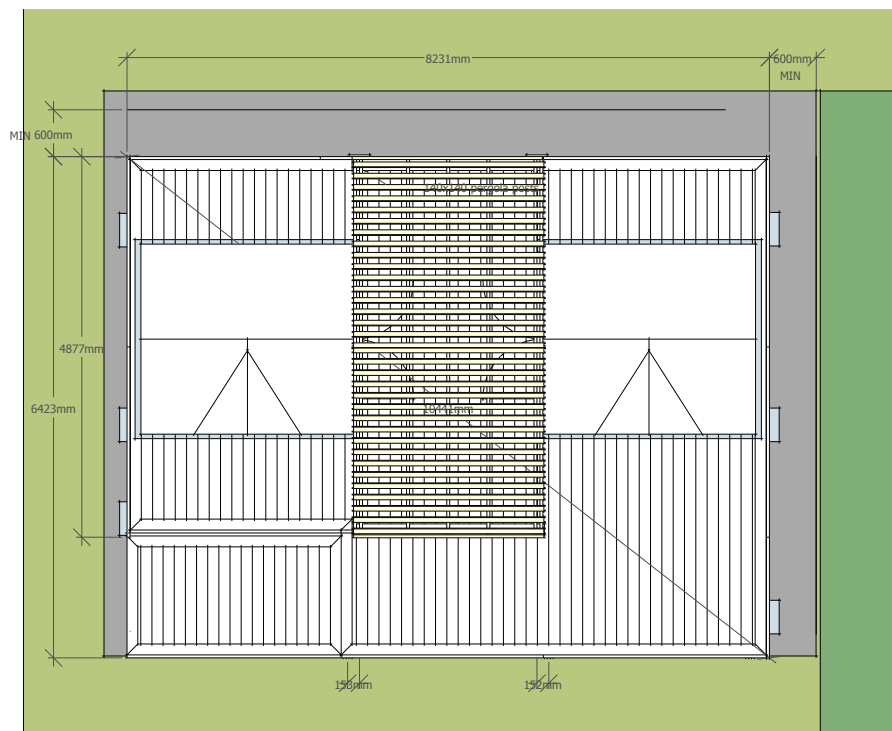


Figure 10.9: Roof plan showing plastic sheds on deck and pergola.

affect their cost—materials literally rescued from a dumpster might be free, whereas the teams at Kieswetter and Timeless take care in choosing and dismantling older structures, with an interest in collecting pieces with character; finally, a project such as the Omega Center which uses reclaimed boards on its exterior facade cites using boards from Obama’s inauguration podium—a structure that was used for a short amount of time and represents materials that are almost new.

Why are people drawn to reclaimed materials? What are motivations for saving and using them?

People buy from Timeless because of their interest in the story behind the materials, its unique look, and its environmental friendliness. In terms of environmental sustainability, reclaiming material reduces the amount of trees that have to be cut down and milled, as well as the amount of waste that ends up in landfills from demolition projects. From a cultural and aesthetic perspective, the material that can be reclaimed from old buildings is often high quality. In fact, the older buildings are more likely to have higher quality material and less products that can’t be reclaimed or don’t have reclaim value such as gypsum, MDF, chipboard, etc. Reclaimed material is very unique and therefore desirable from a design perspective.

If the proliferation of imitation products is anything to go by, the look of reclaimed material is currently highly sought after. Many flooring companies and hardware stores (like Rona and Home Depot) have imitation reclaimed wood products that are nothing more than a printed laminate. Other companies, like Northern Wide Plank, add colour and distressed-looking effects to create a product that looks like it has more history than it actually might—the wood may be reclaimed, but additional effects are added to it.^[220] There are also companies and artisans purposefully aging new wood to make it look older. Jay cited seeing this kind of imitation product at the

²²⁰ interview with Jay and Will, August 4th, 2016, and clarified via email with Will, August 30, 2016.

Interior Design Show and being made by a Mennonite craftsman. The wood is distressed and stained to give it the look of reclaimed in a fraction of the time.

From personal observation, wood is not the only material that has an “imitation reclaimed” counterpart. There is also faux reclaimed brick, and types of brick that are made to look older, more rugged, and more variegated in colour.^[221] It is interesting that the look is desirable, but reclamation isn’t more widespread. However, the trend could be indicative of the potential for the reclaimed materials market to grow. Jay and Will point out, and the buildings I’ve looked at confirm, that reclaimed material doesn’t have to be used to create a “rustic” look. The sense of deep time embedded in weathered material can be combined with the cleaner, simpler lines of contemporary design. Simplicity without the richness of materiality can feel shallow and cold; rich materials used in a “fussy” way can feel overdone and inelegant. I find that weathered materials and simple designs complement each other very well.

Where did Timeless stem from? What are some of the advantages of running the reclamation business?

It started partly out of the founder’s, Ken Kieswetter, frustration with seeing materials pulled from old buildings and destined for the landfill. Before even starting the business, Ken tells the story that in the winter workers would be given the job of straightening nails they had pulled, just to give them a job to do, but it also meant that the wood planks could be re-used.^[222] In that regard, there was already an element of reuse and recycling in the business. Now, Timeless Materials is tied closely to Kieswetter Demolition, and the two businesses bolster each other. The demolition business benefits from

221 one example: <http://bramptonbrick.com/products/clay-brick/historic-series> and another: <http://www.stonesalex.com/brick-and-stone/Brick-Veneer-Toronto-0114>

222 interview with Jay and Will, August 4th, 2016, and clarified via email with Will, August 30, 2016.

an ability to bid its jobs lower in a competitive market because some of the materials pulled from the buildings can be resold through Timeless Materials.^[223] At the same time, Timeless Materials has a steady in-flow of materials from Kieswetter Demolition which keeps it operating.

What are some of the challenges of being in the reclamation industry?

Keeping things organized is one ongoing challenge, because there isn't a steady stream of predictable materials coming in. The materials that come in depend entirely on what's available from a demolition project, which depends partly on its age, and partly on the way it was built when it was designed. The materials that come in to Timeless Materials are carefully sorted before they're "filed away" in the stock yard, although there's no formal catalogue. A catalogue would require setup and upkeep that the company hasn't had time to dedicate at this point.

Working as a small group of people can also be a challenge, because there are a lot of orders to fulfill. The high interest in the look of reclaimed materials is a double edged sword: on the one hand it keeps the company busy and productive, but on the other hand, it doesn't leave much time to consider new ways of using the materials, to make new prototypes, or set up new features such a catalogue. Personally, I frequently hear about this struggle from other craftspeople who come up with a popular product and consequently find it difficult to dedicate much time to developing their new ideas. I've seen some who take the approach of giving themselves a "sabbatical" to work on new ideas every once in a while, but this may be more difficult to implement in a larger business as opposed to a one-person enterprise.

There are also external challenges. Some people are shocked by how much the material costs, or think that this business caters only to the wealthy. In fact, it's expensive because the value of it

223 Other materials such as metals can be sold as scrap to an existing market.

determined by the amount of skilled labour that goes into obtaining, sorting, and finishing it, and by how interesting or unique it looks. This material is not treated like garbage, it is treated as a unique resource that has to be carefully harvested. Its cost is comparable to other high quality, hand-prepared materials, so in that way there is no attempt to “make it” expensive, but rather to charge a fair price that results in a fair wage for the work done and reflects the quality of the product.

It can also be difficult to reverse-engineer structural reuse of materials, and this draws out the design process. The way the process usually goes is that the engineer comes in with a specific idea of what’s needed structurally and then finds out that it isn’t currently in stock. In turn, Timeless gives them a list of the potential options they can offer and have the engineer reassess the design. The design process is reversed in a way, which means that you have to start with the material that’s currently available and then figure out how you would like to use it, as opposed to figuring out how to use it and then simply specifying the right piece, brand new, from what is commonly available in the construction industry. This can add time, which does mean that structural use of reclaimed material can cost more in terms of design effort. However, there are customers who follow through with this process despite the added cost, because they value what they get as an end product—whether from an aesthetic or sustainable point of view, or both. We discussed with Will and Jay that the decision to use reclaimed material is usually customer-driven, and in fact that there might be resistance from an architect or engineer when it becomes apparent that it requires a much more involved design process. Architect and engineers need to be more aware of the process of designing with these materials and how to handle the challenges that will come up.

Reclaimed material demands the willingness to adapt. From the reclamation business perspective, prices might have to adapt to the current availability and popularity of any one material. From the design perspective, the way that things are put together has to

be adapted to the materials that are currently available. In a way, the materials come before the design.

A final challenge can be the material's durability. There's an abundance of old structures in Southern Ontario which are great for the patina they develop, but the age of the wood can mean it's limited to interior use. Our climate is harsh enough to significantly deteriorate older reclaimed material in exterior applications.

Advantages

The Southern Ontario market is quite condensed, which makes it a good place to do business with reclaimed material. If there wasn't an abundance of reclaimable materials and a market for it close by, transporting material would add more cost to it and might make it unfeasible.

Is there an economy of scale?

Processing and selling bulk quantities of material can be done more efficiently than individually considering each piece of material for a different client. In that way, an economy of scale is possible. The cost of deconstructing a building and manually preparing it takes time and can't be priced down.^[224] However, preparing it in one go can streamline the process to result in savings on a larger batch of materials as opposed to individually-purchased pieces.

²²⁴ This is where design for deconstruction could help to make a difference, by making it easier and faster to deconstruct existing structures and reclaim the materials.

FINAL THOUGHTS

Will and Jay described the job at Timeless Materials as being pretty well a perfect fit for them. They seem to really enjoy it, and they enjoyed talking to me about it, describing the staff at Timeless as passionate about their work. We live in a society that seems to value the efficiency of making something more than the impact of that work on people. In the end, the interview seems to support my notion that craft-like work can be a fulfilling and meaningful way to interact with the material world, despite, or maybe because of, its challenges. The process of reclamation helps to engage with materiality rather than materialism/consumerism.

11 MONITORING A COMPLEX SYSTEM

Problem definition for a monitoring tool
Why/how is monitoring important to complex systems?
Pre-design: tools and scale
Precedents for monitoring tool
Schematic design of monitoring tool
Discussion / results of making the tool

Problem definition

My study of the way material industries interact and are governed (from the previous chapter) helps to understand how the barriers to material reuse might be addressed because it placed material re-use in its larger industrial context. The study helped to understand how material re-use interacts with the design industry and other industries.

At the governance level, material reuse can be facilitated by material standards that incorporate procedures for testing and grading reclaimed materials, especially for structural applications but also to ensure that material are non-toxic. For example, CSA-O86 is a very detailed standard for wood design. This might mean that an addition to O86 to specifically address reclaimed wood would be an appropriate way to address structural design with reclaimed wood, rather than a totally new standard. Testing and re-grading procedures of reclaimed wood might also fit under the standards governing grading of new wood products. Municipalities and building codes could also be more explicit about accepting reclaimed materials and equipment in new construction. Judging from case studies, until there is greater standardization and regulatory acceptance of reclaimed ma-

terials, architects must advocate for testing and code changes to make reuse possible in their projects.^[225] This is an additional responsibility which is a hinderance to greater use of reclaimed materials.

However, another recurring challenge for architects is that reusable materials can be difficult to source, and this is a problem that could be addressed through system knowledge and design. First-hand experience showed disparity of material outlets, and a market that isn't geared toward making whole buildings from reclaimed materials. Case studies showed a recurring challenge with sourcing and dealing with the unpredictability and uncertainty of material supplies. Sourcing was often done through a consultant or a willing construction manager. Studying the flow of materials through different industries gave me a better understanding of where reclaimed materials can come from, and how they can be found. Although I found that the market in Southern Ontario wasn't very conducive to using reclaimed material, I propose that we could harness readily-available information to make it easier to reclaim materials from their source: the demolition site.

Actors that play a role in the system of material re-use include other material industries, information sources, and governing bodies. Industries include architectural design, demolition, construction, salvage, waste, and recycling. Information sources that advertise reclaimed materials for sale include print and online classifieds. Furthermore, the recent surge in open information sources can be harnessed to get real-time information and begin to make projections about building materials that will become available through demolition; these sources include municipal records and maps, public

225 Public Architecture, *Design for Reuse Primer: 15 Successful Reuse Projects within Different Sectors Explored In-depth*, 2010, <http://designforreuse.com/pdf/Primer-Online.pdf>; also Vince Catalli of Ottawa-based MHPM Project Managers, one of the designers of MEC Ottawa (built with materials reused in-situ) has served as Vice Chair of the CSA Green Building Technical Committee and occasionally writes on the topic of design for disassembly and material reuse. (source: <http://www.sabmagazine.com/blog/2009/10/27/design-for-disassembly/> and <https://www.canadianarchitect.com/features/designing-for-disassembly/>). This further supports the pattern of architects' involvement in policies that affect construction.

data, open-source maps, and Google StreetView. These can help us learn about *what kind* of materials may be available and in *what quantity*, making it easier to plan for eventual re-use. Policing bodies govern material standards, such as ASTM, SCC, and CSA, as well as the construction of buildings, such as the National and the Ontario Building Code. Integrating processes for testing and grading reclaimed material into material and construction policies goes a long way to integrating material re-use in the construction industry overall.

Census tracts can be used to generalize and anonymize personal information about individuals and families. Some of this data may indicate construction/demolition patterns. For example, my search indicates that demolition takes place mostly in wealthy areas, and if wealth patterns are tracked through time it may be possible to predict sites of future demolition and reclamation opportunity, and to study the materials available from those sites.

Implementing solutions: the role of monitoring in complex systems

Uncertainty is one of the defining characteristics of complex systems, and it is a barrier to decision-making. Decisions range from hard to impossible to make if the level of uncertainty is high because there's a perception that making the wrong decision is risky. In general, when the decision follows the precautionary principle, the consequences aren't risky per se, they are more akin to buying insurance against fire for your house and never having to cash in on it because your house never catches fire.^[226] However, in business there can be risky consequences to time (schedule) and money (budget) management if decisions backfire or have unintended consequences, and these issues are both concerns when using reclaimed material. Although in a more global and ecologically-focused sense material reclamation

²²⁶ similar to Wells' example of hurricane preparation; *Complexity and Sustainability*, p.255.

and re-use is low-risk, for a business the uncertainties that it presents make it seem high-risk.

Feedback and information about a system greatly help adapt to environmental (i.e. contextual) influences and help make decisions despite existing uncertainty. Monitoring a system for feedback and information builds a history and collective memory that allows for self-organization—that is to say, the creation of structure or order in a system without a central coordinator. Monitoring helps understand the effects of policy/governance changes in order to adapt socially-created top-down management in the future. It is a means for balancing bottom-up behaviours with top-down structure. Berkes, Colding, and Folke reflect on this in *Navigating social-ecological systems*:

Given that some level of uncertainty always exists in complex systems, decision makers need to continuously monitor and integrate appropriate ecological, social, and economic information into management. Such adaptive management, whereby policy making is seen as an iterative experiment, acknowledges uncertainty, rather than assuming it away. Carrying out adaptive management requires a great deal of information to provide feedback to the manager regarding the consequences of the policy experiment.^[227]

Management that relies on feedback is termed “adaptive management” because it has an iterative quality—initiatives are set out in policy, tested, monitored, and this information is used as feedback to re-evaluate and possibly change aspects of management. We can’t understand the consequences of a policy change if we have no data on it.

In speaking about the role that myth plays in managing the uncertainties in life, James Kay questions how we can begin to come up with new stories to navigate the uncertainties of sustainability. He partially answers his own question:

227 Fikret Berkes, Johan Colding, and Carl Folke, *Navigating Social-ecological Systems: Building Resilience for Complexity and Change* (Cambridge: Cambridge University Press, 2003), p.187.

Adaptive management is a step in the right direction and the recent emergence of the notion of collaborative learning processes is another example. The challenge is to acknowledge the limits of our ability to know, to design decision/intervention processes which can learn from both the positive and negative consequences of our limitations and which redress those who are the victims of these consequences. Thus any decision making and intervention becomes as much about humility, justice, compassion and learning as about “good science”, rationality, and profit.^[228]

Berkes, Colding, and Folke also address the myth/science duality and the importance of both in coming to solutions:

modern science has little of the wealth of the detailed context-specific observations of the dynamics of complex ecological systems. Knowledge of how to respond to disturbance and how to build resilience for enhancing adaptive capacity is still in its infancy. Such knowledge, site specific and often embedded in management practices of local resource users, exists as a part of the knowledge systems of tribal peoples, peasants, herders, and fishers in many parts of the world.^[229]

In terms of managing an architecture project, monitoring can also help in the adaptation of a design—often through an iterative structure that architects are already accustomed to—because it makes data available about material availability in the present and past. Following that, architects become a source of information themselves—the local resource users to be considered and consulted in policy changes. We are already seeing the beginning of this process through material reclamation case studies, where the architectural design may require policy changes to make re-use of building components viable with the Building Code. Architects take the lead on such initiatives because they act as project coordinators.

Management and monitoring are intertwined, whether it’s on a large scale of policy or on the smaller scale of an architectural project. Monitoring is a risk-management tool that can lead to gov-

228 James J. Kay, “On Myths and Sustainability,” James Kay: Musings, December 2002, <http://www.jameskay.ca/musings/myths.html>.

229 Berkes, Colding, and Foke, *Navigating*, p.206-7.

ernance changes as well as changes in the workflow of architecture firms.

Monitoring can play a second role as well. In *Reshaping Environments* Ruth Beilin points out the link between information and risk management that we've discussed, that more information can lead to greater confidence with regard to decision-making:

The more data available, the better informed decisions can be. Better knowledge provides more confidence in making decisions. Monitoring risk does not provide us with a definitive sense of what can happen, or what is likely to happen in highly connected systems and uncertain situations. Monitoring is important and we need to do it to understand what has happened. It may assist us to foresee emergent patterns that will help predict system thresholds and changes that can then help us to manage risk.^[230]

However, she also points out that sometimes new knowledge gives rise to further questions instead of more certain decisions. In monitoring sightings of Red List species "what we find is that more knowledge changes how we understand the relationship in a system, for example, and creates the need for more knowledge to explain the new links that previously were not known."^[231]

Beilin's observation implies that a monitoring tool for tracking reclaimed materials in Southern Ontario could also serve a double function by providing both academic and practical value. For the former, it may lead to more questions about the system. For the latter, it functions as a decision-making and resource-finding tool.

230 Ruth Beilin, "Conceptualising Change: Complexity, Post-normal Science, Uncertainty and Risk," in *Reshaping Environments: An Interdisciplinary Approach to Sustainability in a Complex World*, edited by Helena Bender, 277-304 (Cambridge, England: Cambridge University Press, 2012), p.300-1.

231 Ibid., p.301.

Pre-design: understanding tools

Tools help solve problems, but can also shape the problem definition and the outcomes or conclusions of the problem-solving process.^[232] Tools both limit the scope of outcomes and enable us to problem-solve within a particular scope. “Tools” can be generally taken to mean anything that is used to problem-solve, and within architecture it includes any of the software that we use to help us design buildings and manage the design process. However, when we work across disciplines, there is a greater range of tools that can influence the range of possible outcomes. Moving outside of available architectural design tools may be necessary to address uncertainties in material sourcing.

A system can be looked at from a variety of spatial and temporal scales, and a tool must consciously address one or more of these scales; this becomes part of the problem definition for finding (or making) the right tool for the problem-solving process at hand. But first, it is necessary to understand the holarchy (or panarchy) of the system to learn about its function in a range of spatial and temporal contexts.

Pre-design: deciding on scale

The first part of this thesis discussed three interdependent variables that are important for material sustainability: psyche, society, and environment. These can be considered to be at the “global” scale of the system. Their relationships are also global, and can relate to various manifestations of material culture, only one of which is architecture. Their relationships help describe issues that we face with regard to achieving material sustainability.

The scale I addressed throughout the second part of this thesis was concerned with material industries involved in manufacturing and construction, with a focus on architectural and structural materials as opposed to other material spheres such as automotive,

²³² Ibid., p.291.

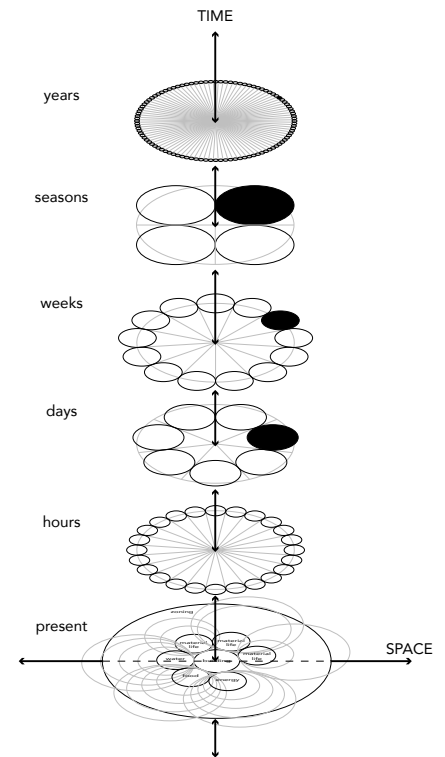


Figure 11.1: *Diagram of spatio-temporal scales.*

fashion, products, etc. There are several industries that are involved in the making and unmaking of buildings, they are also interrelated, and these interrelations are of interest to the creation of a tool that facilitates sourcing of reclaimed structural/architectural materials.

Since there are different approaches to controlling emissions throughout Canada, different economic and ecological challenges, different industries and relationships between industries, and different political leanings, it doesn't make sense to look at the tool at the scale of the country. Manmade, artificial boundaries are created and ruled by policy, and they do not form gradients that can be generalized. It is more useful to look at a smaller scale and understand which local, provincial, and federal policies affect it and may need to be adapted. That is to say, spatially, it is useful to start from the bottom up to understand the effect of top-down policies and how they might be adapted.

Temporally, some issues related to material culture have developed over a century as we've become more globalized and as we've accelerated our material demands in quantity and span-of-use. This has been linked with a long-term global warming effect, which is driving multiple types of climate change. Other effects become apparent over the course of a couple decades, for example the hole in the ozone layer which we understand now was linked with the release of halogens into the atmosphere. Subsequent policy to ban the use of some halogens has allowed the ozone layer to thicken again.^[233] This is an example of how monitoring helps to adapt policy, and then follows up on the consequences. Finally, there are patterns linking climate and production that are more observable over the scale of a year, such as the ability of tree cover to drastically reduce atmospheric CO₂ in summer months when vegetation flourishes.

233 Ben Spencer, "Ozone Layer 'on Track to Recovery': Shield That Protects Earth from Sun's Rays Is Slowly Repairing Itself, UN Scientists Reveal," Mail Online, September 12, 2014, <http://www.dailymail.co.uk/sciencetech/article-2753148/Ozone-layer-track-repair-says-scientists-Shield-protects-Earth-Sun-shows-early-signs-recovery.html>.

Although long-term monitoring and projection of trends is important to understanding the ecological consequences of production trends, the challenges that I've defined from personal experience and literature on material re-use suggest that it would be very helpful to designers to have real-time data on material availability in order to manage material use on a building scale. Spatially, too, the materials have to go from demolition to new construction, suggesting that the scope should be fairly local to emphasize local availability (and less transportation). In time, it may be possible to establish long-term trends of material cost and availability, although the creation of a tool that aids practice will also (hopefully) skew the results to show an increasing trend in material reuse and availability of reclaimed material. Making a historical record of reclaimed material availability deepens the understanding of the reclaimed material market.^[234]

In *Mapping in the Age of Digital Media*, Balmori points out that the scale of time being studied affects how reality is understood. Changing the scale of observation can transform the way that we perceive reality. She gives the example of monitoring phosphorous levels in urban streams: when they are tested once a month they appear negligible; when they are tested every 15 minutes they show huge spikes that can harm river life. This revelation indicated that a change is necessary to avoid ecological harm.^[235] Stories and hypotheses that we base on infrequent samples may not hold up under examination on a closer scale. On the other hand, a phenomenon

234 As Silver and Balmori put it, it helps create a four-dimensional understanding. Mike Silver and Diana Balmori, "Networking Maps: GIS, Virtualized Reality and The World Wide Web," in *Mapping in the Age of Digital Media: The Yale Symposium*, ed. Mike Silver and Diana Balmori (Chichester: Wiley-Academy, 2003), p.50.

235 Diana Balmori, "Just in Time," in *Mapping in the Age of Digital Media: The Yale Symposium*, ed. Mike Silver and Diana Balmori (Chichester: Wiley-Academy, 2003), p.16; cites study from A Cattaneo and Y T Prairie, 'Temporal viability in the chemical characteristics along the Riviere De Lachigan: How many samples are necessary to describe stream chemistry?', *Canadian Journal of Fisheries and Aquatic Sciences* 52(4), April 1995, pp 828-35 and J H Lee, K W Bang, L H Ketchum, J S Cho and M J Yu, 'First flush analysis of urban storm runoff', *Science of the Total Environment* 293(1-3), 3 July 2002, pp 163-75.

such as global warming may be better understood by longer-term trends and larger spatial bounds. For example, just because one locale experiences cooling in one year does not negate the fact of overall global warming. The relative temperature difference also has to be considered in light of recurring phenomena such as El Niño and La Niña.^[236]

These ideas about spatial and temporal scale illustrate the usefulness of building a localized data set that can be analyzed on multiple time scales. Spatially, the tool I'm proposing is intended to focus on the local and immediate availability of materials to limit the scope of the problem, make use of my own local knowledge, and to exercise the idea that when it's time for reorganization in a system, it can come from an individual organism or an individual person.^[237] Temporally, I'm proposing it would be able to track data on a finer time scale to provide real-time data on availability and to subsequently study whether there may be seasonal or yearly trends in availability.

Pre-design: deciding on format

It's important to the aim of the tool that it is hosted on the world wide web and available for access by all. In *Mapping in the Age of Digital Media* Mike Silver and Diana Balmori discuss the opportunities of open and public tools. GIS (Geographic Information System) allows us to collect, layer, and relate maps to each other, building up a database of knowledge. Moving this database to the Internet converts it from a closed system to an open system, which allows it to function as a "public space" that could form the basis of a sharing and

236 for a short discussion and sample maps see Scott Sutherland, "April Marks Longest Streak of Broken Climate Records Ever," The Weather Network, May 18, 2016, <http://www.theweathernetwork.com/news/articles/april-marks-longest-streak-of-broken-climate-records-ever/67917>.

237 C. S. Holling, "The Backloop to Sustainability," foreword to *Navigating Social-ecological Systems: Building Resilience for Complexity and Change*, by Fikret Berkes, Johan Colding, and Carl Folke (Cambridge: Cambridge University Press, 2003), p.xvi.

discussion platform.^[238] Their suggestion is reminiscent of what's happening with Grasshopper: this is a parametric design plugin for Rhinoceros 3D, which has a lively online forum of users asking questions and sharing solutions for free and open to public reference. It's an extremely helpful resource to those who are just starting out with parametric design. Similarly, a monitoring tool for reclaimed materials that's open and accessible could be helpful to designers wishing to try out material re-use.

Pre-design: precedents

I found several web-based tools that could act as precedents for the design I'm proposing. Some exist for finding reclaimed materials outside of my spatial focus zone (Southern Ontario), while others are a useful study in using crowd-sourcing and public data to create databases.

Superuse Studios, a firm based in Rotterdam that specializes in material reuse, created a tool called "Harvest Map," centred on the idea of listing and finding reclaimed materials for use in projects. It's Europe-based, with most of the listing in the Netherlands. The site gives the ability to search by specific material and location. However, it looks like it may have been abandoned, or simply isn't very active; there are only a handful of postings from 2016.^[239]

Trashswag is a Toronto-based curbside scavenging site. It is entirely crowd-sourced, meaning that it functions by getting people to submit reports of re-usable things that they find (or put out) on the curb in Toronto. It also has a "salvageable building materials" category. The number of postings on the site varies greatly—sometimes there are only a couple listings if submissions are low.^[240]

238 Silver and Balmori, *Mapping*, p.54-55.

239 Superuse Studios, "Marketplace for Professional Upcyclers," Oogstkaart | Recycling Design Platform, accessed July 24, 2016, <http://www.oogstkaart.nl/>.

240 "Crowdsourced Architectural Salvage," Trashswag, accessed July 24, 2016, <https://trashswag.com/>. It currently requires you to create an account to view the map.

Figure 11.2: "Harvest Map" by Superuse Studio.

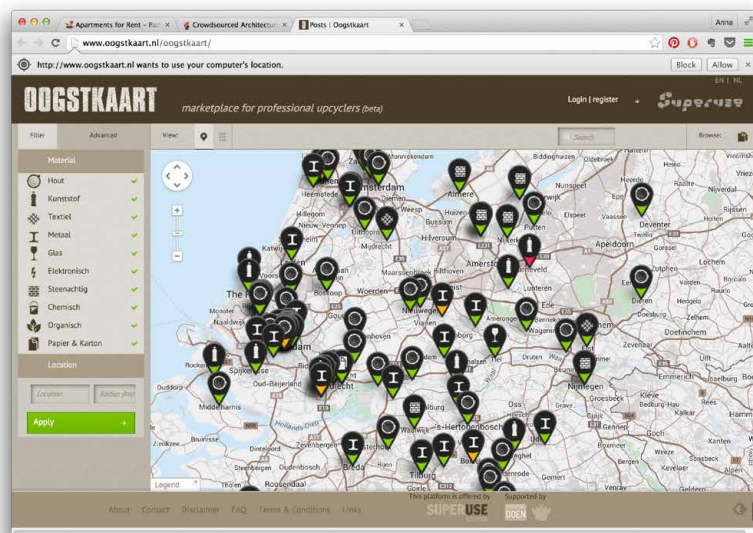
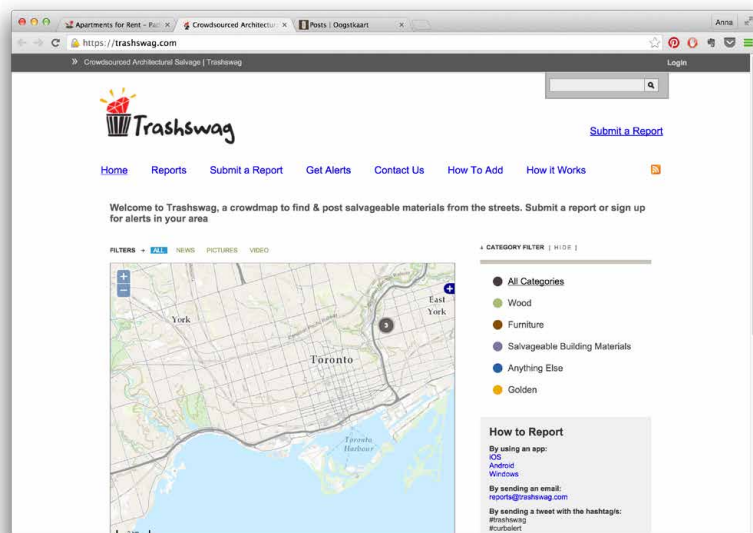


Figure 11.3: "Trashswag" by an unknown creator.



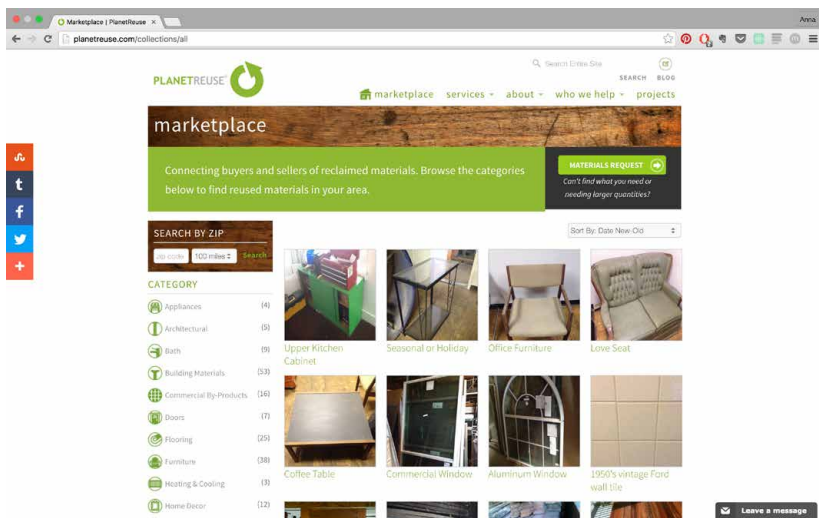


Figure 11.4: PlanetReuse Marketplace.

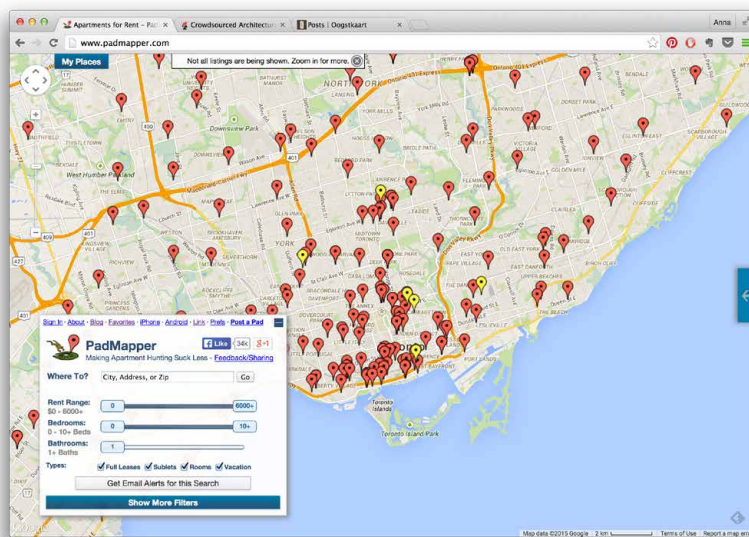


Figure 11.5: "Padmapper" by Eric DeMenthon.

Planet Reuse Marketplace is a partner of the Building Materials Reuse Association, both US-based organizations that facilitate material reuse by creating a network of professionals and helping consumers find appropriate reclaimed materials. The Marketplace website isn't the most user-friendly, as it's fairly difficult to search for materials within a given spatial range. It's also hard to tell when postings were created.^[241]

Finally, Padmapper by Eric DeMenthon is an example of a web-based tool that uses public listings to map all available rental properties in one centralized interface. It also offers an improvement on the websites it "scrapes" for information, because neither Kijiji nor Craigslist can be browsed through a map interface, making it more difficult to focus on geographically-relevant listings. Padmapper offers many browsing features, giving the ability to sort listings by parameters such as price, number of bathrooms, type of lease, whether pets are permitted, and more. As of recently it also has a "PadLister" function, which allows to post listings directly to the map. This tool is an important precedent because I'm proposing that public classifieds could similarly be "scraped" for reclaimed materials and displayed on a more useful interface.^[242]

SCHEMATIC DESIGN

To reiterate, the aim of designing this monitoring tool is to create an information source for designers and property owners about available materials, thereby making it more accessible and mainstream. It is intended to popularize material reclamation and re-use by making sourcing easier and providing data on past availability of the material so that a designer can assess whether something is common or rare,

241 "Marketplace," PlanetReuse, accessed July 24, 2016, <http://planetreuse.com/collections/all>.

242 Eric DeMenthon, "Apartments for Rent," PadMapper - Making Apartment Hunting Suck Less, accessed July 24, 2016, <https://www.padmapper.com/>.

or when it might be available. There are specialty consultants who already have such knowledge and can assist on projects, but again, the aim is to increase accessibility, awareness, and knowledge to make the practice less scary, opaque, and economically risky.

The tool is founded on the notion that in a world where we can't afford to expend massive amounts of fossil fuel energy, new material goods will theoretically become scarce, but we can turn to the waste stream as a potential resource. Much of what ends up in landfills is a reflection of our fast-pace consumerism rather than the usability or durability of material goods. In this sense, urban built-up areas are potentially a useful mine of reclaimable materials if we harness the waste stream and the already existing salvage industry. This idea stems from the assumption that construction and demolition will continue to take place to some degree, even in a world of energy scarcity or stringent regulation. To assume otherwise (that no more construction or demolition takes place, that only adaptive re-use is allowed) represents a scenario that's catastrophic to those industries and the people working within them. What is more desirable is a gradual adaptation of those industries, which may in fact move more and more towards adaptive reuse and material reuse to save energy and natural resources.

The tool has three projected functions as determined by the pre-design research. It will act as a "scraper" that gathers public data from other websites in order to put together one cohesive database. It will also layer several datasets from public information that can help designers individually prospect for reclaimable materials without going to each site. Finally, it will build up and parse past availability of materials, in case useful trends emerge.

One: the scraper

The first function of this tool is to gather information about available reclaimed materials from disparate sources into one database with a map component that lists materials by proximity to the new construction site. That is to say, it will aggregate data from decentralized sellers who post listings for building materials in classifieds such as:

- » Craigslist
- » Kijiji
- » Newspapers (online and in print)
- » salvage.ca
- » leftover.ca
- » eBay

A defining characteristic of decentralized actors is that they are virtual (and sometimes printed) listings that bring together otherwise dispersed single-person/-household actors under one interest category such as “building materials” (very general category suitable to smaller pool of sellers) or “architectural beams” (very specific category suitable in a large pool of sellers such as eBay).

It will also have an underlying map showing centralized sellers such as those in the “used building materials” category of the YellowPages, but the inventory of these sellers would likely have to reside on their own website.

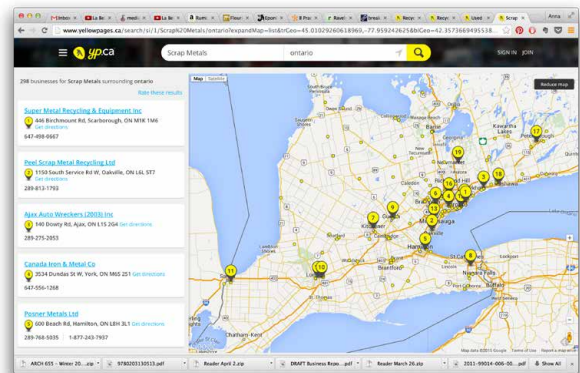
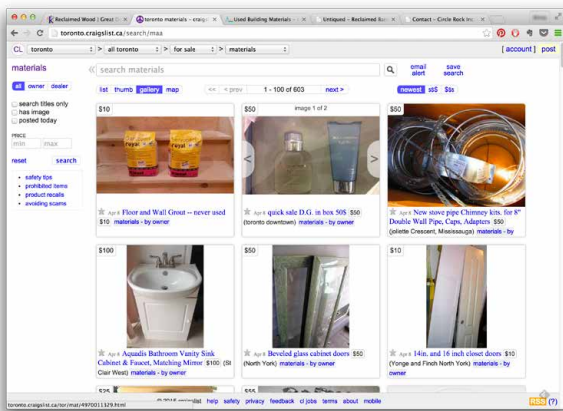
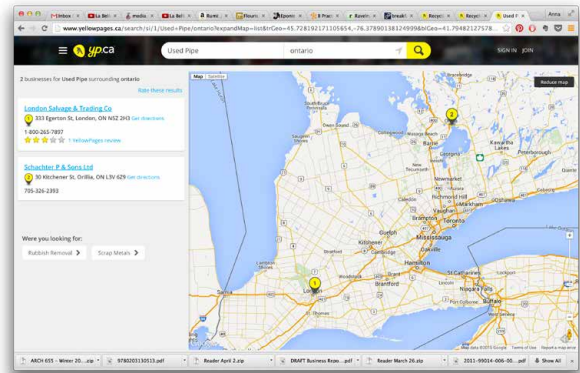
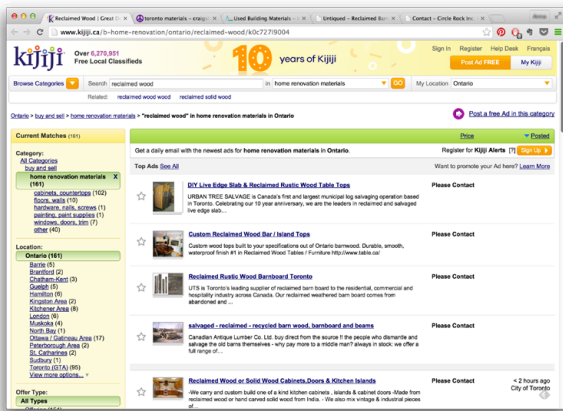
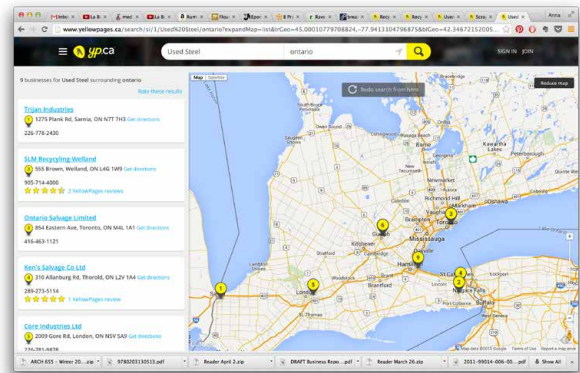
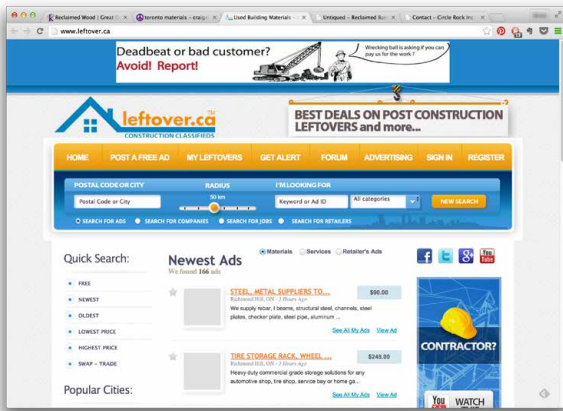


Figure 11.6: leftover.ca, kijiji, and Craigslist are just a few sites listing reclaimed materials

Figure 11.7: Used steel, used pipe, and scrap metal categories on YellowPages

Two: the prospector

A second function of the tool is to map active demolition, construction, and renovation sites as sources that could be harnessed with a bit more effort and coordination on the part of the seeker (they will likely have to arrange their own deconstruction, transportation, and storage facilities). To make it easier to judge what materials and in which quantities may be available from such a site, the database can rely on additional layers about land use, building construction date, renovation history, photos (such as Google StreetView), and possibly even 3D scans. Cooperation and input from the contractors working on the site would be immensely helpful, and leads to the potential option that these same sites would auction off deconstructed materials (possibly to offset costs of deconstruction directly to the owner), feeding back into the tool as a listing manager. Potential sources of data include:

- » Open Data portals (e.g. <https://www.ontario.ca/page/sharing-government-data> covers Ontario, municipalities have their own)
- » Google StreetView, Maps, 3D Earth (building massing)
- » TObuilt.ca (construction dates and building use)

More data may be gathered through the tool via third parties to obtain:

- » additional photographs
- » material quantity measurements/estimates
- » 3D scans of buildings

Data such as land use, construction date, and building type can help to determine the kinds of materials available in our cities using already-available information. To illustrate: one would expect different construction methods, and therefore different materials, in an 1873 single-family residence than in a 2001 commercial high-rise. This is an extreme example of difference, and it may be more difficult to

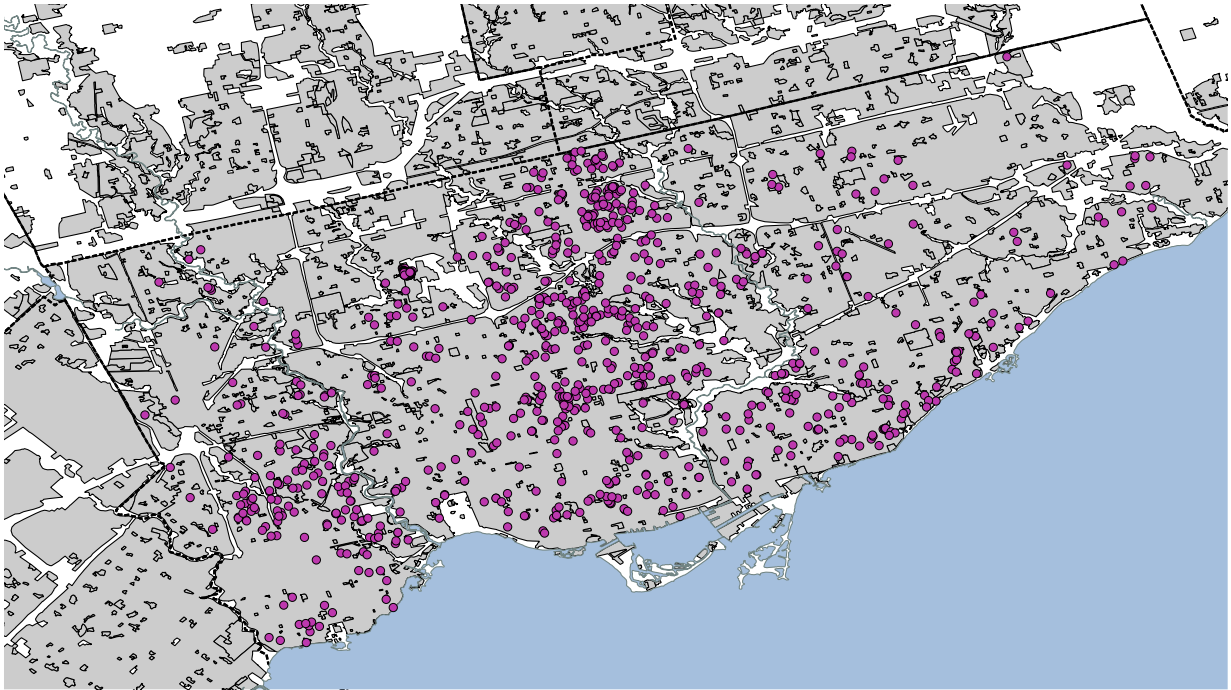
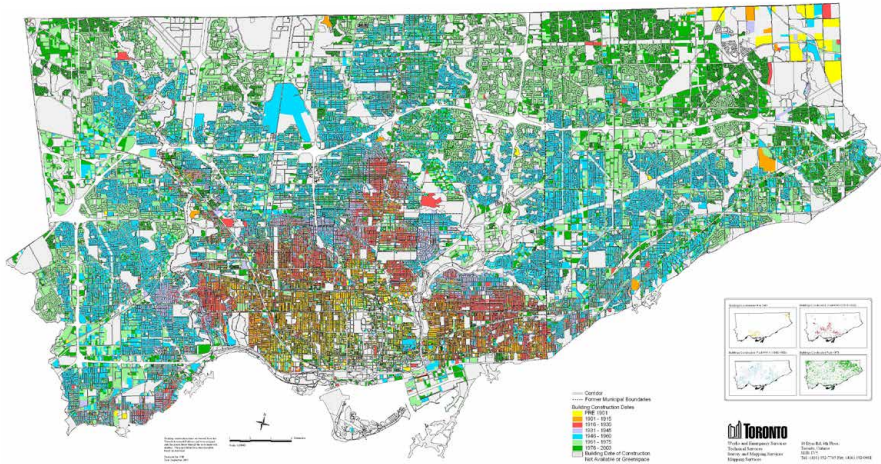





Figure 11.8: *Sample base map, active demolition permits in Toronto.*



Figure 11.9: *Publicly-available Google StreetView could be used to gather visual information about materials on a demolition site.*

find differences between an 1873 residential building and commercial building (of similar size), but it does provide additional useful information assuming that the viewer has some understanding of the historical progress of construction methods in a given region. Some information isn't readily publicly available and would have to be compiled, while some compilation has already taken place by civic-minded hobbyists, such as Bob Krawczyk who created TOBuilt.ca as an archive of buildings in Toronto by neighbourhood, date, height, building type, and building use (the two latter entries often don't match in the case of land use changes and renovations e.g. of industrial buildings into residential apartments). Trying to understand the materials used in a building becomes partly a historical exercise, of uncovering the stories of urban infrastructure.



	House for Home Smith 1 Baby Point Road York, Baby Point	York	Baby Point	1911	Completed	3	0.00	Detached house	Residential
	New St. Paul's Anglican Church 227 Bloor Street East Toronto, Bloor-Yorkville	Toronto	Bloor-Yorkville	1913	Completed	0	0.00	Religious	Religious
	Toronto-Dominion Bank 420 Bloor Street East Toronto, Bloor-Yorkville	Toronto	Bloor-Yorkville	1912	Completed	2	0.00	Low-rise	Commercial

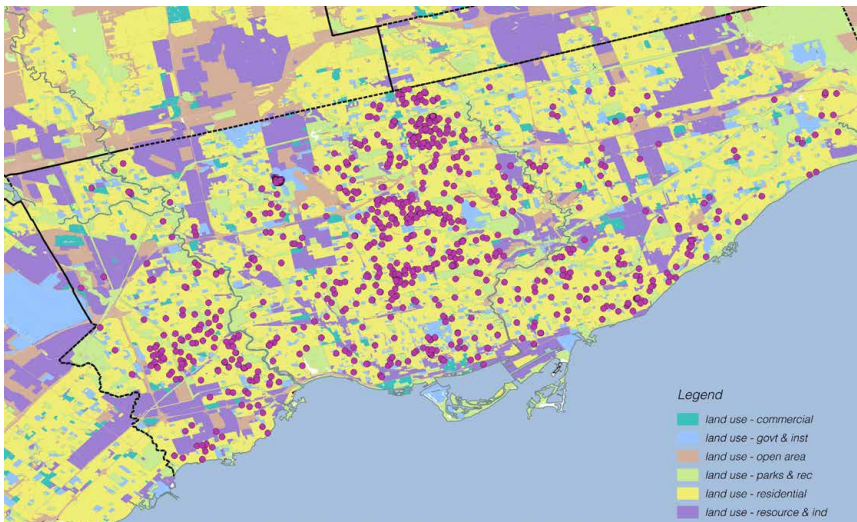


Figure 11.10: Construction date, building type, and land use designation can help determine the kind of materials available at a demolition site.

Three: the historian

The third function of the tool is to gather and display historic availability of a material. This will allow practitioners to learn about material availability trends in their region, and assess the risk of designing with a particular material. If it is rare, then there may be sense in purchasing it for the project upfront to avoid a shortage later in the design and construction process. If it is common, there is less risk in leaving purchasing to a later time. Availability will be shown as a graph with a time scale.

INPUTS

Urban built-up areas (physical infrastructure) function like resource “mines” for recycling and re-use. Open data portals (information infrastructure) can allow us to virtually mine them for available resources. The most highly built-up areas also have municipal open data portals, making it possible to gather data on the nature of the built-up areas and make some conclusions about the types of materials embedded within. Since the Open Data portal for the City of Toronto contained the most information on building and demolition permits, I chose to use Toronto as a case study for the tool.

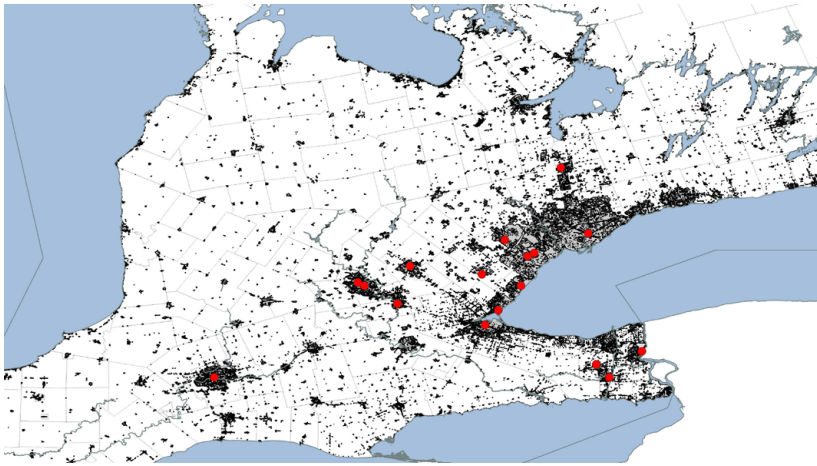


Figure 11.11: *Built up urban areas and municipal Open Data portals. Some data portals offer significantly more information than others, though the virtual infrastructure is there.*

OUTPUTS:



718 Marlee Ave., Toronto M6B 3J7
Demo permit issued October 4, 2014
Single detached house
Inventory:

bricks - approx 5000
windows - vinyl frames 10 years old 1'x1', 5'x8', 4'x7', 4'x4'
exterior doors - 2
wood studs - approx 300 2x6
insulation - TBD
shutters - 10; various heights
exterior pavers - 15 1'x1'

INFO CARD

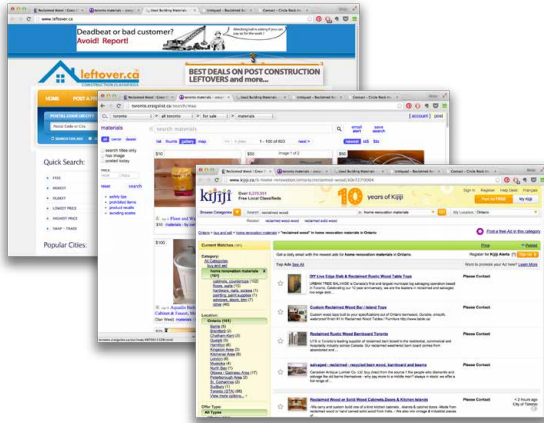


RECLAIMED MATERIAL FINDER INTERFACE

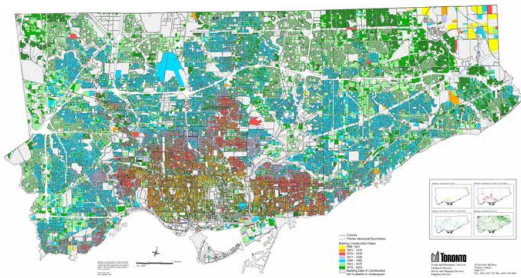
Current resources for finding reclaimed materials are rather disparate: in Ontario there are centralized locations that can be visited such as ReStore shops (run by Habitat for Humanity) and Timeless Materials (run by Kieswetter Demolition), and there are de-centralized sources such as Craigslist, Kijiji, and salvage.ca. Although the public classifieds are potentially easier to browse for specific materials, they are currently difficult to navigate geographically – an important factor for cutting down on the environmental costs of material transportation. Centralized locations such as shops and salvage yards, on the other hand, may have a limited quantity and selection of materials. It is of most interest to them to stock high-value goods like doors, windows, fixtures, and furniture rather than lower-value bulk building supplies such as wood and masonry. Salvage yards currently don't have the capacity as a storage point for all possible re-usable materials from demo sites; they are not sufficiently widespread because this is quite a small industry.

This industry can grow through architects adopting the role of salvagers or scavengers instead of relying solely on existing reclaimed building material depots and listings. To meet this challenge I propose a real-time monitoring tool for re-usable materials, the “Reclaimed Material Finder,” which starts with a view of built-up areas as resource mines and compiles demolition and construction data from city records as well as public classifieds. I have begun to explore a monitoring framework by using demolition permit records from the City of Toronto and mapping them against other data layers such as nearby used material depots, architecture offices, and land use zoning. Creating a tool/app that functions as a real-time database of reclaimable materials will help make the process more accessible and enable architects to grow the industry: it reduces the knowledge gap which is a barrier to engaging in re-use, and it goes straight to the source of re-usable materials.

INPUTS:



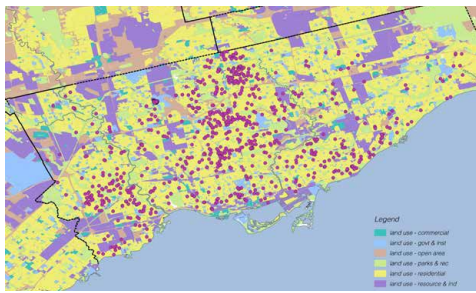
Decentralized public classifieds



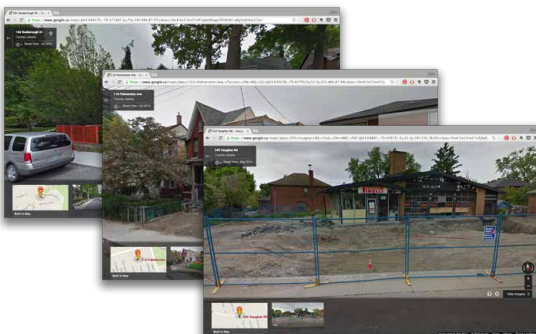
Construction date

Screenshot of the TOBuilt.ca website showing a table of buildings in Toronto. The table has columns for 'Title', 'Photo', 'Address', 'Status', 'Year', 'Type', 'Description', and 'Built'. Three buildings are listed: 'House for Home Smith', 'New St. Paul's Anglican Church', and 'Toronto Dominion Bank'.

TOBuilt.ca - database of buildings in Toronto



Designated land use



Google StreetView visual information

12 RE-USE CONCLUSIONS

When I embarked on writing a thesis on sustainability I started at ground zero by asking what sustainability is. The answers that I got back had a similar theme: it is a complex phenomenon of many interdependent variables, the value of which can't always be described quantitatively. It not only respects human dependence on the environment, but it also respects the environment itself and the many other species it hosts. It is a question about how we can have a high quality of life for many, many generations in the future by living symbiotically with natural systems. It is also a question about how developing countries will be able to have a high quality of life, as opposed to being merely a question of keeping high quality of life in developed nations and assuming the status quo to persist elsewhere. In this way, sustainability is also about social equity.

Delving deeper into issues of social equity, ecological degradation, and individual quality of life made it clear that many of our problems are material problems. Our economic structures favour human and ecological exploitation in the name of economic growth and purchasing power which supposedly increase our quality of life. In fact, consumption and materialism don't improve quality of life past a certain point, and inflict damage on society, nature, and



Figure 12.1: *The C. K. Choi Building by Matsuzaki Architects Inc. in Vancouver, BC, was completed in 1996. 100% of the exterior brick is reclaimed, and 50% of other building materials are reclaimed or recycled products. (source: <http://www.aiatopten.org/node/206>)*

psychological well-being. These three criteria are taken as a basis for analysis because it became clear that all three can work as driving factors both towards and away from achieving a sustainable lifestyle. Therefore, sustainability has been defined as a symbiotic relationship between psyche, society, and nature that can be perpetuated for many generations, whereas non-symbiotic relationships create unsustainable conditions.

Speaking to sustainability as a system of interdependent variables made it helpful to reference concepts from systems and complexity theory regarding diversity, feedbacks, and the paradox of efficiency. These concepts informed the analysis of relationships between psyche, society, and nature in today's material culture as well as the analysis of different approaches to material sustainability in architecture. The interdependence and feedback loops between psyche, society, and nature were discussed, as well as the need for sustainable architecture to learn from these feedback patterns. That is to say, when it becomes clear that materialism and over-consumption are globally pervasive cultural problems, a question for sustainable architecture is how it can function outside these paradigms.

I undertook an analysis of various approaches to material sustainability suggested in architectural literature with these questions in mind, initially fearing that the conclusion I would come to is that architecture, as a material object, can't be practiced sustainably. Indeed, there is an oxymoron in building more and more new structures in the name of sustainability, because this continues to contribute to over-consumption and materialism. I thought that perhaps the most sustainable thing to do is not build new, but repair and adapt older structures. However, I also realized the importance of acknowledging that not all older structures are necessarily fit for adaptive re-use, and that regardless of what might be "best," the construction industry still produces large amounts of waste as people decide to demolish and rebuild rather than adapt older structures. Although we might want to move towards lower rates of demolition and longer building lifespans, I came to the conclusion that some degree of

demolition will occur for varying reasons because, again, there are no perfect scenarios. At the very least, if we succeed in moving to higher durability and rates of adaptive reuse, this is likely to happen slowly as all systems take time to change. In the meantime this leaves us with the waste of resources from demolition, and with the question of how to build in a way that addresses the problems of materialism.

Applying this conclusion further, I find that a variety of strategies is part of a holistic way to address sustainability concerns and that there is a sequence that's implied in deciding which strategy to pursue. For example, ideally each building would be analyzed to see if it's structurally and operationally fit to be re-used, or whether it would be better to tear it down to replace it with a newer and better-functioning structure. If the building is demolished, reusable materials should be identified and stripped off the building first, then demolished materials should be sorted for recycling, and only then should the rest go into a landfill if they're completely un-usable. This sequence also implies that new materials developed for construction and put into buildings should follow at least one important rule as well: that it be possible to disassemble a building into homogenous parts for recycling and reuse processes. This touches both on product development and the way that materials are chosen and assembled into a building. Design for disassembly has a lot of guidelines for how make structures that are amenable to dismantling. This range of considerations covers both production and waste streams of materials, effectively addressing all stages of product life from the perspective that we need to become better at reducing the energy expenditures and ecosystem destruction of raw production as well as reducing the amount of waste we create (which represents unrecoverable energy). That is to say, we need material use to form more of a closed cycle, which will be achieved through a multitude of strategies rather than just one.

However, having identified that approaches to material sustainability represent a decision tree rather than the possibility of finding one best solution, I focused in on material re-use because it's

not only a gateway to the decision-making tree for material disposal but also addresses ecological, social, and psychological issues encountered in material culture in a variety of ways. Ecologically, it's beneficial when it can be done locally and with minimal refinishing, and when it's tested to ensure that it's non-toxic and structurally sound. Socio-psychologically, it provides an anti-materialist image of sustainable architecture that asks people to reflect on consumption patterns as well as the loss of memory and stable identity that comes with accelerated development patterns. At the same time, it engages tradesmen, architects, and passersby through its materiality, fostering the idea that consumerism is not the only way to achieve beautiful objects and urban environments—that in fact there are much more fulfilling qualities to be found in the slowness of craft.

However, I also discovered systemic obstacles to using reclaimed materials more widely in construction: availability is uncertain, which can impact the design even at late stages, demanding that the architect be flexible; ways to source reclaimed materials are unclear, and projects seem to rely on personally reaching out to potential sources to establish a word-of-mouth knowledge base; locally, I found that reclaimed materials are targeted to a niche market—mostly for interior and furniture applications that capitalize on their authentic, artisanal, rustic qualities—which can make them very expensive if bought “off the shelf”; building codes don't explicitly allow, and sometimes explicitly prohibit, material and equipment reuse; material standards haven't incorporated material re-use procedures, so all testing has to be done on a one-off basis.

The research on material re-use helped to understand how it addresses several themes:

Transience and Permanence

In order to strike a balance between transience and permanence, which can also be thought of as newness and history or disposability and durability, material re-use allows for the human need of self-ex-

pression through new creation while maintaining ecological consciousness and a sense of social continuity. Preservation of goods and buildings has a psychically grounding quality because they provide a historic context for modern life to play out. Such preservation gives a sense of stability and upholds a strong local identity. Material re-use embraces these qualities by way of the traces of past use (i.e. history) embedded in the material while allowing new creation. It slows down the rate of materials from original source to eventual dissipation but does not force material flow to stop altogether; it stands between disposability and durability.

Light weight and Heaviness

Qualities of disposability and durability or transience and permanence go hand-in-hand with qualities of light weight and heaviness. Material re-use occupies the middle ground between these because it cannot, in practice, go to an extreme of light weight; it requires some redundancy in order to be built into its new application. Materials can be tested for performance requirements, but it is still impractical to perfectly predict the effects of past use on every part of a re-used material. Redundancy will help to ensure resilience of the structure, but it does not have to go so far as to make a structure so heavy that it's ready to outlast an apocalyptic weather event. That kind of heaviness is reserved, perhaps, for strongholds and pre-engineering-era structures. We can strike a balance between frugality and redundancy to both reduce resource depletion and increase resilience.

Scarcity and Abundance

In order to find balance between ascetic scarcity measures and indulgent fantasies of abundance, material re-use inhabits the mindset that we have enough. The concept of enough is neither completely oblivious to the satisfaction of new creation and renovation which both require material, nor does it fall into the trap of thinking that



Figure 12.2: *Ningbo Historic Museum* by Wang Shu, *Amateur Architecture Studio* in Ningbo, China follows in the tradition of *wapan* construction by using a mix of reclaimed bricks and tiles from the demolition of historic neighbourhoods.



Figure 12.3: “Wikado” playground by Superuse Studio in the Netherlands reuses aircraft parts to make a children’s playground.

living a life overflowing with material pleasures will bring lasting happiness. Positions of both scarcity and abundance stem from a fear of not having “enough” when in fact most of us (especially in, but not limited to, the developed world) already have enough, and even more than enough. There is a limit to how much happiness and feeling of security material wealth can bring.

The scarcity/abundance duality is difficult to overcome psychologically because scarcity clouds judgement, particularly the ability for long-term planning,^[243] while a desire for abundance is the natural reaction that looks like an escape from scarcity.^[244] Marketing exploits this duality by trying to convince us that there is scarcity in our lives which can be “fixed” if we will just buy a product or pay for a service. This is detrimental to the actual pursuit of sustainability—which of course makes obvious that an economy built on unlimited growth is impossible to perpetuate. This is how the concept of sustainability becomes greenwashed and a marketing tool. As Pallasmaa puts it: “The emotionally and ethically appealing concept of sustainability can even undermine true sustainability, as it makes us believe that we are already doing our share in this big task.”^[245]

Instead of searching for fulfillment from material goods, what we really need is to have a basic sense of what is enough and then to continue the search for fulfillment by finding meaning in our lives. For Thomas Fisher, meaning comes from “community, collaboration, and co-existence.”^[246] For Schumacher it comes from mean-

243 Sendhil Mullainathan and Eldar Shafir, *Scarcity: Why Having Too Little Means so Much* (New York: Times Books, Henry Holt and Company, 2013).

244 Brené Brown, *Daring Greatly: How the Courage to be Vulnerable Transforms the Way We Live, Love, Parent, and Lead* (New York, NY: Avery, 2012), p.29.

245 Juhani Pallasmaa, “Architecture and Human Nature: A Call for a Sustainable Metaphor,” in *Local Architecture: Building Place, Craft, and Community*, ed. Brian MacKay-Lyons and Robert McCarter (New York: Princeton Architectural Press, 2015), p.32.

246 Thomas Fisher, “Seeing the World Whole,” in *Local Architecture: Building Place, Craft, and Community*, ed. by Brian MacKay-Lyons and Robert McCarter (New York: Princeton Architectural Press, 2015), p.19.

ingful work or endeavour.^[247] For Viktor Frankl, a psychologist and Holocaust survivor, it comes in at least two guises: collective purpose as well as “actualizing the potential meaning inherent and dormant in a given situation.”^[248] To live meaningfully is to live with a purpose, whether personal or collective in nature.

The case studies helped to illustrate how material re-use creates more opportunities for meaningful work and conscious engagement with materials.

Chaos and Order

We often think of chaos as negative, and with reason, but complete order also has its downsides as it edges toward absolute control that does not allow mistakes or spontaneity. In biological and environmental systems, complete order is brittle, meaning that as a system it is prone to sudden failure without a warning grace period when something disrupts it or overwhelms it. An analogy to materials is apt here, as a brittle material is one that shatters as opposed to deforming or adapting. In the field of complexity science, there is a special point between chaos and order known as the “edge of chaos” which is considered to be the most resilient state of a system. For architecture, it means that as much as we attempt to bring order to the world through design we will always have new problems and new forms of chaos to face; it is strangely comforting that this is as it should be, and that this is a productive and resilient state to be in.

Having no fondness for disorder, we have prudently ignored it, and have been unable to reckon how necessary it is, how natural or how fertile. In rejecting hypocrisy we have lost ambiguity, complexity, subtlety and contradiction; then we strait-jacketed ourselves with crusading zeal, submitted ourselves to the dogma

247 E. F. Schumacher, *Small Is Beautiful: Economics as If People Mattered* (New York: Harper & Row, 1973), p.34.

248 Viktor E. Frankl, *Man's Search for Meaning* (Boston: Beacon Press, 2006), p.138.

of missionaries, to manicheanism and a naive attitude towards the organization of work.^[249]

Material re-use requires that we learn to work between chaos and order. Being complex, it presents a degree of uncertainty which is a challenge in the design process. Learning to deal with uncertainty and manage it so it is just on the edge of chaos will be discussed in the context of craft, and through case studies of projects where materials were re-used or donated.

Past and Future

In order to find a balance between past and future, I try to position material re-use in the present: how can it be practiced starting now? how can architects be helped to practice it now? In itself material re-use starts as an option at the beginning of an architectural project; it does not need to rely on the future to pay back for itself (in terms of carbon emissions, not dollars) it makes a difference from the first day. It bridges lessons from the past about local, vernacular wisdom with a vision for the future by starting with current issues and the current workflow of architectural design and construction.

Linearity and Cyclicity

Material re-use recognizes that the linear production models of the past century are unsustainable, but also that perfect cyclicity is an unrealistic dream that isn't thermodynamically permissible. It also allows for materials that are otherwise antithetical to a perfectly cyclical system, such as any earth material—masonry, stone, and ceramic. These materials neither biodegrade to become nutrients for new resources, nor are they mechanically recyclable. At best they are kept in service for as long as possible, and/or reused from one application to another. The fact that earth materials don't fit neatly into

²⁴⁹ Lucien Kroll, *The Architecture of Complexity*, trans. by Peter Blundell-Jones (London: Batsford, 1986), p.12-13.

a conception of cyclicalty makes them antithetical to the idea that there's a "sustainable" version of consumerism.

The re-use of materials is neither linear nor perfectly cyclical because most materials and products (e.g. windows) aren't fit to be re-used indefinitely; some wear down and some may simply go unclaimed. What is important is the decision-making process that takes place before the destiny of a material, or building, is decided.

Non-negotiables

There are a few tendencies that material re-use clearly prioritizes. One is slowing down the rate of material flow, which brings to mind a "slow architecture" with similar values as the better-established movements of "slow fashion" and "slow food." Another priority is minimizing the greenhouse gas emissions of new construction by reducing the amount of new materials used but not at the cost of human or environmental health. It also leans toward craft intelligence and skilled labour as opposed to machining and skill-lessness.

Limitations and future opportunities for research

Limitations of this research include the fact that I wasn't able to review every re-use project that I've found to determine whether my conclusions are completely consistent or if there are further nuances. Furthermore, I'm uncertain how to find examples of re-use that haven't been certified by a third party or published as success stories; this leaves an indeterminate number of projects outside the scope of my knowledge and makes the research biased towards success stories. It is not known how many re-use projects there might be in Canada or the US that are undocumented. My own attempt to build a deck from reclaimed material was an enlightening experience that highlighted some difficulties particular to Southern Ontario. It suggests that one way to further the research is to try and use reclaimed materials in future design projects, in order to learn from failures. Further-

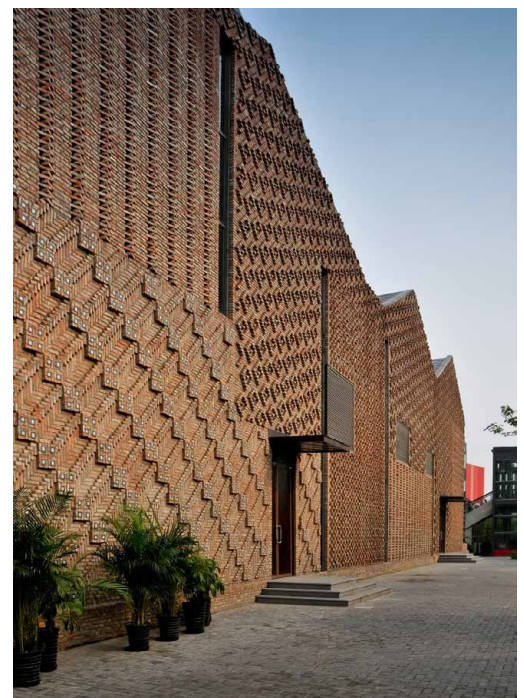


Figure 12.4: *Pavilion 4 by HMA Architects & Designers in Shanghai, China uses reclaimed brick.*

more, I am not able to authoritatively speak to ecological impacts of specific projects, including the projects described in the case studies, other than by referring to a few studies on material re-use in general.

Having done this research makes it more likely that I would apply material re-use in practice and suggest it to co-workers, especially if working on a project that will be certified as “green” or “sustainable” by a third party like LEED or Living Building Challenge. In the larger scheme of implications for the field of architecture, I hope that the framework of this thesis inspires others to approach sustainability as a complex cultural question that may be addressed through cultural means such as design. Specifically, I have been interested in how sustainable architecture can be less materialistic to symbolize a paradigm shift from the belief that consumerism equals greater quality of life to a belief that quality of life is largely independent of consumerism. Material goods and wealth can only increase feelings of happiness and security to a certain degree. The thesis opens the question for further research: how can architecture, as a cultural object, contribute to sustainability by addressing the social and psychological problems that present barriers to adapting environmentally sustainable lifestyles?

Material re-use also opens up a different way to look at the historical development of cities and the materials that went into them, with a goal of identifying what era of structures are likely to provide the best materials, and what era might provide harmful materials. Further research could include an analysis of our cities to understand the inventory of materials they already embody.

I acknowledge that, as with any intervention into a complex system, making it easier to use reclaimed materials in new construction may have unintended consequences that I can't foresee. For example, I have criticized Cradle to Cradle for its focus on cyclicity because overemphasizing the “waste is food” concept can lead to more consumption because it makes waste seem innocent (whereas I argue that it's not innocent, since materials can't be infinitely cycled without degradation and the faster materials cycle in a system the

more energy we use to reprocess them). The same criticism can apply to material re-use. This makes it even more important to emphasize the use of multiple methods for reducing problems that arise from material consumption, and to question how design can positively influence social/cultural modes that drive consumerism.

I propose that material re-use is a way to establish a meaningful relationship to the material world, by showing the “shadow” of wealth, status, and the race for growth and development—waste and inequality—at the same time as it encourages material engagement and a philosophy of imperfect beauty.

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APPENDIX A

The following is the transcript of the interview with Jay (Jason) Murdoch and Will Currie of the Timeless Material Company. The interview took place on August 4th, 2016 at the Timeless Material Company — 305 Northfield Dr. East, Waterloo, ON N2V 2N4.

Anna Beznogova: I want to start at the beginning, and I was wondering if you guys could talk a little bit about how the business started, if you know what drove the decision to start it, whether it was a set of circumstances, or someone was really interested in it?

Jay Murdoch: Yeah, so, Timeless Materials was started by our president, Ken Kieswetter, as a spinoff company from Kieswetter Demolition. Ken was sort of frustrated with all the material he was pulling out of these old buildings—churches, factories, houses—that were basically destined for the landfill, and it struck him one day to start reclaiming it and open up this entire different branch of Kieswetter Demolition that was strictly for selling the reclaimed material and salvage.

Anna: So he saw the value in...?

Jay: In the story—this will probably come up a lot in our interview—it's the story behind the wood. You know, the age of it, and the fact that you're reusing it. It's those unique factors that this business is all about. Before that, though, Kieswetter Demolition is a 100 year old family company that was always in the business of tearing down, demolition, but Ken tells the story about how back in the day, they would have their workers in the winter actually straighten out nails that they had pulled just to give them a job in the winter. And it's always had this element of reusing and recycling.

Anna: That's really interesting.

Will Currie: I think Timeless Materials was started about 25 years ago, but yeah, Kieswetter Demo is about a 100. It just bore out of necessity almost. Because every time that you take things to the landfill, it's perfectly good material, it may not be new or graded for structural integrity, but it's perfectly good material so there's really no need to put it in the landfill. And there's a cost involved in that too, in bringing things to the landfill, so if we can avoid that it's great, but also the environmental impact is huge.

Jay: Yeah, there's definitely a business decision involved. It sounds romantic, this story we tell, but yeah, you pointed it out, Will, it costs money to throw things out, right? So I think it's Ken's vision to reuse it, sell it, all that, but

it's also "I can save quite a bit of money here," bid jobs lower, bid demolition jobs lower because all of a sudden what we're pulling out of these buildings has value.

Anna: Ok, so would you say that it is a significant savings?

Jay: It's significant, but also in the demolition business, it's gotten so competitive now that it helps. It definitely is an advantage, but other people are wise to it now, that reclaimed wood has value, and scrap, and copper, which always has value—scrap metal is a big part when they're quoting demo jobs, or putting in tenders.

Anna: How did you guys get involved, and how would you describe your role in the company?

Will: I got involved just over two years ago, I guess. I was just in the market for reclaimed wood, so I was really just shopping. I was moving to Waterloo and I just happened to be looking for a job when they were posting for a position as a sales associate. It's right up my alley, I'd worked in a woodshop at the Museum in Kitchener for a few years prior to that, but I was moving so it just seemed to be kind of perfect. But it also struck on a few passions of mine, which is woodworking for one, design which is huge, and sustainability which is huge as well. It just seemed to be the perfect fit. And I just happened to be moving into a house that was like a hundred and fifty years old too, and everything just seemed to converge as being the right place to be, to cater to all of my interests. So it's something that I'm really passionate about, so it's really perfect for me. Jay's been around longer than me though.

Jay: Yeah, I guess I'm coming up on five years, and before I worked here I had a great experience working for a really elite carpentry group up in Muskoka, and they did everything the old-fashioned way, so handnail everything, the houses were entirely wood, there was no drywall whatsoever, so I got a taste of how things were done the "old-style" way, that's sort of how they coined it up there. And I was looking for something in the area that was kind of off the beaten track as far as work, something that was kind of elite as far as the work itself, and ended up meeting Ken, and we sort of hit it off, and next thing you know it's fast forward, we're here. But it was more like, doing interesting work that was different, and then the reclaim aspect was a really pleasant added bonus.

Anna: I noticed that your card says Design/Build, so what does that entail day-to-day?

Jay: Well, I physically do build a lot of the pieces that we fabricate here, and then the design work that we do is a lot of problem-solving, which I'm sure

we'll get to later—like the dimensions of the wood, knowing what wood will work, what species will work for any given project, what we actually have, what size of material we have, what kind of shape it's in. So there's a lot of sort of—and Will mentioned that design is important to him, and it is to me as well—it's kind of like the design factor, or even we'll get architects who will come in and say “ok, we want to use reclaimed”, and that's kind of it, and “this is sort of the size,” or maybe a specific size, and then we have to figure out OK, how's it going to work. Is there going to be end grain showing, is it going to miter return, is it going to die into another material, what's it going to interface with? Like all these kinds of things. That's kind of what the Design/Build is.

Anna: Do you work on several projects at the same time?

Jay: Yeah, often. It's kind of a wood farm, so like any farm everybody's wearing multiple hats, and you have to shift gears quickly, and we're, frankly, making it up as we go. We don't really have a model to go off of. We're all just kind of passionate, and we see this potential floating around, but how do we actually make this a viable business?

Will: A great part of it is that because it's tied to the demolition side, we don't necessarily always see what's coming down the line from different demolition sites, so we don't necessarily know what material's coming to us, but it'll come from the guys at Kieswetter demo. Oftentimes a bin is dumped here and it's sort of up to us to determine what it's best suited for—if we're going to mill it into flooring, maybe, or if it would be great tabletop stock, or just beautiful timbers for mantles, or as-is.

Jay: Or as-is, with like material ready to go out for exposed ceiling joists or something like that.

Will: So it's hardly like a conveyor belt factory, where you know the drill every time, there's a huge element of creativity, which is the best part about it.

Jay: Yeah, there's no international standards that's for sure.

(we all laugh in agreement)

Anna: Those are some interesting themes I think I might want to get back to later. Can you tell me a bit more about how closely Kieswetter and Timeless are related?

Jay: There isn't one without the other. So if Timeless Materials as a business had to go out and source material it would change the look. As it is right now, people often mistake reclaimed as being “oh, it must be cheaper” or “it must be free,” when there's so much work: there's staff being paid, like pro-

professionals to dismantle these buildings, pull the material, the material will be loaded with hardware, get the material (which is often massive in size and in weight) on the ground and physically move it from the job site, in a timely fashion, to get it back here. And we haven't even done anything with it yet. There's a pile right over there that's dumped, that's sort of a lighter brown colour, that was just dumped. So it's loaded with hardware, and we have to stack that neatly, cull it, and figure out what we're going to do with it. There's a lot of hands, a lot of labour, that goes into it before you even sell it.

Will: It's kind of like a perpetual motion machine. Because they (Kieswetter Demolition) do their job we're able to do ours, and because we exist, it kind of dictates the way they do their job; it dictates each other. They wouldn't be reclaiming the things they do, necessarily, so carefully in all cases. They're professionals at that, but for other demolition companies that wouldn't necessarily be the case, to take such care in making sure things are still intact when it comes back here. So, they're good at their job, which makes it easier for us. If it was on us, it would take forever.

Jay: Yeah, we'd have to have a whole other team going out and buying the materials, and then transporting it. The demolition company has its own fleet of machines and trucks, and we're able to use them to transport, whereas different demolition companies might just take their excavator and knock down a factory until it's rubble, and then just start putting it in bins and dump trucks to go to the dump, whereas our guys are up there by hand, dismantling wood.

Anna: That leads to the next question: the scouting for reclaimable materials, is that just— let's say Kieswetter gets a demolition project, somebody goes to look at it, to figure out what's reclaimable, is that kind of if?

Jay: Precisely, yes.

Anna: And then do they assign a deconstruction specialist to that project or how does that work?

Jay: Well, they're all, the whole team is a team of deconstruction specialists, and they've been doing it so long, that kind of goes into the strategy of it, the demolition right from the time they get the contract. And then also that scout will be looking for the copper, and the scrap metal, and stuff that has direct value, there's a market rate on those commodities. So they look at that, and at the same time they're also going to be looking at "ok, there's 100 2x14x20 foot Douglas Fir joists," there's value there. They're going to have to figure out how to get these boards off and preserve them, and keep them dry.

Anna: It's interesting to me, in Kieswetter Demolition, is everybody in the company kind of aware of deconstruction processes? Or is there still kind of a more specialized team that works on these projects?

Jay: We're talking about two very small companies as far as staff, so what are we at here? Eight, maybe ten?

Will: Ten at the most.

Jay: And Demolition is about the same. And in the office, the scout or the "white collar jobs" we'll call it, there's three or four individuals, of which one is the president, who's sort of overseeing everything, and the rest of the team is actual professional labourers that are up there cutting out joists and professional machine operators using excavators and driving trucks, etc.

Will: So it's like our company, everyone wears many hats and we're all pretty familiar with everyone else's job. Even if it may not be our job, we know how they go about it. You can't help it when it's such a small environment, and knowing someone else's job makes you better at yours.

Jay: So to answer your question, everybody kind of is a specialist.

Anna: Maybe this is getting more into the demolition side of things now, but how many demolition companies are in the area? It sounds like Kieswetter doesn't just take any job that comes up.

Jay: That's a good question. There is quite a few demolition companies in the area, so it is very competitive, and then once you look at Ontario, it's highly competitive. You're right, they don't just take any job. They generally try and work within the area, the tricity. The odd time, we have a satellite location in South Hampton, of Timeless Materials, so they will go out towards that way. So they've done jobs in Mitchell, and Goderich, around London. But typically, once you start traveling, then it's added expense: it's fuel, it's more hours that you're paying out to the staff, you start to get into law of diminishing returns. Generally, it's looking for jobs in the area, and the ones that are going to be our specialty, which are the older buildings.

Anna: You mentioned some of the process for getting the material from demolition. And could you go from demolition to point of sale?

Jay: Sure. So, demolition would be: we get the demolition contract, and then from there it would be their (Kieswetter Demolition's) specialty, "how are we going to do this," whether it's roof first, then if it's rafters that we're saving. It would just sort of be the reverse of how you would build a building. Roof, rafters, wall ties, walls, that kind of thing. Once the wood and anything else

(there could be interesting architectural features on the building, like spires from barns) is salvaged, we try on site, if time permits, to add partial value to the wood. So we'll try and surface denail anything right on site, and cut to manageable lengths. So there'll four or five of the guys actually physically pulling nails with hammers, culling the material: cutting out the bad, and getting it to manageable lengths like I said. So if they happen to be 20 foot boards and they're really pristine, then we'll try to keep them that way, just because 20 foot boards are rare. But if not, then we'll cut them down to 12s or a mix of 12s and 8s, nominal lengths. From there we'll load them on a truck and bring them back here, and once it's here we're sort of depending on if the denailing happened at the job site, or sometimes it has to happen here, and then they get dumped in a mess, and we have to do that sorting here. From there, we sticker it, which allows the air to circulate around the boards. Stickers are the little runners that you put in between boards, big boards, about every 16" or so, and we'll usually do four feet wide, by approximately 12, flushed at one end, and maybe not more than four feet high just so that we can manage a lift with our skid steer. Then we'll band it or just carefully stack it, and depending on what we're going to do with it, sometimes we'll already know that it's perfect material to be molded into flooring, in which case then we'll metal detect it, and then we'll send it out to be turned into flooring. Sometimes we'll actually split a 2" board and be able to get two original faces, and then we'll be able to keep that as the flooring face. Then we'll have it milled, we'll bring it back here, and we will mark the square footages (if it's flooring for example), and get it right inside in our basement and then customers will come in looking for reclaimed floor and it goes out the door once again. The flooring example and the board stack example would be similar, just it might stay outside covered and sort of waiting, and we'll bring it in slowly as we can manage inside the barn.

Anna: I noticed you also make samples for what some of the finished products might look like, like flooring samples, furniture samples.

Will: It's important to do what we can. There's tons of possibilities for what our material can be, but if we can lay it out a little bit, in terms of what things can look like, we do that with things like furniture samples, and flooring samples. It just kind of helps. We're used to seeing this stuff get processed every day, so we have a bit of a vision for what's possible, but as much as we can help people along to see what's going to fit into their vision it's helpful to us. It's a battle though, it's something we're constantly trying to stay on top of because there's endless possibilities for what this material can be. Any samples go a long way for a lot of people.

Jay: When you look around the yard, everything's grey, but as soon as you sand it then you start to see the nuances of the species, the age, if there happened to be paint, or if it's under some kind of stress—maybe it was exposed

in the elements for a 100 years, and once you sand it's not going to look the same as a piece of pine that's 60 years old, that was inside. Every piece is unique.

Anna: Do you also try to sort out by species to figure out how much of each you have?

Jay: Yeah, that's kind of another ongoing battle we have, just managing the material because we'll get just a pile that's dumped, and we have to go through it, and that's actually a mixed species. In barns, they would fell trees that were on the property and use them, so they would be mixed species. When it's a factory, it's a little different because they would have just bought all the joists or whatever the same. It's quite a bit more manageable. And typically it makes our job easier when the materials are sorted because when we get a customer come in, and they're looking for a particular size and length of board then we can say we have 50 planks at this dimension, that are the look that the customer is going for.

Anna: What are some of the challenges in running this business with reclaimed materials?

Will: I think a challenge is the irregularity of the material. Keeping things organized is very difficult because, like Jay said, there's lots of different species to organize and separate, but also in each species there's a crazy array of dimension as well. And because the piles are so large, it can sometimes be a daunting task to keep everything the way that we want to with a steady stream of material coming in, so we have to be as organized as we possibly can on this end in order to keep things simple and efficient for us. That's a huge challenge.

Anna: Do you guys do much cataloguing to keep that organized, or is it not worth the time?

Jay: It's a common-sensical question, and it should be but it's not. It's, again, although the company's been around for a while, Timeless Materials, I feel like we're kind of in a youth as far as going next level with it, and that's on the list, getting a catalogued inventory. But it changes so much, and that kind of leads to another challenge, which is staff. We have a great staff right now, but good people are hard to find in any business, and particularly in this business because not everybody understands wood, not everybody understands design, not everybody understands sales, just as those individual aspects, but anybody who works here has to have the full package, really, to fit in. So that's a challenge, and just the physical size of the material, and the handling of it, is another big challenge.

Will: Our size is a challenge too. Because we are such a small company, we have no shortage of creativity in terms of what we'd love to turn all this stuff into, but time is a constraint, and there's orders coming in all the time, new material to process, a lot of times it doesn't allow us the luxury of time to really maybe get creative even with inventory stuff that we want to start to do, because we're trying to catch up on what else is going on.

Jay: With customers coming in in the meantime, you know?

Will: Yes, and that's awesome, we love that we're busy! We are very busy. But it is sometimes a challenge that can get a little frustrating. Like "I've been meaning to turn this into this for so long" and we'll get around to it, we will. It's good because it means we're all creative, it means we're busy, those are all good things, but definitely a challenge when you see the great material around you and you think there's so much potential here, but I don't have time today. And I don't have time tomorrow, you know? It's tricky.

Anna: I wanted to talk about the market that you guys are maybe catering to, or that you're in. Do you think that there's one kind of main market that you could categorize that Timeless tries to appeal to, or does appeal to?

Jay: I guess there's a market there, but it's more like a psychographic. If you could really boil it down to the simplest things, people (the customer, the end user) are looking for something unique, off the beaten track, like I mentioned the story of the wood. That's the nucleus right there. Sometimes we've been accused that we're only accessible by the wealthy or something like that, and that's entirely not true. It's that person that's looking for something unique, and sometimes yes, they happen to be wealthy, but it's more the unique—it's that design person that is our true customer.

Will: I think of it as being kind of two-pronged, and I guess a lot of times there's overlap, but it's sort of like people who are really design-conscious, they love what's going on around here, or at least that would be a reason to come here and source material from us, but also people who are environmentally conscious, this is always a good option for that as well. A lot of times that's sort of overlapped, but a lot of times, like for builders, it'll call for reclaimed material, or reclaimed, locally-sourced material, and they can guarantee that's from us every single time. So whether it's the look or whether it's because they don't see the need in milling new trees or anything like that, I think we cater to both of those people, which ends up being an awesome clientele to come through. Because people who are passionate about it, they love the way it looks, and we're passionate about it too, so when we get into a conversation it's always quite lovely.

Anna: Do you find that there's more interest from kind of, I would say the professional sector, for example like interior designers and architects, or more the do-it-yourself kind of people?

Jay: It's both. It really is. The nucleus truly is that "we want something off the beaten track." And sometimes it's designer driven, sometimes it's DIY driven. I don't think you could say "it's 60% this or that," it could really be anybody any time. When it is a designer or an architect or a contractor, anybody like that coming in, it's always the end user that's steering their hired professional. So it's rare that we'll have contractors come in and say "I had a great idea." Because you know, wood is expensive, and I think people forget that. We're all caught up in the Home Depot sort of MDF, engineered flooring and stuff, and I'm not knocking any of that but builders can make a lot more money using that stuff. They would have to charge a lot more to use ours, as they would if they were using brand new purchased wood. If they're having brand new wood milled to spec, that's not any more expensive than that—wood's expensive. We often get the question, "why don't you reach out to designers, and architects?" And we do, but they're not really making the decision, it's the customer that we need to be reaching out to, to say "hey, I'm building a modern home, or renovating my kitchen, and I want to use reclaimed," then go the contractor and ask "how can we make this happen?"

Anna: Is it possible to generalize what application your products are usually used in? What are people looking to make?

Jay: I think that it is possible, and I think you could sum it up by saying it's veneer. So flooring, wall cladding, false beams, you name it. It's rare that it gets used for structure. The only time we'll see it used for structure is if it's exposed structure. When you're talking exposed structure, you're generally talking to a higher end. Somebody's thinking on paper from the beginning, there's a professional there, an architect or designer, or maybe it's customer-driven, to say "we want to do this." That we don't see very often. Not as often as we like, anyway. For the most part it's veneer of sorts.

Anna: On the structural applications, do you guys get involved at all with the regrading of it?

Jay: We don't, no. Experiences we have with doing that kind of thing, is there will be a structural engineer will come in, there'll be a lot of back and forth like "what do you have? we need to put a beam in, it's going to be exposed, it's structural." And then it's like "what sizes of material do you have?" And then they go back to the drawing board and try and make whatever we have fit. Usually they'll come to us at first and say "ok, we just need a beam this big" and it's like "well, we don't happen to have that. We have this, we have a glulam, we have a solid 16 by 16, whatever the material is." And then

it's back to the drawing board, in some cases it'll be almost reverse engineered to use the material. Which again, that's a backwards way of doing it when you can just, if you're an engineer, you know what's on the market as far as building materials, and you can just spec brand new stuff, and boom, it's done. So there's a time factor, and time is money, this kind of thing.

Anna: Sounds like it does end up adding to the cost of it, because it's more involved.

Jay: It is more involved, on every step. And it's back to that end user. It takes somebody really interested in the story, the look, the recycling factor. Those elements are the important thing, and then price disappears a little bit, right?

Anna: Right. Ok. I'm not sure if you could also speak to trends in time. So do you find that reclaimed materials have gained popularity, decreased, or stayed the same? Over how much time? And if there has been a change, to what can we owe it?

Will: I think they've certainly gained popularity, over the last 5-10 years.

Jay: Especially though, the last five I would say.

Will: Certainly. You see it everywhere. You could walk through the mall and see it. In terms of shelving, cladding on stores, stuff like that, it's now sort of in the middle of the zeitgeist in terms of design, where it wasn't before. But again, it goes back to that two-pronged thing because sustainability and eco-friendly is also gaining popularity. So for us it has become a perfect storm.

Jay: I think the perfect litmus test is to go to any flooring company and there's a faux reclaimed product. At the Interior Design Show Northern Board was brushing hemlock, new hemlock boards, to raise the grain. And then using unique staining processes to make new boards look old. We also do a lot of work with the Mennonite community. There's a particular area just near Listowel, and they've lined their fields with hemlock 2x12s. New hemlock. And built a machine that raises the grain, a brushing machine, and not only raises the grain but then adds what they call a "scratch mark" which replicates the look of an old sawmill on the boards. Their forecast is two years out and these boards will be ready. And at the back it's white wood, but on the face it'll be beautifully aged.

Will: But the fact that it takes so long also speaks to the fact that it's really difficult to replicate time, that weathered look. That's the thing we have in droves and we see it every day so we'd be able to spot a fake, as you call it,

but I think a lot of end users are discernible that way as well. But it's true, that does really speak to the time we're in in terms of design, where that starts becoming more a churned-out product rather than something that you can only find in certain places.

Anna: Do you think that the market for reclaimed materials could be larger?

Jay: Yes, I do. I think that reclaimed has a natural fit to create a rustic look, but really wood can be used in modern applications, like it always has been. I think it's our responsibility to educate our customers that it doesn't have to, you don't have to have a rustic look, it can be a modern look with reclaimed materials. A clean, linear look. I think that's an untapped market segment. But I think maybe the wood market in general is kind of shrinking you know? But I think there's potential for the reclaimed wood market to grow.

Anna: Why do you say that it's shrinking?

Jay: This is just my take, I think it's a cost thing, the competition with MDF. Look at the houses around subdivisions that are going up. It's the old saying, "they don't build them like they used to." There's lots of amazing advances in efficiencies and that kind of thing, but you go into a neighbourhood that's 15 years old, and all of a sudden that's starting to look pretty shabby. But if you compare them to Craftsman places that are 80 years old, or what have you, or older, there's a difference.

Anna: Ok. Do you think that there are challenges specific to Ontario for using reclaimed materials? For example policy, but maybe there are other factors?

Will: I don't know of any policy. I think a challenge that might be with us in terms of being a retailer, would just be the abundance of older structures. If you go out west, they don't have 100 year old grey barn board, barn structures, really. So if you're a retailer out there there's less competition, but it also becomes a more expensive product. So there is sort of an abundance of that sort of thing around here, but I don't know maybe that caters to people's tastes out here as well.

Jay: Yeah, I don't think there's policy per se, I think there's that challenge of the engineering side for selling the wood. And then, another challenge would maybe be, if you're in a southern climate, you could maybe use the material for sort of an indoor/outdoor application where here you can't just put this stuff outside. It'll deteriorate even more, especially if we've gone and sanded it, or put a finish on it, or built something like a table. I guess that would be a challenge.

Will: But there is an advantage being in Ontario, southern Ontario specifically, versus anywhere else in the country really, which is that there's so many markets compact in a small amount of area. So it goes back to our efficiency of travel or even where we get the material, and then where it goes. We live in a really condensed place, which is really efficient for us. I think there's a larger market here which is great.

Anna: I want to kind of go back a bit to ask, on any given project, how much material ends up being reclaimed versus going to a landfill?

Jay: That's a good question. On the demolition job you mean? (Anna: Yes.) Yeah, anything that can be reclaimed, is reclaimed. So it truly would depend on what the structure is. For example we just did a barn outside of Guelph, Ontario, last month, and I would hazard that 100% of it was reclaimed. We have the old tin roof bundled up, all of the wood was dismantled, and then the actual timber frame itself was then dismantled and sold. It was going to be erected somewhere else. That's like a shining example. You get a job that's maybe a 1980s building or something like that, we'll end up pulling out the spruce. But 80s spruce doesn't have the cachet of 100 year old pine, or 100 year plus hemlock. But nonetheless, if we can reclaim the spruce, we do. And then go from there. But unfortunately those buildings do end up having a lot of waste, a lot of landfill.

Anna: And is that more because of the engineered products that you don't want / can't resell?

Jay: Precisely. Like pulling off a piece of drywall, it's going to be garbage.

Anna: Now, this is kind of a hypothetical, but not so hypothetical, question because about a year ago I came here with the idea that maybe I would build a deck out of reclaimed wood. So if I came to you and said "I want to build this deck, completely of reclaimed materials," what would you say? I was talking about even structural components that you can't see, because I was interested more in the sustainable side of things.

Jay: Sure. That's a good question.

Will: It's funny you say deck, too, because a lot of people build their decks out of pressure treated lumber, new pressure treated lumber, and there is a decent reason for that. I mean, Jay mentioned that earlier, it's kind of with the climate that we're in, it's sometimes restrictive. You can do a deck out of older material that isn't pressure treated, but it's sort of a tradeoff.

Jay: Yeah, for wood that's going to be in the elements, specifically deck, your options are really just pressure treated or cedar. We don't come across

cedar very often because it's not a structural building material. And then cedar decks, I would hazard to say, are sort of more of a newer phenomenon within the last 40 years. But then cedar's lifespan isn't that long. So we don't come across it very often. Certainly when we do, we reclaim it, and it sells right away. You could build a deck out of reclaimed pressure treated, which we do get, but again pressure treated is newer within the last century, we're talking, so we don't come across it quite as often.

Will: We get it, but it's not our bread and butter. It's certainly not why people would come here.

Jay: No, it kind of gets back to the sort of veneer thing. The wood is better suited inside. If you wanted to build a wall or flooring, or something like that, we would sort of advise you that way. I mean, here's this picnic table we're sitting at. You maybe wouldn't want to have a deck with these as the floorboards. And they also wouldn't last as long. So if we found you a bunch of pine planks, it just simply isn't going to last as long as a cedar deck or a pressure treated, and particularly new pressure treated or cedar deck wood. Frankly, in that case we would probably suggest that you use new boards.

Anna: Yep, ok! We covered some of this, but do you ever come across people that have an attitude barrier to using old materials?

Jay: Certainly. I sort of touched on it a little bit. Sometimes people have sticker shock almost, they come here, they've driven by, and they're like "oh, that's probably like cheap wood." And they come in and then we start educating them on the value, the value is in the story, and the uniqueness, and the age and the recycling. A lot of effort has gone into reclaiming this stuff. So a lot of the time people simply balk at the price because they had a preconceived notion that it was next to free.

Will: Which is fair enough, in every other case something used is less. But that's on us to do the education that way. I think it's rare that we explain the whole process and someone still doesn't get it.

Jay: Most of the time they've come here because they know about reclaimed. This is a destination location. It's kind of more that the uneducated person comes in. And also I think there would be the opposition as far as from an engineering side, an architectural side as we touched on a little earlier too. You can map out a new building spec-ed with all new materials much easier, it's much more efficient, and then if you want reclaimed, great, we're going to build the structure with new materials and then we're going to do our veneers on the inside with reclaimed. Maybe it's the cabinet fronts, or the furniture, that kind of thing.

Anna: What sort of factors affect your pricing of a material here?

Jay: The age would. The uniqueness of it.

Will: Even species alone sort of dictates our pricing. Rarity of certain sizes. [How much time we have to spend on it, too.] Barnboards are a really good example, because a lot of the times we'll get really really naily barnboard, which has a very unique, very cool look. It turns kind of black around the nail holes, it's all been oxidized. But oftentimes we'll spend the time and remove all those nails so it can be milled, it can be worked with, and there's a lot of time that goes into that. So we have to make sure that we're covering our bases too, so sometimes, depending on how much labour goes into one particular product, it could dictate the price as well.

Jay: It's sort of a balancing act of the value added. And what I mean by that is, you have the raw board that we just pulled off the building, the adding value is: it's surface denailed, is an example, or now it's surface denailed and metal-detected and we've removed the metal that's buried in it. Now it's surface hardware, metal-detected, and sanded. Each step is value added, so we kind of have to go through this process of partially processing the material without going too far and putting too much money into it, where now it's sort of too expensive or "I want to use it for x, and you've taken it too far," so now it's not wanted. Maybe "I wanted only surface hardware removed" because it's going to be ceiling joists. And maybe the end user is like "I only need the bottom edge and one face sanded," for whatever reason.

Anna: Does the price sometimes fluctuate based on availability?

Jay: Yes, if it's something rare and particularly nice, we're a business and we'll charge more for it.

Anna: I mean also, if you find you have a lot of something coming in, does it decrease the price?

Jay: Oh sure, if we have an abundance of a particular product, then price is definitely a factor. An example of that is roof decking. So if we're doing a building where they use actual T & G [tongue and groove] substrate over the rafters, if it's a particularly big building, we'll get thousands and thousands of square feet of that, so like you're saying, we'll get a bunch of that in, and all of a sudden it's a viable product to use again now as flooring, and we can adjust the price to be really attractive for an interesting product. That's the ideal. If we can do that, offer a low price point, then we're happy because it gets it out the door and makes a lot of customers happy. Because they hear you can come in and buy reclaimed material for the price of, not to pick on

Home Depot, but Home Depot's inexpensive flooring. And have the story, have the uniqueness, have the recycle factor.

Anna: Another kind of hypothetical question, I guess, but if someone came to you looking for a lot of reclaimed material for an entire facade of a building, maybe even for everything in the building including the structure, would you be able to coordinate that? Or is Kieswetter / Timeless too small?

Jay: We would be able to, depending on the size of the building. There's talk of doing a spec timber frame house, that's one of the projects, like we mentioned, that's kind of "on the list." Yes, Timeless materials could do that. If it was a big factory or something, 50 000 sq ft or something, we would think twice, but certainly the facade of a structure.

Anna: What's the biggest project you guys have been involved in?

Jay: There's been some massive Kieswetter Demolition projects like Babcock and Wilcox in Cambridge, Kaufman Footwear. Million square foot factories.

Will: For Timeless a lot of the times the biggest projects aren't actually all in one spot. It'll be a big contract. We've supplied reclaimed material to Roots Canada, let's say, and Starbucks.

Jay: Whole Foods has been a good customer of ours, where over the years we'll get the call once or twice a year "we'll need 5000 sq ft of wall cladding" or something like that. It's kind of an ongoing relationship.

Anna: Does putting together a large order or for a specific application where you kind of know the end use, help to bring the price down?

Jay: The more somebody buys, the more flexible we can be on the price, certainly.

Anna: I guess what I'm kind of trying to get to is, do you think there's such a thing as economy of scale in reclaimed materials?

Jay: Hmm... I don't know ... What do you think Will?

Will: It's tough because it's not like our labour has shrunk. If we take care with every piece as we do. But I know we are happy to move a big lift of material and we'd break the price on that, but we do have sort of hard margins in terms of our overhead and what we could feasibly do.

Anna: Right, so it's limited by the amount of work that actually goes into it.

Jay: I would say.

Anna: Right, absolutely. But it also helps if you're not selling individual pieces, but you're selling larger quantities.

Will: Certainly.

Jay: We want to sell quantities. We have this duality in the business where we have the business-to-business side, and then our customer side where it's the DIY or somebody's coming in and they want a table built. So for us to build a table, though it's a service we offer and we like to do it, it doesn't really keep the lights on. But moving 80 boards at a time, that's where we truly make money.

Will: Yeah, when I say there's a hard margin, there is in our reclamation side, but just as Jay said, in sales... if I can sell a whole lift of timbers instead of spending the time custom milling—by the time I get that thing done, what I've done in coffee tables and mantels, that's a lot of labour on our end so there is certainly the allure of moving a lot of material at once, on the Timeless end of things.

Anna: I think that's really it, that's all my questions. Thanks for being available. Is there anything you guys would want to add?

Jay & Will: I don't think so, I think that's covered a lot of ground.

Anna: Ok. Thank you!