

**The Value of Values:**

An Analysis of the Tools and Technologies of Sustainable Practice

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**Abstract**

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Competing and often contradictory values that shape the built environment hinder progress towards practices that are better for people and the planet. These values, both personal and professional, are key factors in project decision-making and inherently reinforce top-down practices within relationships, making true interdisciplinary collaboration difficult or impossible. The fear of risk and uncertainty prevents innovation and risk-taking, leading to a continuation of buildings which are detrimental to the health of both humans and the environment. An alternative system based on interdisciplinary teamwork, in addition to an understanding of value-based decision making, establishes the base practices which prioritise working in collaborative teams to create valuable, healthy, and sustainable spaces. As the built environment demands a better integrated method of design, construction, and management, challenges and opportunities in technologies and strategies will arise. In order to create a valuable and impactful future that incorporates the challenges of the climate crisis, what we value in our built environment will need to change.

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## Chapter 01: Introduction

### *1.1 Position*

Competing and often contradictory values that shape the built environment hinder progress towards practices that are better for people and the planet. These values, both personal and professional, are key factors in project decision-making, resulting in buildings with a dictatorial focus on economic gain and risk avoidance. This mentality inherently reinforces top-down practices and relationships, making true interdisciplinary collaboration difficult if not impossible. Narrow communication pathways, closed-loop discussions, and forced and/or unbalanced relationships all have a significant and serious negative impact on our designs and our relationships, yet this is the traditional method that owners, contractors, and architects, and other professionals willingly employ. The illusion of safety and certainty prevents innovation and risk-taking, leading to a continuation of buildings which are detrimental to the health of both humans and the environment.

An alternative system based on interdisciplinary teamwork, in addition to an understanding of value-based decision making, establishes the base practices which prioritise working in collaborative teams to create valuable, healthy, and sustainable spaces. This project integrates attitudinal data from professionals in Seattle to document and analyse what personal and professional values currently influence the projects in Seattle. The building industry needs a shift in values that radically challenges the old, because sustainable systems are bigger than the value of cost. As the built environment demands a better integrated method of design, construction, and management, challenges and opportunities in technologies and strategies will arise. In order to create a valuable and impactful future that incorporates the challenges of the climate crisis, what we value in our built environment will need to change.

## 1.2 Objectives

- a. This thesis seeks to understand the relationship between interdisciplinary collaboration and current sustainability practices. It focuses on personal and professional values and how these beliefs impact the decision-making in practice. It argues that the illusion of safety and certainty prevents innovation and risk-taking, leading to a continuation of anti-environment and inhumane buildings. Based on interviews of various professionals in Seattle, it suggests an alternative system based on interdisciplinary teamwork and an understanding of value-based decision making, as well as focuses on collaborative practices which prioritize working together to create valuable, healthy, and sustainable spaces.
- b. This study seeks to understand the impact technology and sustainable practices have in the professional realm within Seattle.
- c. This study aspires to gather and assemble different ways of thinking and design processes to create a collective database of knowledge and tools.
- d. This study aims to propose a workflow or design process which may address some of the challenges and opportunities suggested by the research.
- e. This study intends to understand how values factor into design decisions, particularly ones that weigh more into the ecological or social value (versus economic).
- f. This study chooses to focus on and analyse the ways in which interdisciplinary collaboration can potentially implement new or modified methods for design, construction, and operation, based on a reevaluated values system.

### *1.3 Purpose*

The purpose of this study is to understand why the current values in the building industry disproportionately prioritise a conservative approach to design and construction, and propose an alternative conceptual framework that implements sustainable and integrative design and decision-making processes.

### *1.4 Assumptions*

While this study seeks to understand and implement performance-based design, technology, and sustainability in practice, it does not intend to do so on a massive scale. Instead, it aims to use selected individuals in the professional world to gain an overall understanding of the challenges and opportunities being addressed here in Seattle. Information gained at a larger scale may be incorporated if it is relevant to the question and helps to form an overall understanding of the issue, since these are not isolated or only relevant locally. Additionally, any proposed workflow(s) or methodology(ies) will be based on the data found and collected and therefore may only be implementable in this area at this specific time. This study will attempt to understand the discussion of sustainability and personal/design values at a global and historical level in order to inform the research and context, but it will not attempt to answer all potential questions or “solve” the problem(s) themselves. As this is intended to be an architectural thesis, and not a sociological, psychological, or economical one, related aspects will be discussed to the degree necessary to understand the complexity of the problem, but this study will not attempt to delve into the detailed specific of those fields.

## Chapter 02: Review of Literature and Studies

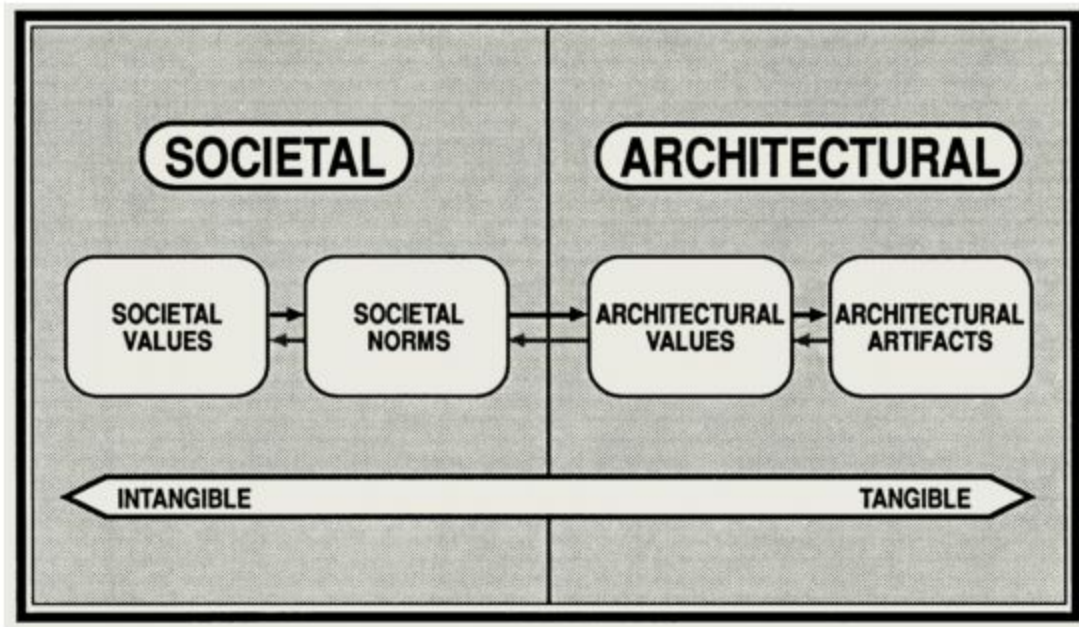
### 2.1 Value and Design

“What the world desperately needs now is to have more value added to it, which is exactly what business should be about... If adding value is what business should be about, then I suggest you can’t add values unless you have them. Our personal values, seemingly so distant and removed from the juggernauts of commerce, are important and integral to the healthy functioning of our economy.”

- Paul Hawken, *The Ecology of Commerce* (1992)

In a standard architectural education, there are many discussions around what the “value” of design is to itself and to the rest of the world. Architecture has typically been presented as an ideal unto itself, outside of art and science and able to withstand the test of time. Less talked about, I argue, are the interdisciplinary relationships that architecture and design are built upon. From Laugier’s “Primitive Hut” to The Cenotaph, isolated elements of these links have been sketched, analysed, designed, and in some cases, prototyped, but most (if not all) studies up to a certain time remained within the realm of Architecture, leaving other disciplinary studies to themselves. Even though architectural studies have demonstrated the impact different cultures have on developed styles of architecture, the understanding of the depth of the relationships have not progressed much further than simply recognising stylistic differences. In the piece *Societal Values and Architecture: A Socio-Physical Model of the Interrelationships*, Mazumdar and Mazumdar (1994) refer to cultural values and proxemics; proxemics are defined as the differences in the ways people (of different cultures) relate to the space around them. Cultural values are defined by the categories presented later in the article, and are claimed to mediate the effects of climate, availability of materials, and technology. Mazumdar and Mazumdar (1994) theorise that there are four categories of values in architecture - the first, “value-referential,” in which architectural features and artifacts are considered “referents” of the occupant group values and is characterised by the idea that design

should draw on either historical trends or analysis of forms, not constrained by social concerns. This is seen typically with local vernacular architecture as this tends to have some intrinsic personal value to people of the region. The "value-normative" stance claims that architecture ideally focuses on human and occupant needs; architecture and design are simple tools which help humans function better. Most of the work focused on programming and post-occupancy evaluation falls into this category. (Mazumdar and Mazumdar, 1994) The "value-critical" idea attempts to make architects and professionals aware, self-conscious, and self-critical of the values they create and apply to their design. This can reach into all three major realms; natural/ecological, economical (client and user), and experiential (professional values and ethics, the architect's role, and education). (Mazumdar and Mazumdar, 1994) The "value-descriptive" approach manifests architecture as a physical representation of how a society sees itself and the world; it demonstrates the ways buildings are related to spirituality, world view, religion, rituals, social structure, labour divisions, and mental constructs/beliefs. (Mazumdar and Mazumdar, 1994) Buildings are not only physical structures, they structure human existence. Architecture is only one of the many manifestations of these architecture interrelationships and abstract concepts, and the extent of the connections between cultural or social values and architecture are still unknown. (Mazumdar and Mazumdar, 1994) The authors cite Altman Rapoport's statement that "culture is a theoretical construct and ideational and that it is virtually impossible to link culture to built form." They also cite his propositions to dismantle culture - look at "social variables," institutions, structures, status, roles; or analysing the jump from culture (through an understanding of world views and values) to lifestyles and activities. (Mazumdar and Mazumdar, 1994)



*Figure 01: A model of the relationship between societal values and architectural ones.*

When it comes to categorising and analysing the interrelationships of architecture and society, one has to understand that they are not isolated ideas with a brief area of overlap. Instead, they fall onto a spectrum, ranging from intangible, conceptual societal values (such as deep convictions, shared cultural beliefs, and a general idea of what a person's role in that society is, etc.) to architectural artifacts, the most tangible and objective elements of the interrelationship. Societal values provide general guidance and ideas about life and the role of individual members, whereas societal norms are more specific notions and rules about what is preferable, tolerable, and acceptable in terms of ideas, thoughts, expectations, interactions, behavior, etc. (Mazumdar and Mazumdar, 1994) Societal norms provide directives about ways to live, goals, activities to engage in, and behavior towards other members and the environment; they are the code of conduct of a society and include both formal and informal rules and norms. Because societal norms are so ingrained in ourselves and our societies, the potential to affect architectural values is enormous. Though architectural values specifically are more definitive

preferences that enable and support the more intangible and abstract societal values through ideas about physical forms, it is crucial to understand the impact our beliefs and traditions have on our constructed spaces. These values affect the choice of architectural elements or spatial implications, as well as limit the range of choices of architectural options. Architectural artifacts, at the tangible end of the spectrum, are the elements and components of the building (including forms, shapes, sizes, materials of construction, structural system, and objects inside the building, including their design and layout). Selection, design, and use of similar architectural elements, designs, forms, materials and artifacts are seen as indicative of the presence of values or preferences which affected or guided choice of these. (Mazumdar and Mazumdar, 1994) Mazumdar and Mazumdar summarise that as there are differences in the values, mores, traditions, beliefs, forms, selection, and use, the inherent meaning of architectural artifacts will differ from one society to another and need to be understood in order to comprehend the significance to a particular society. (Mazumdar and Mazumdar, 1994) This is important to keep in mind as a person's behaviour, such as how they use a space, is directly influenced by the culture within which they most readily belong. Values in this sense are defined in relatively familiar terms, even if one is not a sociologist. They are qualitative elements, defined for us in ways we cannot understand before birth and lasting long after we pass, as well as integrated into the very built fabric around us. Because both cultural (and therefore, personal) values and architectural design lie on the same spectrum, they are inherently linked and cannot be separated.

"The architectural artifacts of a society are seen as being influenced and affected by complex social factors and processes in which societal values, societal norms, and architectural values play important roles. Four levels of interrelated values, preferences and choices affect society's beliefs regarding the suitability and selection of architectural artifacts." - Mazumdar and Mazumdar, p.69

In a high-tech, modern approach, those involved with the Perkins and Will Research Labs suggest an alternative way of combining values with technological processes and toolkits. In their article featured in the Journal of Information Technology in Construction, they define value as "a synthesis of alternative impacts and stakeholder preferences into an objective function that orders the alternatives." (Haymaker et. al., 2018) Haymaker et al. continue on to present the concepts and processes used in defining the values as they change from project to project and stakeholder to stakeholder. Depending on the certainty of information and preferences of stakeholders, different alternatives can score different values. The term "value" in this particular framework is broadly defined to be able to account for both multi-attribute utility and economic objective functions. The process of value formation and translation is an iterative process of narrowing and expanding the search as key elements and preferences change.

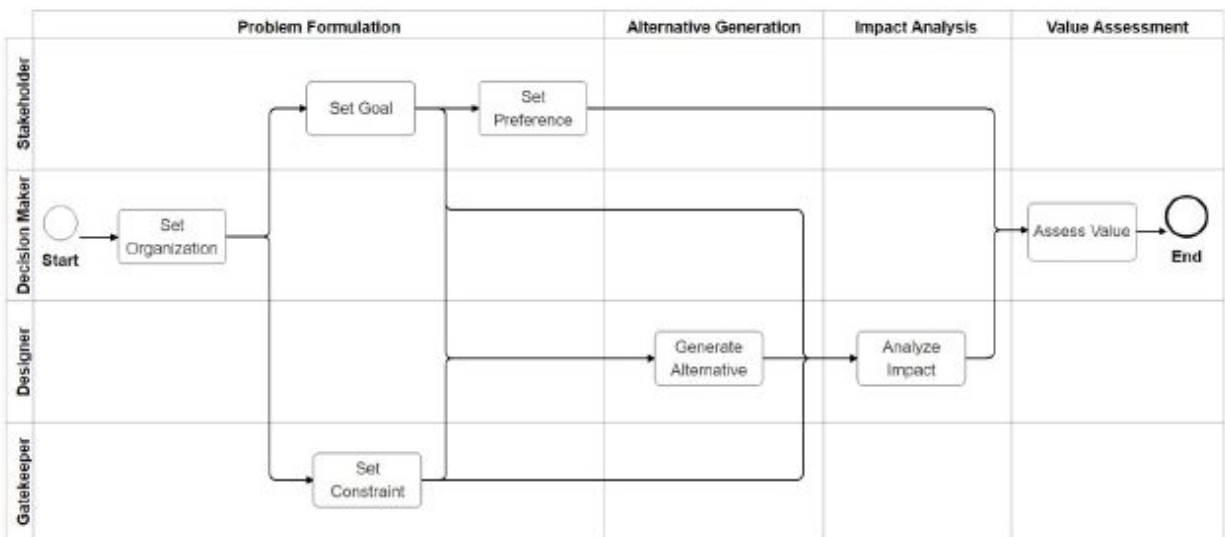


Figure 02: The iterative "Design Space Construction Framework," which demonstrates the interaction and activities of various project stakeholders. (Haymaker et. al., 2018)

The alternate design solutions also have to be sorted and prioritised, which can change depending on the value for each individual. (Haymaker et. al., 2018) Values in this framework are a set of changeable and measurable parameters, able to be normalised and processed

through a series of nodes and spreadsheet formulas. In this sense, the “values” one brings to the table can be weighed, quantified, and explicitly integrated into multiple designs. Personal and professional values are individualistic; they are associated with that project and that stakeholder, and the opportunities for user or project team involvement become almost limitless.

In Paul Hawken’s impactful piece, *The Ecology of Commerce*, he states that "if adding value is what business is, or should be, all about, then it follows that you can't contribute values unless you have them. Our personal values, which have become so distant and removed from [the corporations], must become increasingly important and, finally, integral to the healthy functioning of our economy." (Hawken, 1992, 2010) The built environment cannot realise its full positive impact potential when we (the designers, the builders, the financiers, the owners, the planners) do not hold these values ourselves. Is it a societal problem; we cannot change because our society or culture is set? Or an individual problem, where we protect our own interests first and everything else comes second, or not at all? In the Perkins and Will piece, the author states that "design is a decision-making process... Performance-based design specifically seeks to maximize the value of those decisions." (Haymaker et. al., 2018) With what value system are we making those decisions? Where does our inspiration and idealisation come from? Within the Architecture, Engineering, and Construction (AEC) industry, architects, planners, engineers, landscape architects and other designers have developed a rich set of frameworks, metaphors, and terms of art to understand the interaction of the built environment and living systems." (Cowan, et. al., 2014) Different strategies, such as heavy focus on and implementation of ecosystem services into projects or a computational performance-based design process, demonstrate the innovation available to those who seek to solve or mitigate the mostly negative impact our built environment has on the world today. Ideally, multidisciplinary teams come together to research, weigh, and document value rationale efficiently, looking at a

plethora of alternatives for the best and widest range of experiential, ecological, and economic factors. (Haymaker et. al., 2018) If that is the case, then working with values informed by a multi-faceted look at a particular design problem seems to yield the best results for all involved, from the planner to the commissioner to the occupant. Interdisciplinary work allows for cross-examination of potential benefits and challenges, particular as systems and technologies grow more complex in trying to tackle more of the issues in the built environment.

Ecosystem services classification systems and frameworks demonstrate our growing understanding of the complex links between natural systems, societies, and economics. (Cowan, et. al., 2014) The term "ecosystem services" was coined by Paul and Anne Ehrlich in 1981 to specifically emphasize the role of ecosystems in providing fundamental life support systems (food, water, air, etc.) to the human species." (Cowan, et. al., 2014) There are four classes - supporting (primary production, soil formation), provisioning, (food, fresh water, fuel), regulating (flood and disease regulation, water purification), and cultural (aesthetic, spiritual, education, recreational). (Cowan, et. al., 2014) Attempts to implement these strategies, ones that seem fairly straightforward and overall beneficial, demonstrates one of the key issues the AEC industry (as well as others) face today: the economic bottom line. Hawken states that "while there is a debate on whether we have a human problem (people who are unwilling to change their thinking or their lifestyle) or a business problem (opportunistic companies willing to benefit from expediency, greed, and short-sightedness),... [what we actually have is] a systemic problem that involves both people and commerce." (137-138) (Hawken) Though a continually adapting, dynamic approach to optimising ecosystem services supports flexible, integrated models focused on both buildings and infrastructure, much of these strategies are fairly new and fairly unused in the current built environment. Though the models are designed to provide reasonable estimates of ecosystem services flows in order to affect decisions based on specific

benefits and values, and they are grounded in regional design and planning frameworks, there is still a good deal of resistance. (Cowan, et. al., 2014) The concept of ecosystem services provides a critical component that is otherwise missing from these other disciplines, because it helps designers to understand the consequences of landscape changes for ecological, social, and economic conditions. Not only does this aid in shaping more resilient, healthy, and sustainable cities, in reframing the interrelationship of ecological, social, and economic systems *within* a human value context, it demonstrates the need and want for the manifestation and implementation of these outcomes. (Cowan, et. al., 2014) Still, most people are not willing to sacrifice for the ethics and values they claim to have. (Hawken, 1992, 2010) However, if there ever is to be an ecologically sound society, it must come from the “bottom up,” (people) not “top down” (governance and regulation). (Hawken, 1992, 2010) By expanding the understanding and comprehension of the possible ecosystem services to incorporate learning from other disciplines, as well as revisiting the values we bring to the table as designers and planners, the potential for developing regenerative or restorative economies, communities, and infrastructure grows with each successful project.

One of the key values suggested by much of the research is the innovation and imagination that pairs well with the willingness to take risks. The issues which press upon our values today are not easy ones and they are not isolated to one specific culture or region of the world. Hawken summarises his position by saying that "many [of the] proposed solutions to environmental degradation arise from the same industrial paradigm that caused them - increased growth, better technology, and more money - but most of these solutions tend to be half measures that bring up the rear in terms of innovation and imagination." (Hawken, 1992, 2010) The solutions suggested by his book are there because "given our belief systems and institutions, they are an attempt to describe how we can realistically begin to reverse our

downward environmental slide. Society must recognize that ecological principles apply to human survival and that is we are to long endure as a world culture, or as a group of cultures, we will have to incorporate ecological thinking into every aspect of our mores, patterns of living, and most particularly our economic institutions." (Hawken, 1992, 2010)

## *2.2 Ecology and Economy in the Built Environment*

Ecology and economy are typically portrayed as polar opposites, when in reality, they are more like two sides of the same coin. According to Hawken, economists measure efficiency in monetary terms and produce extraordinary conclusions... [while ecologists] measure efficiency in terms of thermodynamics and conservation of resources (and also reach extraordinary conclusions, ones that conflict with those of economists)." (Hawken, 1992, 2010) Even with these differences, there is some overlap in the two realms; both agree that inefficiency in the form of pollution or waste is uneconomic and costly, and increases in efficiency will reduce global warming effects and improve the economy. (Hawken, 1992, 2010) In looking for historical context for this dichotomy, one can start with the Industrial Revolution. With the Industrial Revolution, emergent social conflicts that were inextricably linked to a parallel environmental impact were almost inevitable across many continents. (Keeler and Burke, 2009) This is partially due to the fact that nature was objectified and viewed as an agricultural and economic commodity (think of America's Manifest Destiny). It wasn't until the 20th century that economic theory could begin to think of land in terms of environment and resource economics and start to recognise the limits of the land's ability to yield. (Keeler and Burke, 2009) Later on, the energy crisis of the 1970s and the interest in energy efficiency due to the aftermath led to the establishment of federal agencies with goals propelled by the environmental movement, such as the Environmental Protection Agency (EPA), the Department of Energy (DOE), and the

AIA Committee on Energy, now AIA Committee on the Environment (COTE). (Keeler and Burke, 2009) In current times, most, if not all, major corporations have to address environmental issues in its reporting, communications, products, and services. However, as Hawken points out, there are still institutions who will “breathe their own exhaust if it means they're profitable.” (Hawken, 1992, 2010) According to Keeler and Burke, the “buildings of the twenty-first century make sense as machines, appliances, and industrial design; they are high-performance inventions.” (Keeler and Burke, 2009) Though business is supposedly meant to increase the well-being of humankind through service, creative invention, and ethical action, when environmental issues are presented to businesspeople, they are typically seen as yet another cost and regulation. (Hawken, 1992, 2010) Doing the “right thing” becomes burdensome and intrusive. [The] way our economy is organized... doing the right thing might put [businesspeople] out of business.” (Hawken, 1992, 2010) However, in looking at the data presented by Keeler and Burke, the direct impacts of low indoor air quality, for example, include increased healthcare costs, lost productivity, worker's compensation claims, undesirable real estate, and, in more extreme cases, expensive legal-settlement costs. In the United States, the potential reductions in health care costs and improvements in work performance from providing better IAQ are estimated at an annual value ranging from tens of billions of dollars to more than \$100 billion. (Keeler and Burke, 2009) Hawken argues that there is the capacity and ability to create a remarkably different economy, one that can restore ecosystems, reduce carbon in the atmosphere, and protect the environment while bringing forth innovation, prosperity, meaningful work, and security, but the businesses continue to ignore this. (Hawken, 1992, 2010) Anachronistic corporations want to continue things "as is" and stand in the way of transformative change. Attempts at constructive changes in the current system have been stopped because our business model isn't able to handle or adapt to the situation we face. Businesses are designed

to "break through" limits, not respect them, particularly if they are found in "small [and] refined relationships." (Hawken, 1992, 2010) Current environmental policy tries to balance the needs of business with the needs of the environment, but this isn't possible, because the only needs that matter are the ever-changing interrelationships between the "forces of life." If ecology and commerce were to be united into one "sustainable act of production and distribution that mimics and enhances natural processes" it could be a prosperous, intelligently designed and constructed commercial culture which is a symbiosis of company, customer, and ecology; a restorative economy. (Hawken, 1992, 2010)

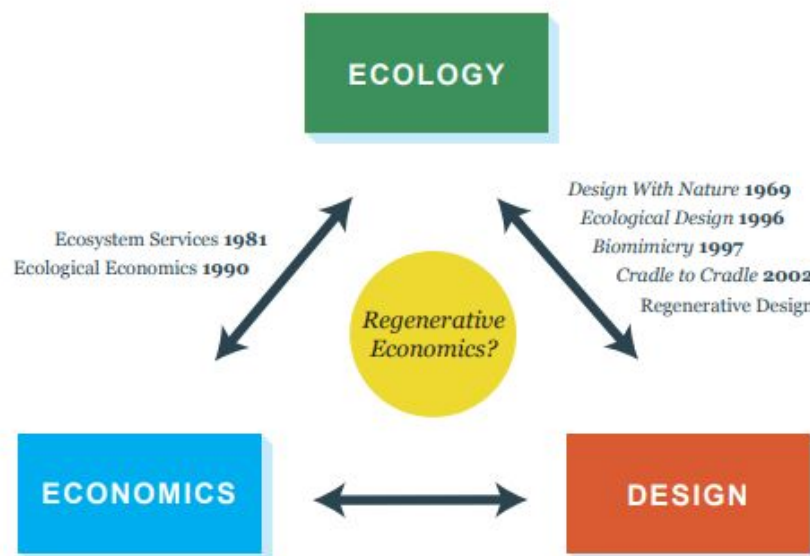


Figure 03: Integration in the form of "regenerative economics." (Cowan, et. al., 2014)

One of the rhetorical questions posed by Hawken is "if the free market is so efficient, why, as it affects the environment, is the overall economy so inefficient?" This is due to the fact that markets are fantastic at setting prices but incapable of recognizing costs, thereby causing harm to both natural and human communities. (Hawken, 1992, 2010) Markets do not reflect the true cost of products and services. "The single greatest flaw of modern accounting is that the cost and losses of destroying the earth are absent from the prices in the marketplace."

(Hawken, 1992, 2010) Consequences of politics, equity, fairness, or distribution of wealth are mostly ignored because of the free market's overwhelming ability to produce goods, innovation, and technological change. Humans have not been able to imagine or implement a better or more superior system of production. (Hawken, 1992, 2010) Yet given the current corporate practices, much of our natural and human world, particularly the wildlife reserves, wilderness, and indigenous cultures, will survive the global market economy. (Hawken, 1992, 2010) According to Keeler and Burke, globally we are overshooting the planet's capacity to regenerate natural resources by 23%. (Keeler and Burke, 2009) This data comes from the ability to track and assess resource usage, also known as resource asset management. The Ecological Footprint and Environmental Accounting refers to the amount of biologically productive land and water area it takes to produce resources for human consumption and to absorb the waste generated by this consumption. (Keeler and Burke, 2009) Biocapacity and footprint data can inform environmental work through governmental policy, public health practitioners, corporate sustainability programs, non government organisations, manufacturing industries, and municipal infrastructure providers, including those in the design and construction of buildings. (Keeler and Burke, 2009) There are three basic business issues proposed by Hawken - supply ("what it takes"), profit ("what it makes"), and waste ("what it wastes"). (Hawken, 1992, 2010) Currently, commerce takes too much from the environment, mostly in a harmful way. The products produced require excessive amounts of energy, toxins, and pollutants, and the high amounts of waste cause harm to both present and future generations. Net primary production (NPP) measures our impact on ecosystems; currently, our economy utilizes, consumes, converts, burns, or clear-cuts **annually** more than 40 percent of the total NPP on land. (Hawken, 1992, 2010) And when faced with that reality, businesses typically respond by invoking its duty to

protect shareholders, markets, and profits. Efforts to clean up pollution were expenses that came straight off the bottom line.

In terms of green legislation and regulation, green taxes could potentially revolutionise the economy and cause it to evolve into natural systems of production and design. (Hawken, 1992, 2010) But in the past, when governments and municipalities tried to legislate green building measures, regulations were attacked as regressive, reducing international competitiveness. Though green building projects have started to see streamlined operating costs, improved worker efficiency, and durable buildings (meaning money saved in the long run), economic critics claim that any forced integration of cost and price would lower productivity, reduce economic output, cause greater costs to be passed on to the consumer, lower real income, slow economic growth, and insinuate government further into the economic arena. (Hawken, 1992, 2010) No major piece of environmental legislation has ever been supported by corporate America because of these ideas. (Hawken, 1992, 2010) If the manufacturer were forced to bear the full costs of production, including pollution, sickness, or environmental damage, then they would support and implement incentives to reduce the negative impacts, thereby lowering the cost. (Hawken, 1992, 2010) Any concern about higher costs to consumers ignores the fact that consumers are already paying in the form of higher health costs (both individually and through higher insurance premiums), mitigation costs to clean up toxic waste sites, lost economic output, and environmental degradation, which drives up the cost of resources. (Hawken, 1992, 2010) America has a long political tradition of demanding the cheapest price for everything and fighting any regulation or law that would inflate prices as being punitive to the little guy; however, by arguing for cheapness, invention, innovation, and job creation have been lessened while strengthening large corporations, the concentration of wealth, and the disenfranchisement of the poor. (Hawken, 1992, 2010) The

key, Hawken argues, to redesigning the economy is to shift most taxes derived from "goods" to ones placed on "bads," from income and payroll taxes to taxes on pollution, environmental degradation, and nonrenewable energy consumption. It should already be incorporated into the price a company or customer pays for a resource, product, or service in order to create powerful incentives for revision and improvement of methods of production, distribution, and consumption. (Hawken, 1992, 2010) Substantial green fees may improve the quality of life for citizens, but they also make capital investments in outdated, pollution equipment and processes obsolete, and they may completely eliminate some businesses. (Hawken, 1992, 2010) Of all the possible green fees, taxing energy would be the most beneficial because it would provide both the greatest short-term and long-term benefit. The purpose of carbon taxes is to reduce CO2 emissions in order to reduce global warming; ideally, the goal of the carbon tax would be to get commercial industries to replace their carbon-producing systems with sustainable, clean energy ones. (Hawken, 1992, 2010) In a different approach, Keeler and Burke focus on high-performance design, stating that it has already made a green financial deal by demonstrating that major commercial developers had both a use and a need for green building rating systems that would quantify their commitment. (Keeler and Burke, 2009) It also pays to be aware of the high amount of environmental damage that is avoided when constructing sustainable buildings. (Keeler and Burke, 2009) The use of green rating systems to impact legislation through the introduction and implementation of sustainable initiatives is one potential way to increase the amount of sustainable business practices. There are critics who claim that this method is too slow; by the time the necessary initiatives are in place (if they ever are), it will be far too late to make any real progress in reducing global climate change. If one were to look at the US Green Building Council's Leadership in Energy and Environmental Design goals, both "reduce contribution to global climate change" and "build a green economy" are listed, but the

former is the primary goal. It may not be possible to meet both goals in equal parts, however, rating systems are encouraging the discussion of values and decision-making to happen much more frequently than before.

While the world economy grows at a rate of 2 to 3 percent, international companies can grow at a rate of 6 to 10 percent (per year). (Hawken, 1992, 2010) The largest corporations grow at such sharp rates that they basically embody their own political and economic power (just look at Microsoft, Boeing, or Amazon here in Seattle), and concentrated political and economic power is a major deterrent to establishing green taxes and other features of a restorative economy. Commerce and industry grow faster than nature (and those small groups fighting for the environment), and yet the "needs" of humans are placed far above the health of the planet. (Hawken, 1992, 2010) According to Hawken, economists see the world as having an infinite series of reversals (problems and solutions), whereas ecologists worry about "irreversibles," like unchangeable the loss of an entire species. (Hawken, 1992, 2010) If the global economy has already exceeded the Earth's carrying capacity - that point beyond which further growth will decay and effectively destroy its host - and the Earth and Sun potential output remain the same, humanity's unchecked growth will inevitably cause destruction and shortages. Abundance is a theory that is entirely rooted in self-interest, not science, and allows businesses to continue to ignore sustainability in order to "succeed." (Hawken, 1992, 2010) They are able to ignore the fact that present demands on resources are equal to stealing from the future and that selling today's wants is at the expense of tomorrow's needs. Commercial interests do not have to acknowledge the devastating legacy of toxins and wastes and are usually better off ignorant to these facts [and the cost of the additional responsibilities] if they intend to prosper in the current economic system. However, limits and prosperity are intimately linked, and the natural world is a limit that can be circumvented "only at the cost of the world itself." (Hawken, 1992,

2010) Most capital today is used to finance the growth of multinational corporations. (Hawken, 1992, 2010) Under World Trade Organization (WTO) rules, environmental laws and principles are inferior and subordinated. A given country could pass its own environmental regulations, and a company based in that country is free to bypass those regulations when manufacturing the identical product offshore in a country with relaxed or no environmental regulations. It can then import that product back into the country that had restrictive regulations. (Hawken, 1992, 2010) The inevitable result of the WTO is that the rewards of international trade go to the cheapest producer, not necessarily the most responsible producer; it makes the world less safe locally and has a compounding effect, worsening conditions everywhere. (Hawken, 1992, 2010)

When it comes to resources and economy, resources are typically treated (in our current economic practices) as an endless, abundant capital meant purely for financial gain. Businesses take too much and waste even more. Chemicals are released into the air, effluents are discharged into the waterways and ocean, and toxins are embedded deep into the ground or into concrete-lined drums and landfills. Through this pollution, we are allowing commerce to destroy the natural capital of the Earth and reduce our ability to sustain our civilisation. (Hawken, 1992, 2010) Worse still, by allowing businesses to only focus on the immediate problems involving disposal of the waste, industry avoids the fundamental issue, which is the creation of waste. This focus also ignores the fact that industrial degradation of the planet is no longer a regional problem, but a global one with global consequences. (Hawken, 1992, 2010) The current business model of economics argues that corporations are not able to concentrate on (paying for) environmental issues unless they're in a state of growth, and the environmental needs cannot detract from or restrict growth. This position assumes that human welfare and environmental health are separate and less than economic profit, when in fact, welfare and health are irrevocably linked. The industrial ecology theory is a practice where companies try

to interweave their material and waste flows, attempting to eliminate pollution by a tailored manufacturing approach which recycles old products into new. Businesses who practice this model see themselves as problem-solving institutions who are also creative and independent; they have a strong bias to objectivity, technology, and measurable standards. (Hawken, 1992, 2010) Hawken refers to Hardin Tibbs and his argument that in order for industrial ecology to be implemented, it will need to be supported by policies that coherently align financial, economic, and regulatory accountability. (Hawken, 1992, 2010) However, because this practice does not ask for changes in how we live and operate, it is not a long-term solution to a sustainable economy. (Hawken, 1992, 2010) Financial asset management requires assessment and upkeep, and so does resource asset management. (Keeler and Burke, 2009) Resource effectiveness can refer to several concepts; consumption, displacement of species and humans, environmental degradation, and the various strategies to address these. (Keeler and Burke, 2009) The appropriate technology approach typically results in durable, low-maintenance structures, because it uses regionally appropriate materials and technologies, saving in material and labour costs. (Keeler and Burke, 2009) Resource effectiveness also looks at durability, packaging, waste, recycled content, location, water, natural resources, reuse, sustainable forestry, renewability, biobased materials, low-maintenance materials and cleaning products, maintenance, materials efficiency, and disassembly. (Keeler and Burke, 2009) In a different approach to resource management, Hawken introduces the products-of-service concept, an idea in which manufacturers would have to imagine how they would reuse and reclaim the product upon its return and consider its values when it comes back to the manufacturing plant. (Hawken, 1992, 2010) He also speaks to the intelligent-products concept, which states that a certain amount of embedded energy is required to manufacture every product, but with careful design and construction, a good portion of that of that energy can be saved and upcycled.

Products of service are created and re-created in increments that extend their life far into the future. (Hawken, 1992, 2010) Another solution is to change from extractive-resource systems by using a hybrid form of public utility to regulate resource supply and production. (Hawken, 1992, 2010) A utility can make a profit by selling the *absence* of something, instead of its presence. (Hawken, 1992, 2010) Hawken points out that most global resource systems are overexploited and could benefit from becoming a publicly regulated, privately managed, and market-based utility. For example, a salmon utility in the PNW, which would recognise that the existing market regimes and mechanisms don't operate in the best interest of the fish, fishermen, public, or fish habitat. A fee on salmon would send revenue directly to a salmon utility, whose sole purpose would be to increase the amount of salmon. Funds would (ideally) be spent on habitat restoration, education, land acquisition, and protection of key habitat and research. It would be limited in its profitability, and a percent of its revenue would go to restoration. The service would be the growth of the wild salmon population and the increase in salmon would result in higher revenues. (Hawken, 1992, 2010) The hypothetical utility points out the fact that while we get much of our wealth from natural resources, we have not found a successful way to preserve that wealth. Currently, we are losing resources because they are controlled by either private corporations or the state, and neither option has proven successful in establishing long-term strategies for ensuring the well-being of the communities. (Hawken, 1992, 2010)

Economic issues heavily impact design, planning, and construction issues. Urban sprawl is a burden on the local government(s) as it forces limited resources to be spent on new infrastructure instead of updating existing infrastructure, as well as spreading certain resources (such as the tax base) thinly, to the point of diminishment, which in turn reduces the services provided to the remaining population. (Keeler and Burke, 2009) In a different approach, an ecosystem services framework can be developed as a way to translate the multi-scale,

intergenerational, complex, whole systems dynamics of ecosystems into a suite of specific services (of value to the human species) suitable for economic analysis. (Cowan, et. al., 2014) Ecosystem services are a bridge between ecology and economics, but their inherent complexity challenges measurement and assessment. Complementary qualitative approaches may be a beneficial way to mitigate this. (Cowan, et. al., 2014) An alternative approach is actively designing with living systems. This tradition is focused on working with nonlinear living systems in their full complexity rather than filtering them through an economic valuation lens. (Cowan, et. al., 2014)

Technology and natural processes can be integrated to work together to provide the desired ecological performance. This mix of nature and technology, guided by historical ecology and biomimicry, allows for a building like the Bullitt Center to achieve “optimised performance” by balancing the objectives of resilience, density, quality of life, and minimal off-site externalities. (Cowan, et. al., 2014) "Smart Growth" and "New Urbanism " are two significant movements which have focused on promoting development patterns that create more sustainable communities. (190) The primary building blocks of cities are neighborhoods, districts, and corridors that mix uses instead of segregating them like the traditional land-use model. (Keeler and Burke, 2009) Specific development strategies introduced by Keeler and Burle include neighbourhoods being compact, pedestrian friendly, and mixed use; street networks should be interconnected to encourage walking, shorter vehicle trips, and energy conservation; a broad range of housing types and prices is needed to strengthen the community; transit corridors can be used to revitalise urban centres (highway corridors subtract); appropriate, useful densities near transit stops to encourage public transportation as a viable alternative to personal vehicles; concentrations of civic, institutional, and commercial activity should be embedded in neighbourhoods and districts (not isolated in single-use

complexes); and a range of parks/public, open (green) space should connect and be distributed within neighbourhoods and districts. (Keeler and Burke, 2009)

Business is the problem and it must be part of the solution. No other institution of the modern age is powerful enough to push the necessary material and economic changes. (Hawken, 1992, 2010) Some potential methods involve green rating systems, where a high rating can potentially provide an increased eligibility for fundraising goals, high public relations value, incentive for buyers or investors, preferential/priority building permits in some municipalities, or other benefits. These systems also have the potential to create market change on the materials side and increase the knowledge and skill on the practice side. (Keeler and Burke, 2009) The value of a rating system also somewhat lies with the branding and name recognition; owners may be able to use them to compare buildings. The high demand for green buildings is transforming the way projects are designed, constructed, and sold. (Keeler and Burke, 2009) Green practices from planning to design to construction to demolition all aim to encourage thinking about maximising economic benefit of correct implementation, providing a safe work environment for construction crews, and preserving culturally and historically significant buildings and neighbourhoods. (Keeler and Burke, 2009) A different approach to what is ultimately the same goal is a restorative or regenerative economy. A restorative economy tries to create a market in which every transaction feeds the integrity of the commons, as opposed to what we know today, when consumption causes degradation and harm. Businesses must be able to make money sustaining living systems or global restoration will never happen. According to Hawken, competition in the marketplace shouldn't be between a company wasting the environment and one that is trying to save it, it should be between companies trying to do the best job in restoring and preserving the environment. (Hawken, 1992, 2010) Restoration has multiple meanings, but all focus around the idea that to restore is

to bring back something to its original state, or replacing what has aged and died away, or to heal and make whole. To live in the future where restoration takes place, we need a design and a plan. (Hawken, 1992, 2010) Hawken states that we "must forget the economic indices and reconsider what we make and how we make it... a better word for the restorative economy is 'practices'." We need better economical practices. Our economy can either create assets for the future or take away the assets of the future; one is called restoration and the other exploitation. (Hawken, 1992, 2010) It is only when the incentives to continue to manufacture waste are removed and the risks and costs outweigh the gains and profits will designers, engineers, chemists, and investors turn their attention to better, safer alternatives. Wasteful methods used today are there because they are the cheapest solution, and our society values the cheapest and fastest methods. (Hawken, 1992, 2010)

Hawken boldly states that if "corporations are sincerely committed to environmental restoration, as so many claim to be, they will reverse current regulations and propose a 'most sustainable nation' tariff status that will replace most favored nations. This status would grant low or no tariffs to countries that practiced sustainable harvesting of resources that did not despoil the environment, that did not allow worker exploitation, that did not have corrupt government officials selling off tribal forests to the highest corporate bidder." (Hawken, 1992, 2010) The future, dynamic and restorative economy would get its money from continually revising and adapting the green taxes, as well as potentially diminishing its size. (Hawken, 1992, 2010) The world today is in a transformative period and our economical practices need to adapt. We can either let it crush us or we can reconstruct it to allow the imagination of a more sustainable future into our daily acts of commerce. (Hawken, 1992, 2010) Reconstruction means doing something now and doing things that might fail. Restoration is the conservative, ethical, and economic ethic, whereas laissez-faire capitalism is out of control and threatening

our existence and planet. (Hawken, 1992, 2010) In the process of our unprecedented gaining and disproportionately distributing money, our society forgot that success and failure cannot be accurately measured by currency alone and that “our lives, the transience of which often becomes evident all too late, can have little meaning unless we feel in our passing that we were able to serve the nature and humanity that gave us our breath and soul.” (Hawken, 1992, 2010)

### *2.3 Sustainable Practices in the Built Environment*

“Our goal is a delightfully diverse, safe, healthy, and just world, with clean air, water, soil, and power—economically, equitably, ecological, and elegantly enjoyed—period! Which parts of this don’t you like?”

- William McDonough, FAIA

There is less than 12 years as of 2018 to implement changes to keep global warming capped at 1.5°C; any more, even just half a degree, will significantly worsen the risks of drought, floods, extreme heat, and poverty for hundreds of millions of people. (Watts, 2018) According to the United Nations Intergovernmental Panel on Climate Change (IPCC), “[urgent] and unprecedented changes are needed to reach the target” set by the Paris Agreement. Keeping the change at the 1.5°C level suggests that the global sea level rise, extreme heat waves, coral reef loss, and arctic sea ice loss would be terrible, but manageable. (Watts, 2018) At 2°C, the effects are catastrophic. Already, the world is currently 1°C warmer than pre-industrial levels, and there has already been more devastating hurricanes, record droughts, and an increase in forest fires. (Watts, 2018) According to the IPCC, climate change is already happening and every bit of additional warming worsens the impact on the planet. IPCC suggests four ways to hit 1.5°C using land use and technological change; cutting carbon pollution by 45% by 2030 and down to zero by 2050 (requiring carbon prices which are 3 to 4 times higher than the 2°C target); aggressive reforestation (along with greater adoption of carbon capture technology),

significant shifts to electrical transport systems, and strong commitments to implementing strategies to reach the targets. (Watts, 2018) Unfortunately, politicians and countries are still heavily invested in the old ways, particularly gas fracking, fossil fuel extraction, oil exploration, and deforestation, to name a few. (Watts, 2018)

According to Henderson (2012), “green building” can be described as a profession that aims to give more than it takes from the environment and our surroundings, and ultimately, it strives to “preserve the health of both people and our planet.” Per the U.S. Environmental Protection Agency (EPA), green building is defined as:

“Green building is the practice of creating structures and using processes that are environmentally responsible and resource-efficient throughout a building’s life-cycle from siting to design, construction, operation, maintenance, renovation, and deconstruction. This practice expands and complements the classical building design concerns of economy, utility, durability, and comfort. Green building is also known as a sustainable or high performing building.” (EPA, 2011)

As cities become taller, bigger, and more innovative across the globe, their large environmental impacts continue to grow, particularly in regard to air pollution, energy consumption, and water scarcity. (Henderson, 2012). This correlates with Wong and Fan’s (2013) theory that the increase in sustainable designs and practices has increased in recent times due to the increase in global environmental concerns. In addition, Farzad Jalaei (2015) introduces the recent changes in the definition of sustainability, from purely environmentally to encompassing issues from the environmental, social and economic realms. This idea, also known as the “triple bottom line,” comes from John Elkington in his 1998 book, “Cannibals with Forks: the Triple Bottom Line of 21st Century Business.” These three ideas (environmental factors, social factors, and economic factors) are also referred to as the “three P’s” or “three pillars” - “planet, people, and profit.” (Henderson, 2012).

## *The Three Spheres of Sustainability*

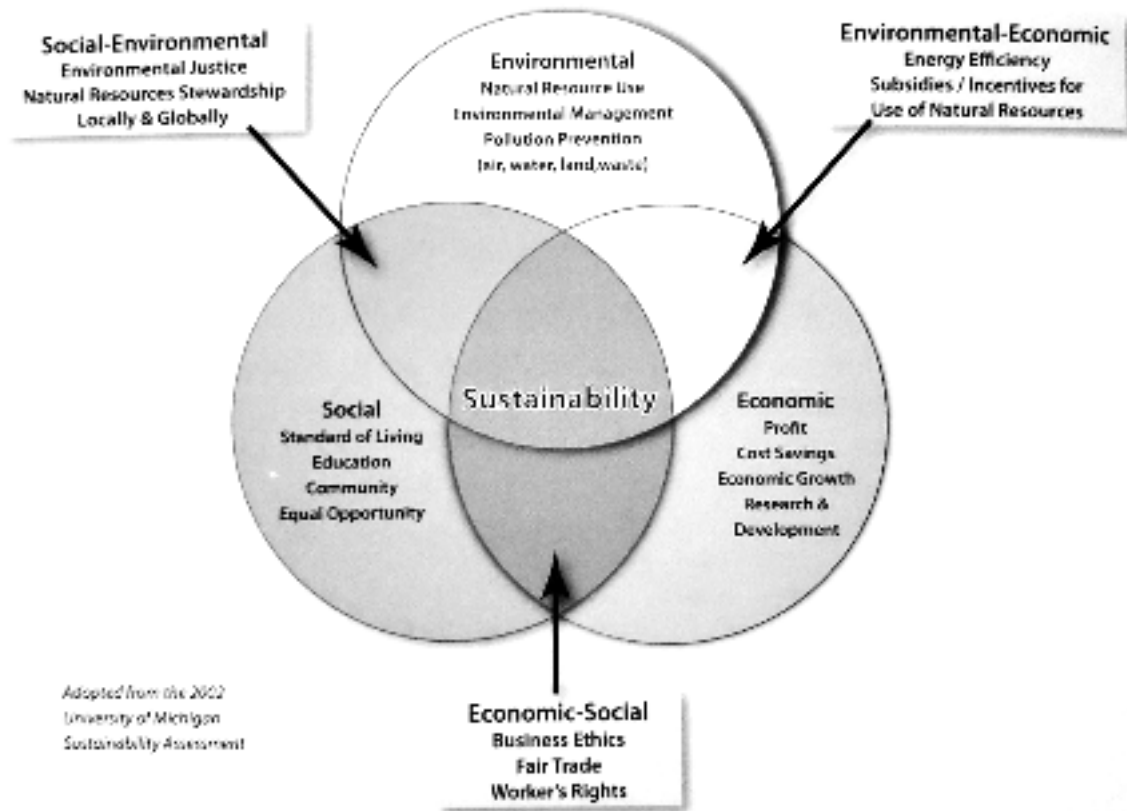


Figure 04: Diagram of the three elements of the “new” definition of sustainability. (Henderson, 2012)

Similar to the Perkins and Will research, Jalaei also discusses an approach to design decision-making; the “Multiple Criteria Decision Making (MCDM) approach.” It is presented as a toolkit for making criteria-based decisions, and this is significant as values of various project stakeholders, particularly sustainability initiatives, conflict due to different goals and their reliance on shared data. In this scenario, designers are usually tasked with finding the optimised solution. While the ambiguity of data and potential is acceptable at the conceptual design phase of a project, Motawa and Carter’s report found that in the post-occupancy stage, “there is a need for a proper and systematic methodology to monitor the behaviour of buildings and to

make critical decisions to ensure that the energy criteria of the design are really met in practice.”  
(Motawa and Carter, 2013)

One of the possible tools for predicting the environmental impacts of a design, material, or product is to perform a “Life Cycle Assessment,” or LCA. LCA is a tool that can be used to select building materials, assemblies, systems, and strategies in the most optimal manner with the least impact on the environment when used in tandem with other building performance tools like energy simulation or daylight simulation. (Keeler and Burke, 2009) Many types of evaluation tools can only be used after occupancy, but LCA tools are helpful in that they attempt to yield quantifiable predictions of sustainable strategy performance, economics, or operation of an integrated building and communicating the benefits of green building practices. (Keeler and Burke, 2009) LCA tools should be used early on because their early application is an effective way to implement integrated building design and reduce design and/or construction costs. (Keeler and Burke, 2009) In a similar way, life-cycle costing (LCC) focuses mostly on financial costs and impacts of a material or product based on future predictions. (Keeler and Burke, 2009) Good LCAs have clear boundaries which determine the scope of the study and strong indicators which predict the impact potential. The challenge of LCAs is in defining the characteristics, quantifiable variables, and analyses of the impacts and present the results in an understandable, relevant manner for designers and builders. (Keeler and Burke, 2009) LCA can be useful in assessing or comparing the environmental impacts of different products, materials, assemblies, or systems. (Keeler and Burke, 2009) The International Organization for Standardization (ISO) sets the standards for LCA and is the world's largest and most comprehensive producer of standards governing everything from climate change to cosmetics, including the environmental labelling and strategic planning for LCA. (Keeler and Burke, 2009) Because of the range of uncertainties and the variability and incompatibility of data, LCA can be

a complex and time-intensive evaluation tool. In addition, LCA data is hard to standardise and quantify, and it doesn't take into consideration sociological implications, such as social justice issues or public health. (Keeler and Burke, 2009) Trade-offs found through LCA tools can be analysed and weighed through sustainable rating systems (such as LEED). (Keeler and Burke, 2009)

Both Life Cycle Assessments and Post-Occupancy Evaluations have been found to successfully produce performative data of buildings. In their findings, Shadram (2015) states that the “Life Cycle Assessment (LCA) method has been widely accepted as a means to evaluate the environmental impacts associated with the construction, maintenance and demolition of buildings and is therefore increasingly applied to assess buildings over their life cycle.” This means that large amounts of data are needed in order to successfully analyse the impacts of various components, such as materials. However, during the beginning stages of design (such as the schematic or conceptual design phase), there typically isn't enough information to successfully analyse it, making early analysis “complex and time-consuming” (Shadram, 2015) due to the effort of manual input. However, studying the impacts early on can inform designers on the impacts of their conceptual designs. This is particularly important in assessing environmental performance of designs produced in a BIM-workflow. (Shadram, 2015) The data exchange is an important relationship in the computational world. In going between BIM and the software required for a LCA, issues occur when some elements are not modelled (and therefore are not analysed), since most elements would need the same naming conventions in order to implement automated processing and quantities would need to be figured out relatively early (Shadram, 2015) in order to complete a detailed LCA. However, there are strategies and tools available for designers to test less-specific variables (such as building geometry) through the conceptual design process, such as Grasshopper or Dynamo. (Shadram,

2015) BIM-integrated LCA workflows can support the development and implementation of an incremental sustainability assessment with the benefit of a continuous documentation of LCA performance in the various design stages of the BIM model. (Shadram, 2015)

The definition of "green building" has remained highly ambiguous, allowing for its misuse and mislabelling in multiple realms. In their work, Keeler and Burke are straightforward, stating that a green building is high-performing, integrated, restorative, and embodies an "integrated whole building approach which considers life cycle at all levels." (Keeler and Burke, 2009) A "well-designed" building is one that "[adapts] to regional climates; [makes] efficient use of readily available construction materials and tested techniques; [ensures] a level of comfort through heat storage...or [reaps] the benefits of the environment by storing water." (Keeler and Burke, 2009) Green buildings must solve more than one environmental challenge (natural resource depletion, landfill overflow, carbon emissions, etc), site-demolition issues and packaging waste issues, resource efficiency (minimise harvesting and mining for materials and provide a means of replenishing natural materials; reduce soils, water, and energy use during materials manufacturing, building construction, and occupant use; planning for low embodied energy during shipment; tracing and logically progressing the chain of materials production), conserve and design for the efficiency of energy consumed by powering mechanical systems for HVAC and electricity (tied to CO<sub>2</sub> emissions), and provide a healthy indoor environment (no VOCs, use clean and controllable equipment, control pollutants through air filtration, ventilation, and walk-off mats; and design a connection to the exterior to provide natural ventilation, daylight, and views). (Keeler and Burke, 2009) Keeler and Burke argue that green rating systems such as USGBC's LEED need to become mandated (accepted by ASTM or ASHRAE) because currently there is not a national, legally enforceable standard for green buildings. (Keeler and Burke, 2009) Even with the idea of the "triple bottom line" - economic, environmental, and social

sustainability becoming more commonplace, most current buildings use code-minimum design to make the "least-bad allowable" building. (Keeler and Burke, 2009) Green building policies, permit requirements, and building codes are strategies of sustainable design that can bridge the gap between voluntary initiatives and mandated public policy. These methods provide a way for the design and construction of new buildings to become part of the solution, implementing effective green policies in building codes and transitioning our socio-economic structure from the 'way things are done' to a new, better standard. (Keeler and Burke, 2009) Green building standards challenge those "best practices" by implementing high-performance materials and demanding better energy performance. (Keeler and Burke, 2009)

In North America specifically, building operations account for over 1/3 of all energy use and over 60% of electricity consumption; the link between energy used in building construction and operations and global environmental problems is "indisputable." (Keeler and Burke, 2009) Regional and local conditions have a major effect on energy consumption. (Keeler and Burke, 2009) At the local level, the demand for more power plants, large-scale dams, natural gas and oil, and mining sites contributes to habitat destruction, deforestation, and degradation of air and water quality. Addressing global warming and ecological sustainability will require more than just changes in the way we build. (Keeler and Burke, 2009) Latest energy standards would reduce the need for new electrical generation facilities and on-site use of natural gas, but the reductions in building energy use must happen. By greatly reducing demand, renewable energy sources can provide a larger percentage of our energy needs. (Keeler and Burke, 2009) When it comes to the interiors of the building, it is up to the designers who do the material selection to verify that the manufacturer's claims about a material match what is actually possible (in terms of reuse, recycling, etc) throughout the design process. Materials have multiple impacts regardless of material, product, or system, including resource effectiveness and conservation, energy

efficiency and conservation, and indoor air and environmental quality. (Keeler and Burke, 2009)

Other materials considerations when selecting building components include locations of material harvesting, manufacturing, and distribution; means of transportation to the job site, fuel type used in material processing, installation energy (power tools, vehicles, temperature or humidity-controlled environments), energy used during cleaning, demolition and/or disassembling technique, and disposable and/or recycling. (Keeler and Burke, 2009)

Characteristics of sustainable city planning include "smart" locations (using land efficiently and to support both transit use and walkability), good urban design (mix of uses, designs connected to and/or imitated of/inspired by nature, restoration of habitat and wetland, and appropriate design of steep slopes to prevent erosion and water degradation, high-quality urban fabric consisting of interactions and public spaces), environmentally appropriate siting (greenfields versus brownfields building on previously developed land, transit-oriented development, not on farmland or in floodplains), green technology (solar orientation of buildings and blocks, reduction of the urban heat island effect, regionally appropriate planning, technology implemented between multiple buildings, neighbourhoods, or cities; on-site renewable resources, xeriscaping, district heating and cooling, green infrastructure, green streets), and social sustainability (housing diversity, compact development, connectivity/walkability, transportation choice and facilities, planning tied to public health/environmental justice) (Keeler and Burke, 2009) In order for a system to compare projects and produce relevant results, it must use consistent metrics - metrics which are verifiable, measurable, quantifiable, and technically robust; it must also be transparent about development and funding. (Keeler and Burke, 2009) Differences in rating systems range from region-specific applications for impact potential, to performance assessment methods, to the consideration of the operations and maintenance of the project. (Keeler and Burke, 2009) In the US, public policy, codes, and

ordinances are typically located at the municipal level, which is similar to incentive programs. (Keeler and Burke, 2009) In implementing the use of these rating systems to develop green building projects, integrated approaches to design and construction are necessary. Several key planning tools involved in implementing rating systems during the design, construction, or O&M of a building/project involve integrated building design (early on). (Keeler and Burke, 2009) Key planning tools are design charrettes, tracking/monitoring of data and documentation, specifications and drawings, construction observation and meetings, and the specific rating system's application process. (Keeler and Burke, 2009) Some best construction practices include not adding secondary finishes to materials, provide/maintain consistent and accurate labeling of materials, use minimum numbers of elements when constructing, avoid chemical connections, use modular or prefabricated elements, separate structure from cladding, and record information on the disassembly process and data on the building, and plan and execute construction waste demolition plans (not only tracking materials costs and waste-hauling expenses but also collection bins, waste-hauler details, donations and material exchanges, weight tags, and costs related to each activity. (Keeler and Burke, 2009) On-site sorting of wastes is more labour-intensive but creates efficiencies down the line. (Keeler and Burke, 2009)

Other strategies for design, construction, and operations include a unique relationship with nature. Biomimicry, the simulation of naturally occurring processes by human design, is a key property of living buildings that is relevant to the question of urban ecosystem services. Approaches that mimic or simulate natural processes are based partially on the many studies that evaluate the benefits to proximity to parks or open space. For many people, the presence of natural areas within our urban environment is the focus of urban ecosystem services. However, while parks and open space are an important part of the urban ecosystem services equation, they are not the full story. In a typical urban context, there is often an integrated mix of nature

and technology. (Cowan, et. al., 2014) It is important to note that whenever our urban design incorporates natural elements, we preserve some aspect of the performance of important ecological functions, which we rely on for survival and quality of life. However, in an urban context, we are not always able to rely on natural processes to provide the level of service needed. This relationship can be seen in the ecosystem services spectrum, which demonstrates the inevitable trade-off between a lower level of performance of functions across the landscape or a targeted high level of performance of specific functions in particular, mechanical locations. This relationship affects the outcome of the effort to optimise density, resilience, quality of life, and minimise externalities. While we reap significant benefits by moving our design to obsessively integrate more natural elements, we also give up some desired (if not necessary) outcomes by doing so. (Cowan, et. al., 2014) The report on the Bullitt Center also focuses on regenerative design, stating that it "is a profoundly optimistic design framework that suggests that humans can help regenerate ecosystems using appropriate technologies and design strategies." (Cowan, et. al., 2014) In a building or development designed with regenerative design ideals in mind, it will "deliberately provide habitat for species other than humans, contribute to soil formation and fertility through careful cycling of biodegradable wastes and recycling of non-biodegradable wastes; purify air, water, and soil; regulate the climate through mitigating greenhouse gas emissions or possibly sequestering carbon, produce renewable energy, collect water." (Cowan, et. al., 2014) Ideally, designers will find a path that recognises limits while using our innovative capacity to invent and reimagine our practices to increase efficiency, decrease harm, and improve our existence. We need to create an economy and way of relating to our material world that is not an either-or argument but a means to create the best life for the greatest number of people (because we do not know the eventual outcome or impact of our current industrial practices). (Hawken, 1992, 2010) Three potential approaches

suggested in *The Ecology of Commerce* that aim to mitigate the gap between what we need and what is available are 1) entirely eliminate waste from the industrial production; 2) change the economy based on carbon fuels to renewables (solar, wind, and waves); and 3) create systems of accountability and response that support and strengthen restorative behaviour (green fees, resource utilities, or reliance on local production and distribution). (Hawken, 1992, 2010) All three recommendations have a single purpose - to substantially reduce the impact that each person has on the environment. (Hawken, 1992, 2010) Hawken reminds us that while there is a debate on whether we have a human problem (people who are unwilling to change their thinking or their lifestyle) or a business problem (opportunistic companies willing to benefit from expediency, greed, and short-sightedness), the real problem is a systemic one that involves both people and commerce. (Hawken, 1992, 2010) Social justice and the environment represent the future, and integrating them requires regulation. (Hawken, 1992, 2010)



Figure 05: The ecosystem services spectrum in an urban environment. (Cowan, et. al., 2014)

## *2.4 The Social Aspect*

In the United States, as businesses begin searching for higher productivity and profits, it usually means downsizing, overseas plants, and layoffs. (Hawken, 1992, 2010) Arguments for international corporations typically ignore or undervalue the questions of scale and dehumanisation. Hawken points out that we “are proud of our large companies, almost as if they were sports teams that can beat the competition... but we are afraid to look at the enormity of their shadow, the rigidity of their thinking, their unbridled power hidden behind lobbyists, PR firms, and ad campaigns.” (Hawken, 1992, 2010) Large corporations take care of other big things: factories, mass markets, mass production. They are the opposite of nature, where habitats and ecosystems demonstrate the importance of the small things. (Hawken, 1992, 2010) Chemicals produced by industries can make their way into human beings, and certain populations are more vulnerable to chemical exposure because of illness, immunocompromisation, pregnancy, malnourishment, or drug-related issues. (Keeler and Burke, 2009) Building systems can either fix the pollutant problems or add to them through various methods of air systems (ventilation, heating systems, and cooling/refrigeration systems), and water systems (delivery, quality, and treatment/filtration). (Keeler and Burke, 2009) In the AEC industry, avoiding these means looking at materials sources, chemical transmission routes, and the human health impacts of chemicals in the environment. (Keeler and Burke, 2009) Indoor environmental quality (IEQ) and indoor air quality (IAQ) have significant impacts on worker productivity, health, and comfort. (Keeler and Burke, 2009) The "demand to perform" in the workplace has become overwhelming; if you're not a top achiever, then you risk being fired. As jobs in large companies continue to decline, health and pension benefits are curtailed, real wages continue to fall in the US, and job security dissipates, workers can hardly be expected to be creative and productive. Decades of insulating prosperity in America have left our

corporations slow to respond to global threats (like the current pandemic) and competitors. Fear of the future has never been an effective motivator for humans, yet today the loss of jobs and benefits is a constant, affecting people's willingness to take risks, speak up, and address critical issues of safety or long-term value. (Hawken, 1992, 2010) Hawken argues that "nothing in the modern workplace, and little in society at large, encourages us to take our time or to be satisfied with what we have. We're being presented instead with a future where we will have to work harder but have even less leisure time than we do today as we are going to maintain our way of life. We are speeding up our lives and working harder in a futile attempt to buy us time to slow down and enjoy our lives." (Hawken, 1992, 2010) In current time, economic insecurity, suffocating debt, and environmental degradation are sharply reflected in the workplace. For example, federal debt reduces the supply of capital for investment, and thus diminishes innovation, jobs, and productivity. High indebtedness and credit are an attempt to re-create the industrial growth of the past, which depended on a unique set of circumstances in relation to the environment and resources. The value a person adds to the economy is now being outweighed by the value that is removed from both future generations (diminished resources) ourselves (unsustainable sprawl, deadening jobs, deteriorating health, and rising crime). (Hawken, 1992, 2010) An economy so disconnected and uncaring to the environment is equally likely to be insensitive to its workers and managers. Employees are used in wasteful ways, which leads to workplace stress, overwork, ill health, and low morale. (Hawken, 1992, 2010) Corporations rarely touch social issues such as homelessness and poverty because they do not have the same opportunities to create an illusion; nature is benign and full of endearing imagery, where the underserved populations are just a reminder of the misfailings of society. (Hawken, 1992, 2010)

In an article posted in The Guardian, Jonathan Watts states that at 1.5°C the proportion of the global population exposed to water stress could be 50% lower than at 2°C. Food scarcity would be less of a problem and hundreds of millions fewer people, particularly in poor countries, would be at risk of climate-related poverty. (Watts, 2018) There are significant consequences to ignoring the potential for the built environment to produce and deliver ecological and economical benefits. Removing nature from an urban landscape, or failing to maintain that urban landscape in harmony with the ecosystem that encompasses it, reduces the resilience and sustainability of those communities. (Cowan, et. al., 2014) With an ever-increasing majority of people living in urban areas, the role of ecosystem services production within urban boundaries cannot be ignored. The ability of these urban areas to provide quality of life over time is inextricably linked to our ability to integrate ecosystem services into our urban planning and design practices. Accordingly, promoting ecosystem services within the urban context is critical to improving the human condition and ensuring the ongoing vitality of our communities." (Cowan, et. al., 2014) To design with human intention, the "details" of the built environment - the block, street, and building - should be proportioned to the pedestrian. Keeler and Burke state that a primary task of all urban architecture and landscape design is the physical definition of streets and public spaces as places of shared use, individual projects should be linked to their surroundings, urban places need safety and security, and the design of streets and buildings should reinforce safe environments (but not at the expense of accessibility and openness). (Keeler and Burke, 2009) Development can still consider and integrate vehicles, but it does so in a way that encourages pedestrian focus and movement. Streets and squares should be properly configured to encourage walking and interactions (and therefore, a sense of community), architecture and landscape design should grow from local climate, topography, history, and building practice; important sites should consist of civic and public gathering buildings to reinforce the idea of

community and culture of democracy, buildings should provide inhabitants a connection to nature (weather, location, and time), particularly through passive design H/C systems; and preservation/renewal of historic areas should affirm the continuity and evolution of the urban society. (Keeler and Burke, 2009) The significance of the population density issue as it pertains to urban design is high because high population density is an existing reality for many of our urban areas. It is an existing constraint that must be addressed while integrating natural solutions into our urban areas. In addition, these urban areas need to support high population densities. Our current world population (as of the end of 2012) is over 7.09 billion and is anticipated to reach 7.1 billion by mid-February of 2013. (Cowan, et. al., 2014) These people need to live somewhere, and if they are not congregated into urban areas, then they will be sprawled across the landscape with dangerous consequences. (Cowan, et. al., 2014) A community with a sustainable economy provides jobs, housing, education, and other services for its entire population while limiting consumption of natural resources - economic sustainability is also achieved by creating a dynamic, diverse, and resilient commercial and industrial sector that can provide jobs and income for the residents and government; they also promote equity between generations and among different groups in society. (Keeler and Burke, 2009) Communities with a single purpose are not economically, socially, or environmentally viable over a long term period. (Keeler and Burke, 2009)

Healthy ecosystems provide services to humans that surpass basic needs and fall more on the intangible qualities of beauty, nature, and spiritual health. (Cowan, et. al., 2014) The benefits of naturalistic conditions through design mean more than just designing access to vegetation; natural light (compared to artificial light) is revitalising and the benefits of natural light have been shown to have considerable implications in health care treatments. Although natural light is not usually included in most lists of ecosystem services, it is one of nature's

benefits and is one of the ones which is most often replaced through technology in the urban environment. (Cowan, et. al., 2014) Other benefits of ecosystem services are more tangible; energy-efficient technologies produce four times as many jobs as building new power plants. Photovoltaic and wind-based energy systems produce two to five times the number of jobs as coal-fired or nuclear power plants. Wind farms, which were initially five times as expensive as nuclear power plants in cost per kilowatt, today can generate energy at prices equivalent to those of coal and nuclear plants. Green taxes on energy increase prices for industrially produced food and enfranchise localized food production, family farms, and sustainable agriculture. (Hawken, 1992, 2010) If green taxes level the playing field for farmers and provide positive incentives to break the chemical addiction, then the lowest-cost foods in the marketplace would be the highest-quality foods. The marketplace is restored to its primary purpose. (Hawken, 1992, 2010)

### *2.5 Technology in Design and Construction*

The National Building Information Modeling Standards (NBIMS) defines “BIM” as “a digital representation of physical and functional characteristics... [and] a shared knowledge resource for information.” (NBIMS, 2010). Outside of changing typical best practices in the AEC industry, BIM and computational design simulations have been instrumental in the creation and development of “evidence-based design,” where design decisions are made after analysis of simulated data, particularly in favour of choosing more sustainable decisions. When implementing BIM technology with the intent of creating sustainable buildings, goals typically include reducing operational energy to a minimum as well as reducing (or making more efficient) the energy and resources required to both build and maintain the building. (Shadram, 2015) Wong and Fan (2013) also conclude that BIM is “found to be ideally suited to the delivery of

information needed for improved design and building performance[,]” as well as finding that design optimisation is one of the highly beneficial aspects for sustainable building design. The significance of such optimisations can be found in Jalaei’s findings, which state that simulating “energy consumption, lighting simulation, green building rating system criteria and associated cost of building components at the conceptual design stage is very useful for designers needing to make decisions related to the selection of optimum design alternatives.” (Jalaei, 2015) Both the use of Building Information Modelling (BIM) and the implementation of sustainable practices are growing in the Architecture, Engineering, and Construction (AEC) industry, yet there are professionals who are resistant to one or both changes. While some of this resistance comes from a financial or liability base, most issues stem from a socio-cultural disconnect, particularly between experienced professionals and recently hired employees with a highly technical education. In addition, the success of implementing BIM into the design and construction of a building directly relates to how much data is available for simulation and analysis, as well as accuracy interpretation of the simulated results. While an increasing portion of architectural design relies on simulation data for sustainable decisions, due to a lack in post-occupancy evaluation and life cycle assessments, it is relatively unknown how accurate or effective these strategies are in a performative way.

There are different ways of implementing BIM workflows into current design practices, and they vary for both firm and project type. Deutsch’s (2011) studies of architectural firms who had adopted and/or implemented BIM practices showed that much of the BIM adoption was “sporadic, incomplete, and prohibitively shallow.” In his book, Crotty (2016) states that “Building Information Modelling (BIM) promises to transform construction” and that the typical method of sharing information, 2-dimensional drawings, is inadequate for the level of complexity of modern buildings. Even so, the shift from 2D to 3D coordination is a challenging one, and

Deutsch (2011) cites differences in technological, business, and social BIM adoption as the main issue. Technological and business -related concerns can be addressed relatively quickly with research into one's industry and conversation with other professionals. Socio-cultural issues, however, are much more complex in terms of the people, particularly as BIM standards shift the usually-hierarchical structure of projects and project teams to a more horizontally coordinated one. Zahiroddiny's findings conclude that "[some] of the key cultural barriers include; digital engineering capability and competency, cost-driven culture, shift from document and records management to data and information management, legal and commercial aspects of project contracts, collaborative frameworks, education, training and support and leadership in a digital construction." (Zahiroddiny, et. al., 2016) In addition, the culture of the firm considering the transition to BIM should look at the internal workplace culture and evaluate the firm's readiness to switch. (Deutsch, 2011) Each type of technological, financial, and social challenge impacts the firm and its individuals differently, particularly when implementing a new "set of data-interchange standards and protocols... which the individual models communicate with each other, and with other applications." (Crotty, 2016) These changes, when adopted incorrectly, negatively impact the users and do not allow for full understanding, integration, or use.

BIM can be used as a tool and implemented as a process, (Deutsch, 2011; Azhar, et.al., 2012) which impacts people on different levels on different scales, such as the architect, project team, internal organisation, profession, or industry. According to Azhar, BIM "can be viewed as a virtual process that encompasses all aspects, disciplines, and systems of a facility within a single, virtual model, allowing all team members (owners, architects, engineers, contractors, subcontractors and suppliers) to collaborate more accurately and efficiently than traditional processes." (Azhar, et.al., 2012). This is particularly important to understand while and after

implementing BIM and integrated design strategies as people from differing backgrounds and experiences transition differently. In addition, soft skills, like communication, collaboration, trust, and respect, are all still relevant and in fact, even more critical, to the design and coordination process (Deutsch, 2011). The successful use of BIM in AEC workflows challenges traditional project delivery systems, contractual relationships, and liability boundaries, in addition to requiring early involvement of project stakeholders. These are the changes that many professionals resist in fear of “losing” their clearly-defined aspects in a project to a more cohesive, belonging system.

While Crotty alludes to the standard of a “lingua franca,” a common language which is used by relevant technological systems to share information, (Crotty, 2016) people are not the same and typically do not have the same functional baseline. Understanding that the tool is only as effective as the data it’s fed is important to implementing successful BIM workflows. While a variety of standards have been put in place for the management and analysis of data, Zahiroddiny states that the key issue is “the industry’s focus [on] the use of digital engineering before establishing appropriate collaborative processes and ensuring minimum information required to support this process is identified, captured and communicated contractually.” (Zahiroddiny, et. al., 2016) BIM workflows have reduced time and costs and projects using BIM require smaller teams than those using the traditional method, (Deutsch, 2011) and integrated workflows between multiple teams are possible through the use of sharing data and simulations, but this becomes untrue if people and firms are not correctly acclimated to the changes in processes and practice. In addition, while this increased demand for resources has led to the creation of various databases, such as those for materials or climate information (which are heavily used in many BIM workflows), there is still a significant lack of performative data with which to adducately base analyses and design decisions. Life-cycle assessments and

post-occupancy evaluations are two effective methods of gaining this necessary information, but many designers and clients refuse to use them, citing liability and financial concerns. However, it is the sharing of resources and data which will allow for variations of BIM and computational work to be successful in impacting design and construction.

Technology use and implications have a broad range in current practices in the AEC industry. Qualitative and quantitative methods of creating/using BIM elements to respond to environmental constraints, and for allowing for data exchange between software to analyse relationships. (Aksamija et.al., 2011) Computational design tools are used to improve design practices and collaboration, as well as provide environmental simulations to test designs (and their data) in increasingly faster ways. (Aksamija et.al., 2011) According to Motawa and Carter, (2013) energy simulation tools and their sources (such as EnergyPlus or Ecotect) evaluation at a fairly in-depth level, taking into consideration building design features such as thermal insulation, climate response, glazing, shading, solar gain, solar penetration, air tightness, natural ventilation, mechanical ventilation HVAC systems, building dynamics and thermal mass, as well as environmental factors such as local weather data and utility rates. Information models are also necessary to provide a database of information about a building, including its geometry and attributes, in a comprehensive and changeable way; if simulated data of a model produces an unwanted outcome, the model can then be modified and reanalysed to address the concern. (Motawa and Carter, 2013) Additionally, building information modelling stores the necessary information contained in traditional building documents such as drawings, specifications, and construction details as well as additional 3D information and metadata in a centralized or distributed database. (Aksamija et.al., 2011) The goal of BIM is to provide a common area for sharing information that can be used by all users.

Currently, the key issue in using BIM for sustainable design is integration. As stated by Motawa and Carter, (2013) the “main problem of the current practices is about the integration between these packages to avoid multiple data entry and also about the consideration of the changes in building features over its life cycle, due to operation and maintenance activities.” BIM workflows are ideally designed to create connections between the data, where information collected (either found in a database or databases, or simulated through other software) can in turn relate directly to the 3D geometry and inform decisions about shape, placement, number, material, etc. Currently, these relationships are highly technical, some requiring their own computer language, Green Building XML, or gbXML. (Aksamija et.al., 2011) The relationship between parametric design (designing with rules, constraints, features, and association between elements) (Aksamija et.al., 2011) and sustainable architecture (architecture that responds positively to the environment through a variety of methods, such as using renewable materials, reducing energy or water usage, or creating daylight, positive-impact spaces) is still relatively new, but increasingly implemented in certain aspects of the design, such as the building envelope and the reduction of solar radiation. (Aksamija et.al., 2011) Strategies can be implemented in a variety of scales, from entire buildings to specific louver angles. Optimising important data workflows throughout design allows the engineers and designers to estimate the environmental performance and simulate alternatives as needed. (Maltese, et. al., 2017)

Another challenge to virtual communication in regard to BIM, CAD (Computer-Assisted Design), and LiDAR technologies is the lack of interoperability. (Anderson et al., 2017) This is less of an issue when it comes to virtual worlds for gaming, where massively multiplayer online role playing game (MMORPG) teams are able to communicate and coordinate with each other on a regular, real-time basis. (Anderson et al., 2017) Though virtual gaming worlds and the AEC industry still have a ways to go before the technology for accurate measurements and

professional appearances is found, more and more professionals also report that they often “collaborate” in these 3D virtual worlds for recreational purposes; videogames are not just for kids anymore. (Anderson et al., 2017) With more gamers entering the industry each year and the built environment continuously shifting to 3D technologies such as BIM, if virtual worlds can enhance collaboration potential and effectiveness (as we have begun to see with virtual reality coordination meetings), the AEC+ industry may be able to successfully implement this technology. (Anderson et al., 2017)

Different methods of simulation in sustainable, BIM-focused design yield different results, depending on parameters such as complexity, intent, and necessary setup for the simulation. (Aksamija et al., 2011) Recent developments in computational design tools are providing methods for improved design practices, including energy and thermal simulations, enhanced design representations, and improved collaboration. (Aksamija et al., 2011) BIM meets a variety of technological and design-based needs, particularly when it comes to the early coordination of a project and buy-in of project stakeholders. (Azhar et al., 2012) The schematic/conceptual design phase of a project is also the ideal time to introduce sustainable design methods and strategies, as well as get the client on board for optimising post-occupancy operations and management. (Azhar et al., 2012)

BIM Application	Owners	Designers	Constructors	Facility Managers
Visualization	x	x	x	x
Options analysis	x	x	x	
Sustainability analyses	x	x		
Quantity Survey		x	x	
Cost Estimation	x	x	x	
Site Logistics	x		x	
Phasing and 4D scheduling		x	x	
Constructability analysis		x	x	
Building performance analysis	x	x	x	x
Building management	x			x

Figure 06: BIM applications for project stakeholders. (Azhar et al., 2012)

Parametric design has some advantages over traditional modelling methods because they eliminate the need to “recreate” the model for every design change. (Aksamija et al., 2011) It allows for adaptation of objects and geometries with rules, data values, and constraints through the manipulation of object properties. (Aksamija et al., 2011) Parametric tools and an understanding of how they work allows for the design team to incorporate analytical data developed in response to environmental constraints into the model. (Aksamija et al., 2011) The research shows that the relationship between BIM technology and sustainable practice is a feedback loop; while the use of BIM arguably increased the possibility of sustainable practices at first, in time both now inform each other, with the current standard of practice based on the lessons learned from both workflows. BIM technology has already revolutionised standard practices in the AEC industry, and should continue to be a tool and process of innovative design solutions.

The “Green Building Triangle” (Lu, et. al., 2017) is a unique representation of the potential and overlap of the implementation aspects of BIM technologies, project processes, and environmental strategies. A proposed a BIM-workflow framework for analysing the relationship of high density buildings and both the embodied and operational carbon within yields a system which can be used to “design buildings which no longer impact the environment so heavily.” (Gan, et. al., 2018) Necessary components include a highly detailed BIM model and a method (typically a software or program) of quantifying and analysing the amount of carbon in various elements by comparing their material types and geometries, for example. (Gan, et. al., 2018)

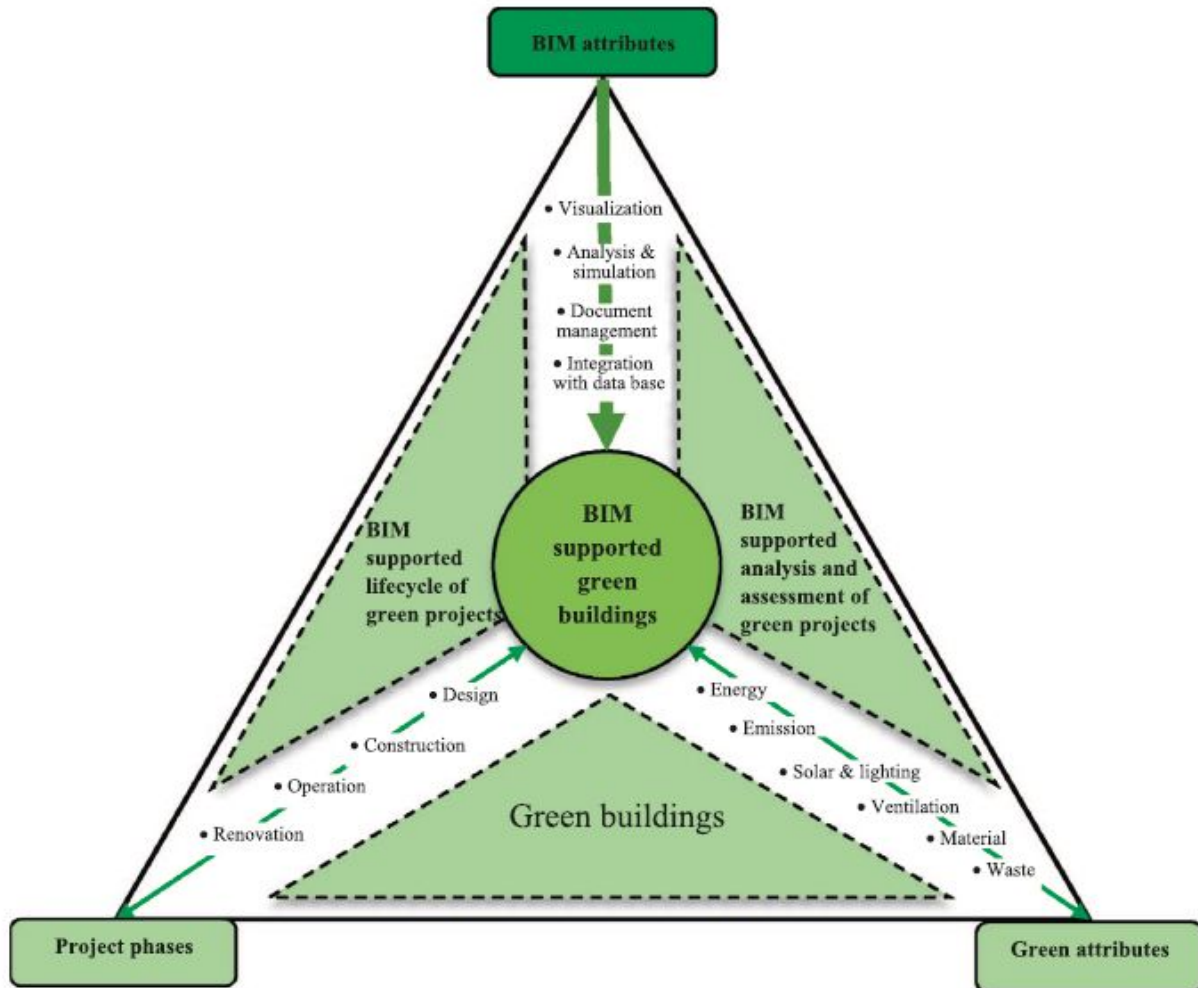


Figure 07: The “Green BIM Triangle” demonstrating how the relationship between BIM and “green” buildings works. (Lu et al., 2017)

In addition, a fairly accurate and effective way of simulating and recomputing design strategies (either overall or in parts) would be necessary in regards to implementing this into a design process. Currently, there is a “lack of consensus remains among researchers and practitioners regarding the applications of BIM for the development of green buildings;” even with high amounts of research into and use of BIM technology, the connection between it and sustainable design has yet to be deeply explored. (Lu, et. al., 2017) Rating systems and assessment tools are used fairly often in the US and Europe, but they are becoming more complex and varied due to the different users and needs for each kind of project/project level, resulting in confusion and

a need for a comprehensive standard. (Lu, et. al., 2017) Integrating complex variables and providing reliable results has become the main task for many BIM-focused workflows, as well as allowing multiple users to obtain the necessary information during various stages of the building process. (Maltese, et. al., 2017)

Most studies focus mainly on energy performance and carbon accounting in the building, particularly on how BIM workflows can highly influence the construction supply-chain. (Motawa and Carter, 2013) While BIM applications are used to monitor energy implications of the design, construction, and operations of a building, this is typically done in the beginning of the design process and ignored for post-occupancy, where the behaviour of buildings is best studied. (Motawa and Carter, 2013) In order to truly meet the industry requirements for sustainable buildings, these types of studies and processes must also occur after the project has been considered complete. “BIM applications produce more usable data and information for visualizations and simulations than the traditional and separate project application tools.” (Motawa and Carter, 2013) Using real, post-occupancy building data can help to overcome the “gap” between estimated energy performance through the use of BIM software and actual usage, since much of the data used in simulations is not exacting in its nature. (Motawa and Carter, 2013)

Computer energy models are used to make assumptions about hours of operation and patterns of use, not used as a prediction tool. (Keeler and Burke, 2009) Whole-building simulations are not necessarily predictions of the energy performance of a building but documentation of compliance with a given standard. (Keeler and Burke, 2009) In addition to compliance documentation, computer energy simulation is an excellent tool for evaluating and choosing among competing design alternatives. It is rarely intended as a precise prediction of energy performance once a building is occupied. (Keeler and Burke, 2009) Daylighting, building

orientation, and building envelope are some of the more significant strategies for reducing the amount of electricity used by a building. (Keeler and Burke, 2009) In order to create a truly sustainable community, [green technology] tools must be reformed and reshaped to ensure that the needs of people are balanced with the constraints of the natural environment. (Keeler and Burke, 2009)

## *2.6 Integration and Collaboration for Sustainable Practices*

“As a collective group, human beings can—and should—be the solution leaders for a sustainable environment... As owners, planners, designers, engineers, constructors, and managers of our physical built environment that sits on the Earth, why wouldn't we be the instigators to a sustainable future?”

- Holley Henderson, *Becoming a Green Building Professional* (2012)

Henderson (2012) states that within the green building profession, it is a well-integrated group of individuals (as opposed to separated “teams”) with varying backgrounds and experiences, who come together to “plan, design, erect, and maintain a building.” The roles and responsibilities are further broken up, with environmental consciousness and overall sustainable strategy falling to the land developers and realtors while architects design the framework, and interior spaces, engineers compose the systems, contractors focus on the proper installation of eco-conscious elements, and facility managers keep the building “green” after the construction is complete. (Henderson, 2012). Adding to this, the incorporation of new technologies that appeared in the 19th century and came to fruition in the 20th century have changed the way we designed, built, and planned. Along the way, these technologies and changes in society changed the role and self-image of the architect, from a tradesman to a professional. (Keeler and Burke, 2009) Later on, in the post-WWII period, architects gave up the responsibility for coordination and design of systems to mechanical and electrical engineers, believing that comfort was best provided by equipment rather than architectural design. Integrated,

climate-responsive design was difficult to achieve in this increasingly fragmented process of architects relying on outside technical consultants, particularly as separate disciplines formed with their own frameworks, beliefs, and languages. (Keeler and Burke, 2009) A business model that paid engineering consultants based on overall cost gave little incentive to the design team to reduce the use of energy-intensive technical solutions, which in part leads to the current energy and envelope issues designers face today. (Keeler and Burke, 2009) Integration of all of the building information from all components is necessary in order to create a detailed and useful BIM environment, which can be used to “spatially orientate necessary information/knowledge.” (Motawa and Carter, 2013) This in turn helps with communication of different energy performances across different levels of the building and building process; for example, coordinating materials from suppliers with designers and contractors. “The green building materials management system was framed based on BIM, combining with life cycle assessment theory, and at last safety monitoring management system with RFID and BIM of construction site was built.” (Wang and Wang, 2015) In addition to the previously mentioned strategies, other options can contribute to sustainable design without implicitly needing simulation. Materials selection and management is instrumental in designing, constructing, and operating sustainable and healthy buildings, which is typically a strong goal of environmentally-conscious building. Life cycle management ensures that materials chosen are not contradictory to the objectives of the project. In addition, managing materials in this fashion allows for a broader understanding of production, application, and compliance, something which was difficult before as most suppliers and manufacturers had various management systems in place. (Wang and Wang, 2015) BIM technology uses material management as a way to increase the collaboration between all players in the industry and to increase “traceability,”

(Wang and Wang, 2015) or the documentation of necessary information for construction, operation, and maintenance.

Keeler and Burke argue that integrated building design is the practice of designing sustainably; that green design and integrated building design should be thought of as equivalent terms. (Keeler and Burke, 2009) An integrated building is a green building; integrated design means that energy, resources, and environmental quality factored strongly into design decisions, especially since design variables need to be seen in a unified whole and as "problem-solving tools". There are implications to every design decision, and the process works because the communication among team members and because each team designer has a thorough understanding of... challenges and responsibilities. (Keeler and Burke, 2009) Integrated design processes require an understanding of the interrelationships of materials, systems, and spatial elements, as well as scope of the project, environmental impacts, team responsibilities and role definitions, issues of site and community, interrelated impacts of proposed solutions, priorities/goals, methodology and tools (for energy - simulation tools considering energy performance; tools for water and resource management, treatment, landscaping and stormwater management, building materials; and tools for indoor air quality (source control of materials, ventilation control of fresh/exhaust air, IAQ commissioning for management, and building maintenance). (Keeler and Burke, 2009) "[Green] building rating systems and other practice tools are necessary as part of a building project's integrated design process. "Rating, labelling, and certification systems provide a scale for measuring a building's incorporation of green building strategies as compared with more conventional, mainstream buildings." (Keeler and Burke, 2009)

Another strategy related to the green building rating systems is the ecosystem services approach. An ecosystem services approach helps us understand the consequences of

landscape changes for ecological, social, and economic conditions. This not only helps us shape more resilient, healthy, and sustainable cities, but by framing the interaction of ecological, social, and economic systems within a human value context, it also helps answer the important question of why we need or should want these outcomes." (Cowan, et. al., 2014) The language of ecosystem services has been critical in linking ecology and economics, but can be confusing to architects, engineers, planners, and others who have their own terminologies and ways of talking about the interaction of the built environment and living systems. Ecosystem services can be difficult to conceptualize at the individual building scale and are likely to become clearer and more effective when applied at the neighborhood or EcoDistrict scale. Ecosystem services models need to be extended to effectively link together natural components with hybrid bio-technical components and purely technical components, and should be a "two-way" model, meaning that information feeds both ways. (Cowan, et. al., 2014) This is especially true with the possibility of developed areas as regenerative contributors to other ecosystems rather than undifferentiated "urban zones" with zero ecological productivity. The Bullitt Center relied on an Integrated Design Process, and in order to address the potential benefits, the Bullitt Center Assessment Team (BCAT) was formed in 2012. The BCAT team originally included Ecotrust, Autopoiesis LLC, and Parametrix - all three organizations possessed deep expertise in the intersection of the built environment and ecosystem services. Parametrix was replaced by EcoMetrix Solutions Group in 2014, and together the team employed a wide range of research methods, including interdisciplinary charrettes, interviews, analysis of documents and narratives, a literature review of urban ecosystem services, and an application of the methods of ecological economics. (Cowan, et. al., 2014) Based on the case study of the Bullitt Center, this report recommend next steps to evaluate and assess social and environmental benefits (and costs) of green buildings, encourage other green buildings and EcoDistricts, work on communication

strategies with the architecture, engineering, planning, landscape architecture disciplines; and aide communities in creating a dialogue between the services, terminologies, and frameworks. In addition, developing a more comprehensive way of linking ecology and economics (ecosystem services) and design (ecological design, biomimicry, etc) into a larger and more comprehensive approach (such as regenerative economics), particularly in terms of modelling tools, so they can operate effectively. (Cowan, et. al., 2014)

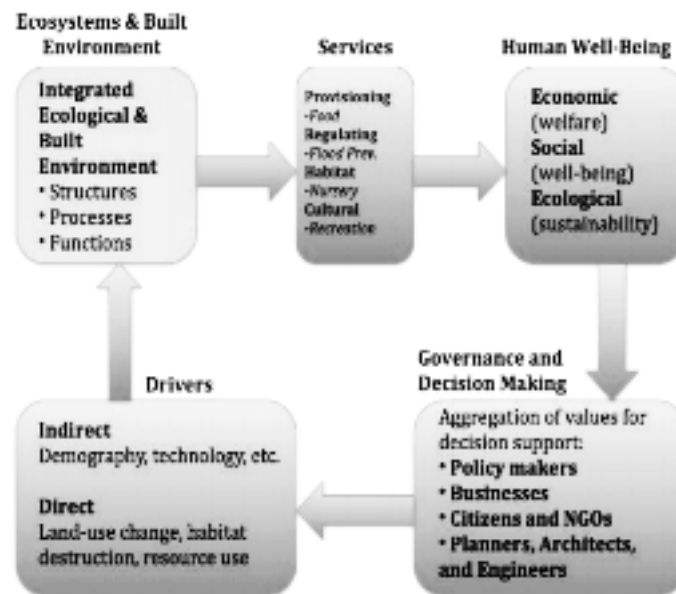


Figure 08: The box labelled “Ecosystems & Built Environment” emphasises the decision making role of planners, architects, engineers, and allied professionals. (Cowan, et. al., 2014)

Part of the education element of the Living Building Challenge relates to the idea of developing policy and market transformation initiatives that provide better supply chain visibility and support regional level coordination between general contractors, as well as conduct more detailed carbon storage studies and related ecosystem services. (Cowan, et. al., 2014) By expanding the understanding of ecosystem services to incorporate learning from other disciplines, the thought process involving urban ecosystem services can be greatly enhanced. In order for the economy to function both effectively and ecologically, the contradictions between governing and commercial interests must be reconciled. There is a need for a

consensus-based, collaborative approach that both regulation and commerce can support. (Hawken, 1992, 2010) Strategies for this include good design (which changes the least number of elements to achieve the greatest result and removes stress from a system rather than adding it). (Hawken, 1992, 2010) Hawken argues that issues are converging - one cannot address social issues without environmental justice, nor can they cannot imagine a prosperous world without a stable climate. (Hawken, 1992, 2010)

The Design Space Construction (DSC) framework synthesizes definitions of the relevant concepts and processes involved in the construction of a design space to support performance-based decision-making. When they tested and compared the DSC framework, the researchers at Perkins and Will asked 16 professional and student computational designers in a workshop at a major international computational design conference to help evaluate how well their firms and university curriculum constructed and explored design spaces. They spent three days teaching the framework and helping them apply it to a similar façade panel case study. They were then asked to evaluate how they felt the framework would help their teams better explore design spaces. Overall, both students and professionals felt that the DSC framework provided a good method for academia and practice. (Haymaker et. al, 2018)

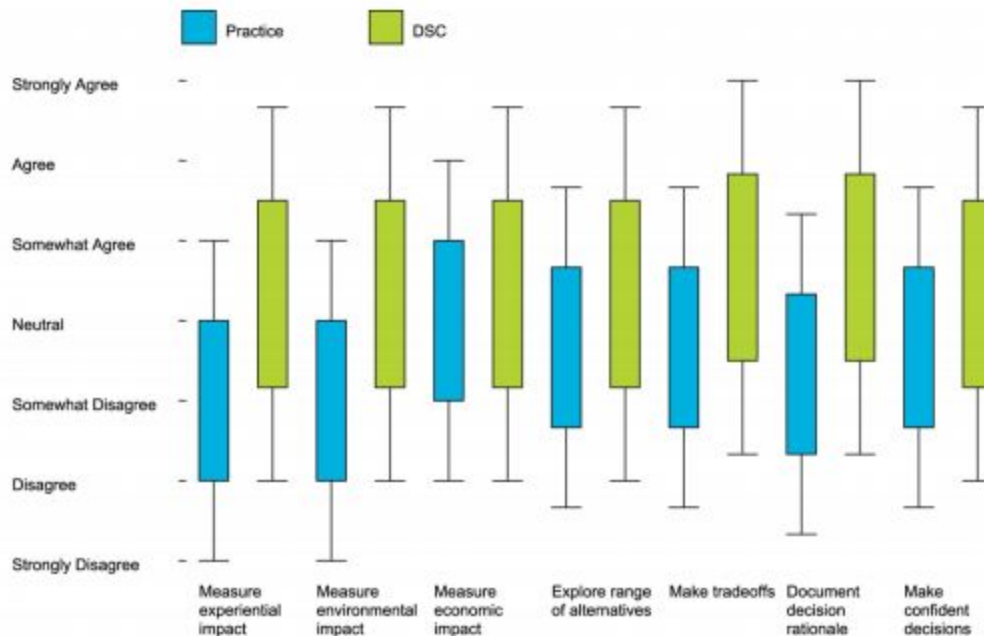


Figure 09: A chart showing the influence of the DSC framework on current practice. (Haymaker et. al, 2018)

The overall issue is that decision-making in practice is a complex process that requires the appropriate input of many stakeholders and experts, as well as the gathering, analysis, and synthesis of the rationale. With standard project deadlines and budgets, design decisions are typically poorly defined, constructed, and explored, and value is not maximised. Many design decisions are based on speculations and assumptions derived from professional experience rather than exhaustive, specific, or pertinent analyses. (Haymaker et. al, 2018) With new parametric and performance-based design tools that aim to allow for better exploration of design spaces, there are faster feedback rates from their initial intuitions. However, to effectively apply these methods in practice, design teams require a unified framework of concepts, processes, and tools to guide them in collaboratively constructing and exploring design spaces, as well as individuals (“experts” or “specialists”) who can efficiently navigate the process. (Haymaker et. al, 2018) A framework with potential, called Design Thinking, consists of concepts that help teams through iterative phases of inspiration, ideation, and implementation, with several sub processes

for guidance. The issue with these methods is that they are focused on creative problem formulation and solving and lack a *computational focus* which implements computational processes to support these phases. Model-based systems engineering is another framework for designing, documenting and implementing systems; however, MBSE frameworks are comprehensive for designing and detailing in great complexity and do not focus specifically on the exploration or construction of these design spaces. (Haymaker et. al, 2018) The questions asked by the Perkins and Will Research Lab was "what is a framework that can enable AEC design teams to leverage parametric design technologies to construct and explore design spaces? What are the impacts?" (Haymaker et. al, 2018) Through iterative development and validation through its application in professional projects and university classes, the Design Space Construction (DSC) framework was formed. It is based in design and decision theory to guide project teams through the process of formulating a problem (Objective), generating alternatives (Alternative), analyse the impacts (Impact), and weigh priorities/communicate decisions (Value). (Haymaker et. al, 2018) Problem formulation assembles the relevant organization, and establishes the objectives. A decision requires a variety of expertise and multiple participants in the decision-making process. Four major roles are identified; stakeholders (people affected by the decision), gatekeepers (define constraints), designers (generate alternatives and measure impacts), and decision makers (appoint stakeholders and designers and then weigh value to make decisions). The interaction among these participants are vital in setting the specific targets for a project, either a desirable goal or a mandatory constraint. Goals, which are defined by stakeholders, are the specific experiential, ecological, or economic targets. Constraints, defined by gatekeepers, represent the admissible limit of an input variable or outcome and must be satisfied for an alternative to be viable. Decision-makers can sort defined objectives by order of importance, from most significant to least, and help to

gather preferences. Ideally, a set of design alternatives are ranked and then explored as potential solutions. Designers generate alternatives by changing the parameters, or the options of variables, of the geometry and/or the attributes. Then, the impacts, which are the amount of influence the combined options of an alternative have on the performance of each experiential, ecological, and economic objective, are assessed after normalisation. Lastly, the value is composed of a synthesis of alternative impacts and stakeholder preferences into an objective function that sorts the alternatives from highest to lowest value(s). Different alternatives have different values. Value in this framework is broadly defined to abridge both multi-attribute utility and economic objective functions. The formulation of a value function is usually an iterative process of varying the exploration as decision makers, stakeholders, and designers learn more about the design space and their preferences. (Haymaker et. al, 2018)

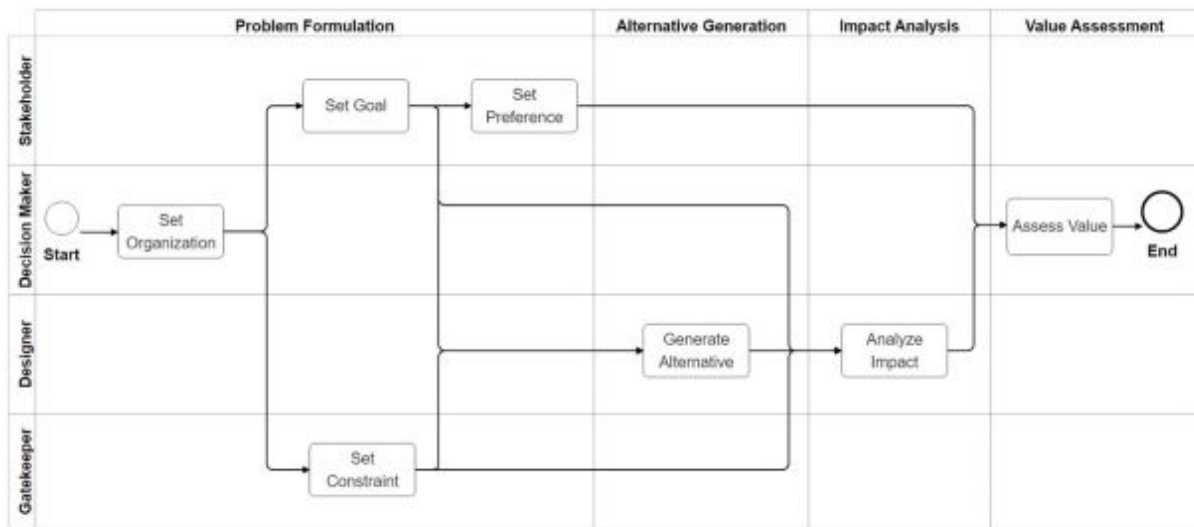


Figure 10: A diagram of the DSC framework and how it relates to the four stages and assigned roles. (Haymaker et. al, 2018)

All performance-based design teams construct and explore design spaces. Previous efforts by the Research Lab attempted to conceptualise a multi-criteria design and optimization framework with integrated problem formulation, alternative generation, impact analysis, and value assessment into design systems. However, these efforts lacked a pre-defined framework

with parametric potential for concepts, processes, and tools that enabled a design team to construct and explore a new design space efficiently and effectively. However, design teams today typically use processes and tools that do not clearly define performance metrics, alternative spaces, performance data, and decision rationale. Such unsystematic design processes lead to inefficient design exploration and loss of value. (Haymaker et. al, 2018) The synthesis of a conceptual framework with a computational infrastructure based on a systems integration approach (that can selectively upload and share data across systems) is ideal in helping teams organise and iterate the goals of a project. In addition to and exploration of different value functions enable design teams to *improve the overall value* by actively choosing, not assuming, better options. Possible performance values for sustainably-minded projects could consist of energy consumption, daylight, view quality, first costs, utility cost, life-cycle cost, or CO2 emissions. (Haymaker et. al, 2018)

In order to construct, explore, and communicate design spaces, design teams need to learn how to work together and adopt new tools and methods. Specifically, project teams need to be able to implement and practice the collaborative and iterative processes of the DSC approach, particularly when it comes to the integrated computational workflow for each of the key steps. The framework provides the ideas and processes to enable a clearer and more systematic modeling of the decision-making process than current practice, but still more systematic and iterative problem formulation are possible as this framework can be improved by stakeholder engagement, preference feedback, and design space reduction to reach an efficient definition and exploration. The workflow implementation relies on the integration of parametric modelling and analysis in preliminary conceptual design stages in order to provide consistent geometric representation and performance indicators early in the project definition phase for a large possibility and potential of alternatives. (Haymaker et. al, 2018) Stakeholders are involved

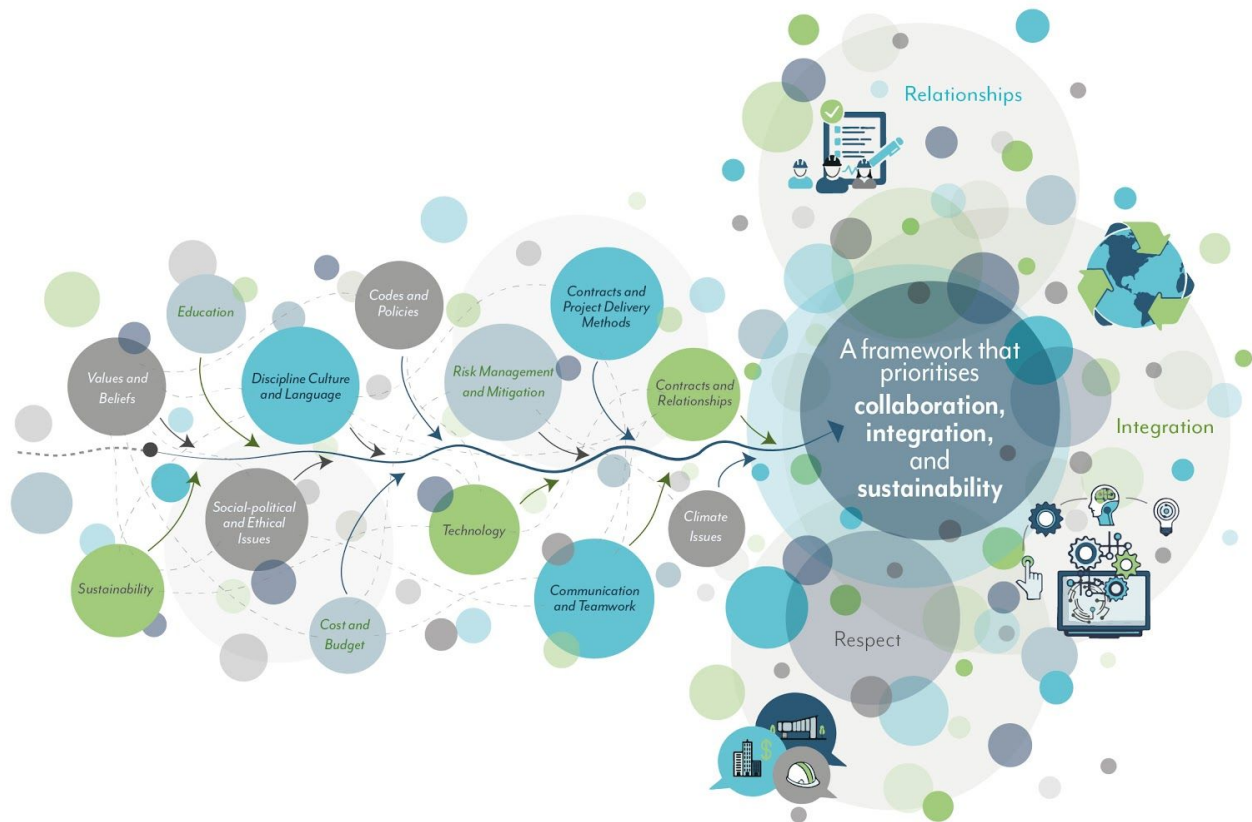
in the decision-making process by iteratively defining preferences, identifying key variables, and determining the overall idea of value. These strategies provide a necessary element in the integration of requirements into the design process. Systematically leveraging computational and analytical technologies into practice to address these ever-changing requirements means that future work can improve the efficiency of generating designs and derivation of analytical input models for different analysis. The exploratory space of the design alternatives can be quickly generated and analysed using statistical optimisation methods. Growing tools of computational infrastructure allow the analysis aspects to integrate other indicators such as cost, payback, spatial or structural analysis, security, or life cycle of the buildings faster than conventional research. This process looks to the future development of strategies to improve accuracy, range, and options of the variables to more efficiently and effectively define, explore, and design spaces with the goal of the highest value. (Haymaker et. al, 2018)

## **Chapter 03: Theoretical Framework**

### *3.1 Summary*

To begin to organise such a complex and deeply embedded topic, the theoretical framework of this study focused on identifying the key topics which were interrelated to the argument presented. I proposed a diagrammatic theoretical structure, aiming to show that the integration and understanding of these theories is a way of achieving a collaborative model for firms and project teams. This diagram does not show the ever-changing “value,” or “weight,” a given focus has because it differs for each person, but begins to suggest a loose idea for pushing our practices to higher levels - not by eradicating the economic value of something, but by enhancing or balancing it with the value of others. If an integrated, collaborative model was needed to implement sustainable strategies in the practices of the built environment, what

factors could help or hinder this process? Composing this framework also aided in the process of sorting information, composing questions, and analysing the weight of particular elements in the study.



*Figure 11: A theoretical framework diagram demonstrating the various “buckets” of topics that tie to this study.*

In combining the diagram above with the research from the literature review, this becomes the baseline for the thesis. There are several significant theories at play that define this thesis; first, that values and beliefs (both personal and professional) impact the decision making process of projects in the built environment. Second, the idea of sustainability has morphed to include various social, economic, and environmental aspects, and that the decision-making process now focuses on weighing competing values of one aspect to another. This includes choices of all scales and weight, and a clear decision-making process is crucial to making effective

choices. Third, in order to implement long-term and successful sustainable strategies, technologies, and practices in design, construction, and management of buildings, the contractual relationships and project delivery methods need to shift to reprioritise, or “value,” integration and collaboration. Currently, research suggests that typical structures and processes are heavily influenced by risk mitigation, insurance/liability issues, and schedule and budget constraints without consideration to how collaborative processes, particularly ones that share the risk as opposed to forcing it to one party, might shift these elements to be more favourable overall. This thesis takes the basics of these theories and analyses them collectively to form an integrated theoretical framework, outlining the interrelationships and their significance as they serve as the foundation for finding new methods of collaboration and green building.

## **Chapter 04: Methodology of Research**

### *4.1 Systems of Inquiry*

To compare and contrast how values in the built environment manifest in practice, this study undertakes the assumption that the current values in the building industry disproportionately prioritise a conservative approach to design and construction and proposes a series of semi-structured interviews of key professionals in the AEC+ (defined as architecture, engineering, construction, *plus* other important parties) industry. The questions serve as a baseline to start from, comparing a particular project or projects of the interviewee’s choosing and the practices of both the individual and the project team. They then progress to bigger picture questions about sustainability and decision-making as a firm or discipline and how one might influence the other. The projects were required to be within the region and built within the last 15 years. A variety of individuals from different backgrounds were selected to obtain a

variety of perspectives; this approach ideally suggests a more “well-rounded” understanding of the current situation in the built environment.

#### *4.2 Research Strategies*

The goal of the data collection is to analyse the relationship between current values, delivery methods, and green building technologies to address the underlying intent in our processes and practices and present a new idea of a collaboration model or conceptual framework. Potential interviewees considered are architects and interior designers, contractors/builders, engineers (including consultants of energy, lighting, and systems), academia (professors, researchers, etc), urban planners and policy-makers, and developers and owners. Other methods to collect data will include both analytical strategies, such as quantifiable surveys or case study reports, and more experiential data, such as observations or lectures. The interviews, with questions and topics composed by me based on the previous framework and research, as well as observations of workflows and methods in practice, will be of particular use in understanding how to produce a framework relevant to today’s industry and current problems. These studies will most likely need to be repeated with a variety of people in order to obtain relevant results, which may be challenging given the current issues at hand. In addition, the existing data in the form of precedents and existing case studies may potentially be helpful when compiling and analysing data collected through my own work. Even with the best settings, there are potential issues with the kinds of proposed data collection methods. Project teams may change unexpectedly or may be hesitant to be observed, simulated data may not be accurate or set up correctly, and interview questions may not necessarily address the full scope of an issue or its underlying components. Additionally, coordinating schedules with busy professionals is a key element of getting the best feedback from the right professionals. These

obstacles will hopefully be addressed as needed, but overall the proposed methodology seems best suited to yield the best results of the study. Success will be determined as having relevant data with which to proceed to the next element of analysis.

Qualitative attitudinal data is the primary data type collected during the semi-structured interviews. The resulting thematic analysis suggests the key takeaways of this portion of the study and provides a unique understanding of the situation as a whole.

<b>Sample Interview Questions:</b>	
1)	What is a project located in or around Seattle that worked well in terms of process and collaboration?
2)	What was the legal structure, contractual relationship, or project delivery method?
3)	Did this have an impact on the success of the project?
4)	Were there any significant aspects that didn't work well for this project? Any challenges or problems?
5)	Would you consider this your preferred method for collaboration and delivery of projects?
6)	Have you experienced other challenges involved with this particular process?
7)	Was there any integration technology used?
8)	What were some of the benefits of this technology? Some of the issues?
9)	Was this project specified as a "sustainable" project, through design intent or rating system certification?
10)	How did you handle decision-making in regards to those requirements?
11)	Does the process or processes you've described lend itself to producing high-level sustainable projects?
12)	In your experience, is sustainability a core value at your company? In your discipline? How is it expressed?
13)	What, if anything, would you do differently, knowing what you know now?

## Chapter 05: Presentation of Data

### 5.1 Data Management

The participants of the study were voluntary participants who agreed to share their experiences and knowledge. Data was collected through semi-structured interviews and was anonymised by the author. The participants either have worked or are working as a practicing professional or research in or around Seattle, Washington. The collected data involved the opinions, experiences, and beliefs of the participants as it pertained to the questions in the previous chapter as well as their opinions, experiences, and beliefs regarding the topic as it was presented. When asked to summarise the thesis topic, this statement was given:

“To compare and contrast how values in the built environment manifest in practice through the study of (a) particular project(s). The assumption of this study is that the current values in the building industry disproportionately prioritise a conservative approach to design and construction. To better understand the current practices and the existing potential to suggest a new approach to collaboration, I am conducting a series of interviews of key professionals and researchers in the AEC industry. Today I am going to ask several questions which will help me focus on the particular workflows currently used on projects in Seattle.”

The collected data was organised, anonymised, sorted, coded, and transcribed by the author using a qualitative analysis tool called Dedoose. This tool is a web application for managing, analyzing, and presenting qualitative and mixed method research data.<sup>1</sup> The data was then processed and sorted based on “codes,” or common themes, such as “collaboration” or “sustainable rating systems,” and key ideas or takeaways were noted. Once this process was complete, the information was sorted by theme and revised for clarity. The result is presented in Chapter 06.

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<sup>1</sup> Dedoose Version 8.3.17. SocioCultural Research Consultants, LLC. 2016.

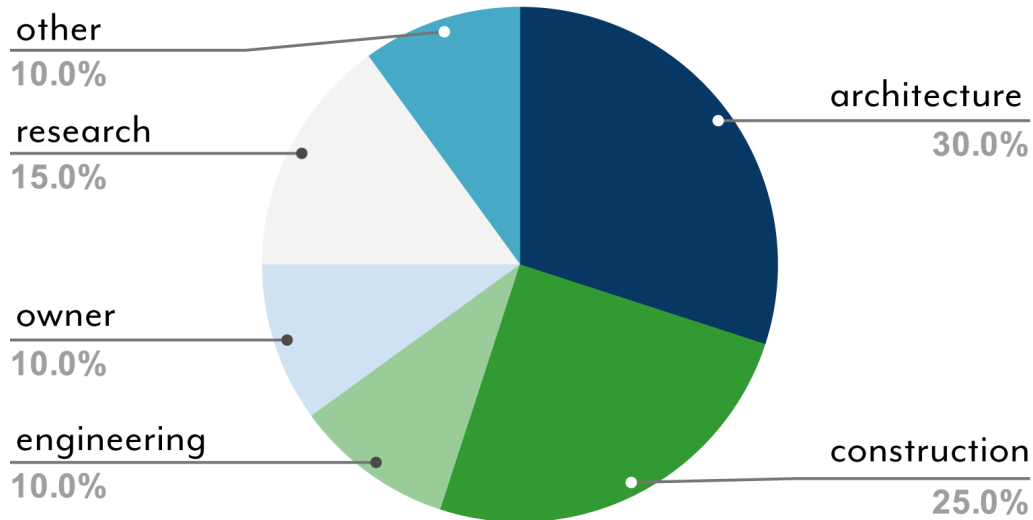


Figure 12: Interviewee breakdown by industry.

The participants were randomly assigned “identifiers” which were used to correctly connect the gathered data to the interviewee as well as identify projects. For example, P05 described their experience with Project 5a, Project 5b, and Project 5c. These identifiers have no connection to any identifiable information gathered from the interviews.

Identifier	Description
P01	Architect with leadership role at architecture firm focused on sustainable design
P02	Technology manager at a construction company
P03	Organisation manager within education-based owner
P04	Sustainability consultant with construction law background
P05	Senior manager at a construction company
P06	Design partner at an architecture firm
P07	Project manager at construction company
P08	Manager and leader at an architecture firm
P09	Researcher with professional industry experience
P10	Researcher with professional industry experience
P11	Practicing architect
P12	Organisation manager within education-based owner
P13	AEC law professional
P14	Practicing architect

An individual’s training, background, and professional experience can and does influence their values. These unavoidable biases should be recognised as they not only impact the results of the research here but relate to the broader subject of discipline culture, language, and values. It is also important to note that these biases are not inherently a negative thing and may actually help when it comes to maintaining balance in a project team.

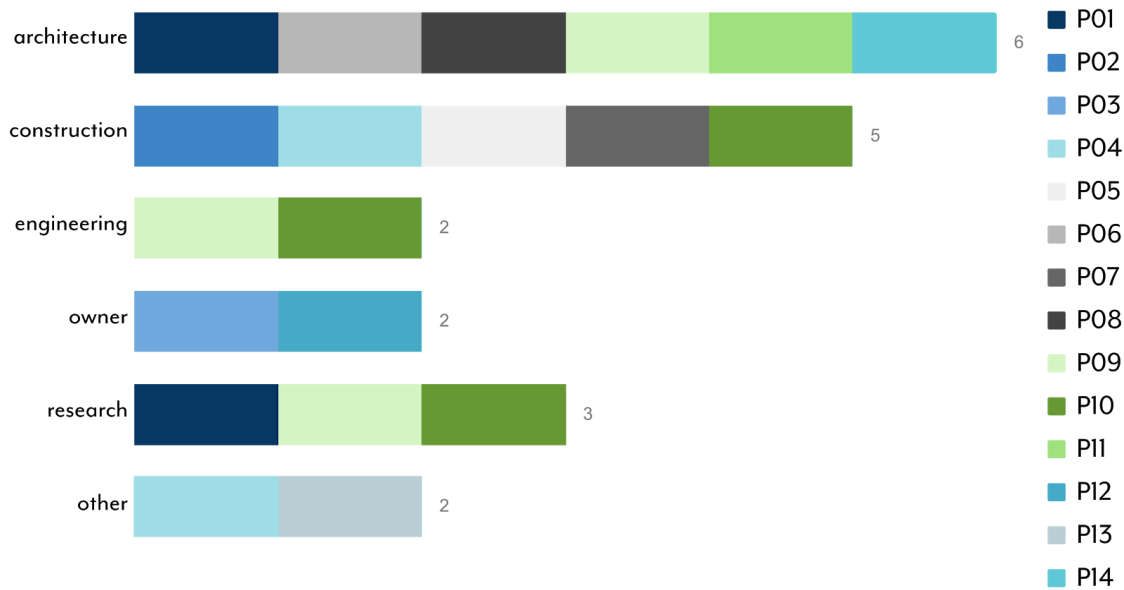


Figure 13: Interviewee backgrounds. It is important to note that the total number of backgrounds is larger than the number of interviewees - this is due to the fact that several participants had multi-disciplinary backgrounds and education.

### 5.2 Case Study: The Hans Rosling Center for Population Health

The Hans Rosling Center for Population Health is a 300,000 sq. ft. hybrid facility designed in response to the University of Washington’s Population Health Initiative, which focuses on the most significant challenges affecting global human health, environmental resilience, and socio-economic equity. This project followed a “progressive” design-build contract, where the owner hired the contractor/architect team as opposed to hiring one over the other. During the interview process, the team was able to work together on project goals and expectations, which allowed for the team to be on great terms with each other before the project

started. According to a member of the project team, the process is not perfect and there is a good deal of trust in it, but this project delivery method allows the team to award the project better, be more cost effective overall, and manage risk better since all of the contracts funnel through one main one between the contractor and owner. This contract method also allows the team to incorporate the risk/reward system of a typical Integrated Project Delivery process and focuses on problem-solving and accountability, something that is challenging or impossible with the typical project delivery methods employed today. Many of the positive aspects of this project are a direct result of the team(s) being able to work together collaboratively from the beginning of the project.

When it came to sustainability, the project team, after research and discussion, chose two green rating systems which matched the values of the project, LEED Gold and FitWel. These values were defined as sustainable goals at the beginning of the project, and included “promoting active lifestyles that reduce our negative environmental impact through bike racks and showers, accessible, restorative garden space, and creating inviting/appealing staircases that serve all floors; making use of natural resources through natural landscapes, harvesting rainwater, reducing water and energy demands, and implement renewable energy on site; and protecting the health and well-being of occupants and communities through materials, biophilic access, abundant daylight access, and healthier onsite choices for food and drink.” Another goal focused on pushing industry change through material transparency, measuring embodied carbon, and using an integrative process for the delivery method to provide high-level choices and solutions. These goals were manifested through the collaborative design strategies, which focused on user collaboration and connectivity while appropriately engaging with both its users and the campus at large. Others included variable 3-foot-deep vertical glass fins to reduce heat gain and glare and maximise daylighting, and this system was only successful because of the

collaborative environment that included the design team, window system manufacturers, and facilities managers early on.



*Figure 14: Architect's rendering of the exterior of the building, demonstrating the iconic fins which are possible because of the collaborative processes of the progressive design-build methods.<sup>2</sup>*

When one party is chosen first over the other, there isn't time to share and come up with agreed-upon goals. Having early involvement of the design team, general contractor, and trade partners when designing and problem solving certain elements is crucial to the success of the project, and really is only possible through contractual relationships that support it. UW is able to utilise the progressive design-build model through the alternative delivery methods by the State of Washington because it follows the requirements that the hiring process is open, but it is a challenge because integrated projects need 3 party contracts, whereas the law only allows 2.

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<sup>2</sup> Miller Hull. "The Hans Rosling Center for Population Health."

In terms of collaboration, the team utilised “wall-to-wall Wednesdays,” which were productive working meetings with various team members. These sessions included setting agendas, pull planning exercises, and checking in on progress and action items. Technology also was crucial in making this a successful collaborative process. Implementing BIM and a sharing platform, the team was able to create a “federated” model that everyone can work in to manage and coordinate various elements of the design. Project team members stated that these systems were easier to navigate than the traditional linear approval systems that use RFIs (Requests for Information) and long processes to get solutions to problems. Additionally, members of the facilities teams can use the model with all of the assets and linked information to track, manage, and prevent maintenance issues within these projects.

The decision-making and governance model implemented in this project used a structure based on one called “A Framework for Making Ethical Decisions”<sup>3</sup> by Sheila Bonde and Paul Firenz. This framework includes a responsible party, executive committee, project management teams, and project working teams. Each level has a varied representation of groups, including finances, facilities, and expertise. Most decisions were made at the project working team level, with very few decisions needing to go to the executive committee. Multiple project team members stated that because the decision-making mechanism was understood by all parties and based on the project goals, that saved time with regard to decisions and responsibilities.

### *5.3 Research Topic*

Collaboration is an essential component in successful projects. Communication about goals, values, and definitions are necessary for successful integration. Interdisciplinary teams are able to identify areas of risk and challenge and take better steps to mitigate them.

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<sup>3</sup> Sheila Bonde and Paul Firenz, “A Framework for Making Ethical Decisions,” May 2013.

Collaborative teams are better equipped to solve complex problems, particularly in regard to new tools and technologies in regard to sustainability. If the notion that sustainable projects are inherently “risky” from an economic standpoint is true, but sustainable practices are valued by many people and industries, then integrated teams for sustainable projects help make these projects a reality.

As mentioned before, the theoretical framework helps to visualize the interrelationships between the topics. The questions and interviews are how the data could be connected and the resulting overlaps analysed. This process begins to show the weight of certain values for specific individuals, which can be used to loosely draw conclusions. These values tie to the factors for implementing an integrated, collaborative model and sustainable strategies in the practices of the built environment, and they also start to demonstrate the complexity of the problem. The “value” of this research is tied to the fact that this is a very current and relevant problem in the AEC+ industry and it affects all levels, from owners with funding to tradespeople installing the systems, and the emphasis of the study is that the changes do not inherently begin with new technologies or shiny designs - they begin with people and their values and the industry shifting the weight it has now for the economical value to an equitable distribution between the economic, environmental, and equity values.

## **Chapter 06: Analysis and Interpretation**

### *6.1 Baseline Studies*

In order to inform a framework that could be implemented now or in the near future in Seattle, Washington (and potentially elsewhere, but the focus of this study is Seattle), both the literary research and the semi-structured interviews focused on the research topic mentioned above. Using the literature review and the theoretical framework as a starting point for the

interview data analysis, the baseline for the thesis product could be formed. Part of this baseline came from the case study in 5.2, where the team came together to collectively agree on expectations and collaboration strategies before the project began as a way of pursuing the project. With this information in mind, the data analysis from the semi-structured interviews focused on the collaboration methods and contractual relationships within project teams, though it did not exclude the other relevant factors.

## *6.2 Attitudinal and Behavioural Analysis*

The data collected for this study consisted of attitudinal and behavioural data. This data is important when analysing the activities/behaviours/values of the key participants as well as the discipline cultures involved.

### 6.2.1 Values, Decisions, and Language

#### *6.2.1.1 Discipline culture and language*

In their work, Mazumdar and Mazumdar (1994) refer to cultural values and the different ways people of different cultures relate to the space around them. Here, this idea is not only applied to the standard idea of “different cultures” but also to the different disciplines within the built environment, including but not limited to research and academia, the real estate/owner/developer component, the architectural and design realms, and the construction industry. In the conversation with the interviewee identified as P10, they point out the research they have done on the “very different disciplinary languages and expectations for languages” as well as tying the importance of language to the nature of collaboration.<sup>4</sup> Members of different disciplines may have different meanings for the same word, with some notable examples being

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<sup>4</sup> Anonymous, Interview with researcher with professional industry experience by author, April 22, 2020.

“green building,” “design,” and “sustainability.” Moreover, these words are not isolated to the practicing design and builder professionals in the AEC industry - these words are used globally and have many interpretations depending on context. This is why, argued the interviewee identified as P04, it is so important to define your values and terms. They referred to the Southern Builders v. Shaw Development case where the involved parties did not protect themselves from legal issues by clearly stating all parties’ understanding of the green building certification process and expectations.<sup>5</sup> Using ambiguous terms in this industry often has unintended consequences, including increasing risk of litigation and making it challenging to capture all the ideas, goals, and concepts that go into a specific party’s expectations.<sup>6</sup> P04 also states that there is a lack of a common language within the industry and this is a significant problem; not only does this make successful interdisciplinary collaboration difficult, it creates additional potential for conflict and misunderstandings. People, including professionals, bring their own personal experiences and assumptions to those words, and when we stick those words into design goals or legislation, that has a bigger impact than we might know.

#### *6.2.1.2 Values*

The world is moving more towards the idea that people and their values are looked at, according to the interviewee identified as P02. In this world, groups and companies are valued for how they treat people and the environment, and groups of companies have high ethical standards, encouraging social equity to be viewed as a bigger, more significant influence in design and construction.<sup>7</sup> Owners and projects shift from a reactive mindset, no longer focused on not doing the wrong things, but shift to a proactive mindset where doing the right things is a

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<sup>5</sup> Kaplow, Stuart. “Southern Builders v. Shaw Development: Green Building Damages.” August 13, 2015.

<sup>6</sup> Anonymous, Interview with sustainability consultant with construction law background by author, April 23, 2020.

<sup>7</sup> Anonymous, Interview with technology manager at a construction company by author, April 06, 2020.

choice. P02 states that they see a yearning for (design and construction) companies to do the right thing and not wait for the owners to pay them for it, however, because design firms and builders are typically seen as "a representative of the owner's values," incorporating this from a firm standpoint is a challenge. A firm may need to set higher fees to implement better practices and still have a thriving business, but this is exactly what other sustainably responsible companies do around the world - they "put their bottom dollar aside to actually try to make a difference."<sup>8</sup> P02 speculates that these companies seem to do what they do not out of a strict economic gain because they thought it was the right thing to do. If government buildings can have a percentage of the budget set aside for the arts, why not implement a similar strategy for sustainable issues such as climate change, social justice, or affordable housing?<sup>9</sup> P04 also spoke to a specific example where the values of a designer (an architectural firm dedicated to excluding Red List materials, for example) meet the ethical requirements of a licensed architect - in terms of the responsibility to resilience and human health, specifying healthy materials should be the logical choice. However, in most cases, it isn't.

An important consideration when it comes to the AEC industry and values are the plans and actions taken on initiatives. In one firm, the interviewee identified as P14 describes the process in place for establishing goals and business practices:

"[We] organize leaders [of] our discipline-specific role titles into forums. We have [a number of] forums between practice-specific lenses and sector-specific lenses. Sectors represent our client-specific markets and practice is where topics that cross all sectors live, like sustainability. The forums are responsible for crafting the business plan year over year, which is how we secure funding for extremely targeted goals. It's important for practice forums to be synchronized with sector forums as the sectors represent the money-generating forums. Practice forums do not generate revenue, and therefore must link in to sector-specific goals if we want to ensure funding is captured for our goals."<sup>10</sup>

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<sup>8</sup> Anonymous, Interview with technology manager. April 06, 2020.

<sup>9</sup> Anonymous, Interview with technology manager. April 06, 2020.

<sup>10</sup> Anonymous. E-mail message to author, May 19, 2020.

P14 also mentions that to them design and sustainability are the same. “It takes design minds to solve sustainability in a way that’s approachable for the client to understand – the same can be said for code or other regulatory constraints / affordances.”<sup>11</sup> This firm is not the first, and certainly not the last, of allowing and encouraging of personal values fostering a grassroots campaign in favor of altering the business plan and direction of the firm as a whole. Employee goals, values, and key projects all support the firm’s message and intention, and companies that are employee-centric or employee-owned appear more likely to support the initiatives shown by their professionals. This example demonstrates the impact of values on decision-making, the key component of defining, designing, managing, building, and operating a project in the built environment.

#### *6.2.1.3 Decision-Making*

Decision-making processes vary from person to person, project to project, and company to company. The main component of decision-making is weighing competing risks, impacts, and outcomes, either individually or within a group. For example, in Project 1-A (P01), the design team had big ideas for the water system but there were cutbacks for cost. In order to come to a decision, 5 different iterations were presented to the owners - versions of "low, middle, and high" tier options - and sometimes the decision-makers (the owners) opted for the lowest tier because it had the highest impact on budget.<sup>12</sup> In the same project, the decision of whether or not to put solar panels on the building came up. At the time of construction, photovoltaic panels were too high in cost, but the ownership knew that the cost would go down and efficiency would go up in the future. This directly led to the building being made "solar-ready" for future integration of that

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<sup>11</sup> Anonymous. E-mail message to author, May 19, 2020.

<sup>12</sup> Anonymous. Interview with architect with leadership role at an architecture firm; focused on sustainable design by author, April 13, 2020.

specific sustainable system. In a separate project, the team of Project 5-B (P05) had owners who decided their values before the project began its planning stages, which made the overall process of design explorations with the architect and client more successful. In Project 6, the interviewee identified as P06 stated that when it came to making good decisions, it required multiple partners to get it right.<sup>13</sup> It helped that the decision-making mechanism was understood by everyone on the project team and was based on the project goals. In addition to contractual and cultural elements, an understanding of the decision-making roles, as well as the expectation of equal accountability by all parties, directly related to the outcome of the successful project.

Even with agreement in project goals, definitions of terms, and roles and responsibilities, the decision-making team needs a clear organisational structure. In Project 3 (P03), a governance model based on the one developed by Brown University<sup>14</sup> was implemented with the owner's preferred contract, and they employed the specific structure for how the team is organised and how decisions get made on this project. P03 describes the decision-making structure as "pretty clear" with "mutual benefit" in the contract; various stakeholders understand that no one is going to get everything they want.<sup>15</sup> In Project 8 (P08), the decision making aspect relied on a consensus-based process through the utilisation of project "working teams."<sup>16</sup> These teams included a fitout group, which focused on the building users and elected leaders; and an ownership/maintenance team, which focused on the building infrastructure; among others. According to the interviewee identified as P08, every decision made was a collective consensus, and if the teams couldn't find consensus, then the decision was brought to the larger executive committee (which also required consensus-based decisions). The use of the

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<sup>13</sup> Anonymous. Interview with design partner at an architecture firm by author, April 08, 2020.

<sup>14</sup> Sheila Bonde and Paul Firenz, "A Framework for Making Ethical Decisions," May 2013.

<sup>15</sup> Anonymous. Interview with organisation manager within education-based owner by author, April 13, 2020.

<sup>16</sup> Anonymous. Interview with manager and leader at an architecture firm by author, April 16, 2020.

executive committee only occurred a few times, and most decisions were made at the project working team level. As a separate example, the organisation started in part by the interviewee identified as P09 consists of "co-chairs" who help make decisions as a whole. This collection of individuals initially began as a laissez-faire overseer, but they began exerting "top-down" leadership as the organisation grew and people began asking for it. The management team includes staff in charge of webinars and digital platforms, volunteer trees, people in charge of organising regional/local hubs, and focus group staff.

It is also important to note that the type of owner and their values have a significant impact on project-team decision-making. In Project 1-B (P01), the owner was an educational institution who would hold the building with a long-term (30+ years) lease. This meant that design decisions with a 30 year payback could make sense (though a shorter return would be preferred).<sup>17</sup> The design team had more of an impact in this situation. This is significantly different from a typical private developer who needs to flip a project and make a "quick" profit. In Project 5-3 (P05), the owner was already fairly set on what they wanted for the design, and the team P05 was a part of only provided input for a few various options in the underground level, such as input for groundwork and connections.<sup>18</sup> They could guide some decisions for the above-grade portion, but the team wasn't part of that design.

Another key element to consider in terms of decision-making is the impact of different players on the decision-making process. In Project 2, P02 describes an atypical situation where the architect has more "power" than the contractor and on occasion, the owner. They attribute this to the fact that famous architects (also known as "stararchitects") have more control/sway because of their nature and way of working, and since the highest level of ownership is buying

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<sup>17</sup> Anonymous. Interview with architect with leadership role at an architecture firm; focused on sustainable design by author, April 13, 2020.

<sup>18</sup> Anonymous. Interview with senior manager at a construction company by author, April 20, 2020.

the style that comes with the name, they don't push back as much.<sup>19</sup> In Project 5-A, P05 states that the challenge came from the fact that no one person was really “the” decision-maker or an authority figure, and it becomes difficult to get things decided in a project with a lot of different players - stakeholders, users groups, design teams, etc. Some stakeholders are used to things being a certain way (not wanting new equipment or the method of operations, for example), and since each group (a “committee of approval”) has its own autonomy and equal amount of influence, they tend to fight amongst themselves. For Project 9 (P09), which has significantly more complex teams due to the nature of the project, the teams involved need a set, clear framework and documentation of the values and decisions in order to be able to execute them. In reference to the governance structure mentioned by P03, the interviewee identified as P12 added that the management and working teams, both under the executive committee in terms of hierarchy, should be a representation of the end users, the finance/budget side, the operations and management side, the owner’s design team, the owner’s project delivery director, and the relevant members of both the designers and the builders to ensure that the health of the project is good. The size of these groups will depend on the size of the project, but P12 adds that more than 12 becomes very difficult to work with.

#### *6.2.1.4 Relationships*

Relationships in the built environment are almost as important, if not more so, than the finished product. From empathy for the leaders and decision-makers who deal with challenging and complex issues to communication across disciplines, it is the foundation of the built environment. However, forming, maintaining, and negotiating in relationships can be difficult depending on the context. P05 mentions that “[how] you approach the person, talk to them, and

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<sup>19</sup> Anonymous. Interview with technology manager at a construction company by author, April 06, 2020.

describe things/relate to things changes with the project type and the person; you have to figure out how to communicate a little bit better [in most circumstances].” On Project 12, P12 learned how to have empathy for those in charge of making decisions, as it is not easy to do and some issues are outside of the project bounds to solve. It takes a lot to get decisions made right and made quickly, especially if it is easier to stall. Learning how to gently push for a decision while still being understanding and empathetic is a key trait of high emotional intelligence.<sup>20</sup>

In Project 3, P03 realised that they could not assume that a contract model that encouraged and allowed for collaboration would flourish on its own. “There’s a lot of ‘coaching’ that someone [in a management/leadership position] has to do,” P03 states. This “coaching” can be from the contractor or the consultant side because it is a reciprocal relationship. In this project, leaders of the different groups were coaching each other - architect, contractor, and owner alike.<sup>21</sup> Multiple interviewees focused on the fact that technical skill and knowledge can sometimes be less important or influential than high emotional intelligence, especially in creating a highly valuable team culture. Leadership that helps the groups bond together sends a message that “fun” is okay and supports the idea that a project team can be successful without needing excessive critique or monitoring. P03 stressed the importance of investing in the happiness of the team from the owner’s perspective and argued that teams need managers who can foster that and sense when there’s a problem. Managing projects is more than just budget and schedule; emotional intelligence is “probably the most important thing now.”<sup>22</sup> That being said, P04 points out how much of our structure for relationships, particularly that of contracts and project delivery methods, do not do the above. They state that humans are better at being

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<sup>20</sup> Anonymous. Interview with organisation manager within education-based owner by author, April 20, 2020.

<sup>21</sup> Anonymous. Interview with organisation manager within education-based owner by author, April 13, 2020.

<sup>22</sup> Anonymous. Interview with organisation manager within education-based owner by author, April 13, 2020.

reactive than proactive, and a lot of behavioural factors weigh into the challenges of project delivery and risk management.<sup>23</sup> Design and construction systems and contracts are still routinely set up in "flow-down" ways, based on a waterfall structure that has not changed despite trying building information modelling and other integrative methods. Part of the reason for this is that some insurance will not cover such contractual relationships, and others are that lawyers don't always help in these situations. These "risks" must be balanced against the risks of not making any changes to collaborative or sustainable practices - intangible issues now will mean catastrophic results in the future. It takes a long time to change old industries, but with the right relationships, decisions, and values, better systems can replace the old.

## 6.2.2 Contracts and Project Delivery Methods

### 6.2.2.1 Contracts

Contractual relationships are an important component of all projects because it sets up the process, decision-making structure, and legal relationships between parties, in addition to outlining expectations and project goals. In this regard, the owner or developer's "values" become incredibly impactful as they are the responsible party for choosing and defining what type of contractual relationship/project delivery method the project will follow. According to the interviewee identified as P13, owners typically drive contracts because they are the ones in charge of the funding, while the architect and contractor can negotiate in the background. While there are many ways to categorise contracts, such as the familiar method of using the "design-bid-build" project delivery method, however this study seeks a new way to categorise contracts: collaborative and non-collaborative contracts.<sup>24</sup>

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<sup>23</sup> Anonymous. Interview with sustainability consultant with construction law background by author, April 23, 2020.

<sup>24</sup> Anonymous, Interview with researcher with professional industry experience by author, April 22, 2020.

In an example, P10 identified a contractor out-of-state who could work under any contract method not because he had the most experience because he focused on team building and leadership. This was meant to reinforce the idea that "contracts matter, but only to a point - no matter what contract, you need to do the hard work of team building."<sup>25</sup> This crucial aspect is why there are successful non-collaborative contracts and unsuccessful collaborative contracts, because simply agreeing to a collaborative contract does not guarantee a successful project. This is particularly true if there are "conflicting obligations" within the contract structure (such as issues with the legal relationship between project parties and who reports to whom).<sup>26</sup> Contracts and expectations matter, which is why it is so important to set them up and clearly define them from the beginning. However, there is research which suggests that collaborative working is usually "spontaneous and unplanned" and typically involves project team members proactively coming together to resolve problems and focus on finding areas for compromise.<sup>27</sup>

P10 has focused much of their research on collaboration and why it is important in the built environment. In one study of 11 IPD (Integrated Project Delivery) case studies, their team found that a lot of project delivery research sorts projects by contract typology. In trying to make sense of the high level of variation and lack of clear relationships in these categories, the team created variables and characterised projects by the ways they collaborate, which gave a clearer picture of the impact of each collaboration mechanism.<sup>28</sup> To summarise, P10 states that this research "tells us that more collaborative delivery tends to lead to better outcomes; more collaborative delivery leads to more collaboration that leads to better outcomes." This is in addition to reframing the way integrated or integrative project delivery methods are viewed, from asking "does it work?" to "how does it help the teams be more collaborative?" For example, one

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<sup>25</sup> Anonymous, Interview with researcher with professional industry experience by author, April 22, 2020.

<sup>26</sup> Anonymous, Interview with researcher with professional industry experience by author, April 22, 2020.

<sup>27</sup> Koko Udom, "Improving Collaborative Construction Contracts," NBS. October 1, 2013.

<sup>28</sup> Anonymous, Interview with researcher with professional industry experience by author, April 22, 2020.

of the found patterns in this area of research is that novel contracts or project process (like IPD) typically lead to interesting team-building activities; in one instance, when a healthcare client required the designer and builder to create a proposal (a process proposal) of how they would work together and with the owner to build the project, the design/build team took the 10 week process to build the foundation of the team relationship.<sup>29</sup> This aided them in reconciling their differences and understanding their respective differences in methods of putting a proposal together.<sup>30</sup> When they focused on process and set aside expectations, the result was process innovation. The team was able to follow the contractor's lead in prefabricating the walls by utilising the architect to design the shop drawings for the walls, something that could not have happened in a typical process because an integrated team is needed to allow the team to work together on a shared goal like this.<sup>31</sup> While the owner set up the contractual relationship and obligations, it inevitably was up to the key project members to agree to work together and compromise in areas which would benefit the team and project in the longer term. As demonstrated on Project 6 (P06), you can use a specific contract and legal agreement but that does not guarantee that the team members will have the same culture or ability, and there must be a mindset for collaboration. A project needs the right partners - the architect, contractor, and client must be bought in together on the same vision.<sup>32</sup>

#### *6.2.2.2 Contract Types*

Only one project in this study was a P3, or public-private partnership, project. P01 attributes some of the success of the project to this contract type because it brought the contractor on earlier and the owner was an equal partner. This, P01 stated, differed from the

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<sup>29</sup> Anonymous, Interview with researcher with professional industry experience by author, April 22, 2020.

<sup>30</sup> Anonymous, Interview with researcher with professional industry experience by author, April 22, 2020.

<sup>31</sup> Anonymous, Interview with researcher with professional industry experience by author, April 22, 2020.

<sup>32</sup> Anonymous. Interview with design partner at an architecture firm by author. April 04, 2020.

typical design-build process where the architect works for the contractor. While P3 is a preferred contractual relationship in many public infrastructure projects due to the nature of the funding, there are many complaints for this method, including that the majority of projects are over budget and overschedule, the “oppressive” contract inherently sets team members against each other, and the intense focus on meeting milestones left little room for healthy relationships between team members.<sup>33</sup> The lack of beneficial contract terms in this method plus the need for “uncommon” ways of keeping the project on track suggests that this project delivery method falls in the non-collaborative contract category.

Another project delivery method which was only mentioned once was the GCCM (General Contractor/Construction Manager) contract. Defined as an “Alternative Public Works Delivery method” in the state of Washington, GCCM contracts “select the contractor early and engage the contractor during the design phase to meet the cost, scheduling and quality criteria for the project.”<sup>34</sup> In Project 1-B, P01 identifies this contract as related to the success of the project because the contractor was on board from the beginning, meaning that the team had cost and budget information early on. A GCCM contract is considered a collaborative contract because it can allow teams to effectively manage complex projects, identify and manage risks early on, and quickly incorporate cost and budget impacts early in design.<sup>35</sup>

One of the most distinct differences in a GCCM contract and a design-build contract is who the architect is contracted to. In a GCCM contract, the architect has a direct agreement with the public owner which is separate from the general contractor.<sup>36</sup> In a design-build contract, the design and construction services are contracted by the “design-builder,” or Contractor. Different

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<sup>33</sup> Elyse Maltin, “What Successful Public-Private Partnerships Do,” Harvard Business Review. January 8, 2019.

<sup>34</sup> “Project Delivery Systems,” Washington State Department of Enterprise Services. December 27, 2019.

<sup>35</sup> Ibid.

<sup>36</sup> “Project Delivery Systems,” Washington State Department of Enterprise Services. December 27, 2019.

owners have different methods of utilising a design-build contract, and because of its potential for collaborative work, this contract method is considered a typical collaborative contract.

Design-build contracts can be implemented in various ways. In a method they call “design-build light,” P02 describes a project that isn’t necessarily a full design-build contract but holds the key elements of one. In Project 2 the contractor and subcontractors are involved in the design process, but the designers (engineers) and fabricators/installers aren't the same. P02 notes that the construction team has been involved much earlier than they would have been in a typical design-bid-build contract, and they state that design-build is a better method for most general contractors because it works well, is the “most aggressive” in terms of collaboration, and has a much more fluid process. A different project employed what P03 called a “progressive design-build” project delivery method. Instead of working with a self-selected team of the architect and the general contractor, the owner switched to a process where they choose the builder first and then works with the builder and an internal design guidelines team to pick the architect.<sup>37</sup> The builder is involved all along the way, and once the internal design team recommends their preferred designer, the contractor chooses the best architect.<sup>38</sup> This process was designed in response to the old method of forming project teams, where the builders would pick 3-4 specific architects because they thought that picking those architects would help them win the project, due to that designer’s success with the owner on previous projects. This was problematic for two reasons - one, the owner kept seeing the same, small range of architects appear on lists, and two, some contractors were upset that these architects were getting locked up on these projects that had yet to start.<sup>39</sup>

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<sup>37</sup> Anonymous. Interview with organisation manager within education-based owner by author, April 13, 2020.

<sup>38</sup> Anonymous. Interview with organisation manager within education-based owner by author, April 13, 2020.

<sup>39</sup> Anonymous. Interview with organisation manager within education-based owner by author, April 13, 2020.

When describing Project 7, the interviewee identified as P07 stated that it took “a bit of a leap to get there,” meaning that there are some things, like trusting the process, which needs to happen to get a lot of value out of it. Progressive design-build allows the contractor to better award the project, be more cost-effective overall, and allows the owner to be more involved in the process.<sup>40</sup> The interviewee identified as P08 described the project as easier for the owner to manage (risk) with one contract, as well as placing incentivising elements of IPD, like the shared risk/reward component, in the contract. This means that the main team (architect, contractor, some consultants, etc.) all share the risk and reward for a particular project.<sup>41</sup> By doing this, the contract allowed for accountability (in lieu of blame) because each company’s profit was directly tied to one another’s work. Also included in this contract was a mandate that the expertise (subcontractors, fabricators, maintenance, etc.) was all included in the beginning of design in order to push the design further.<sup>42</sup> Something of this project’s caliber, argued P08, would not be possible in a typical model because the result was a direct outcome from working collaboratively from the beginning. By going after the project together, members of different backgrounds and disciplines are able to get to know each other, resulting in a team that is on great terms before the project has really begun. In contrast, when one is chosen first over the other, that opportunity is missed and the time to share and come up with agreed-upon goals is lost.<sup>43</sup>

In a similar fashion, the interviewee identified as P11 spoke to their project completed under a somewhat unique design-build contract. The firm P11 works at is a design-build firm with both design and construction services, this company has integrated the workflow between design and construction by having them on the same team. This relationship allows the project team to get good feedback from the preconstruction team early on in design because everyone

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<sup>40</sup> Anonymous. Interview with project manager at construction company by author. April 22, 2020.

<sup>41</sup> Anonymous. Interview with manager and leader at an architecture firm by author. April 16, 2020.

<sup>42</sup> Ibid.

<sup>43</sup> Ibid.

is at the table and/or participating in the OAC (owner, architect, contractor) meetings with the project managers.<sup>44</sup> According to P11, this process saves time and frustration by having the project parameters and constraints set from the start, instead of the case where the architect designs something too expensive and getting feedback at the end. In terms of contractual relationship, the owner only holds a contract with the firm's construction company (separate from the architectural side for legal purposes), and the consultants are either brought on separately through the contractor or located in-house, depending on the project.<sup>45</sup> One of the key differences in process, notes P11, is that the typical process of having to go through a value engineering session to change the building after being handed a full design is removed from the equation, saving time, money, and frustration. This individual also stated that they preferred this collaborative contractual framework over the typical design-bid-build because they had been on too many adversarial projects in the past that ended in a lawsuit.<sup>46</sup> There is a power imbalance in the industry that architects have to deal with because they are unable to control the execution of the design in a way that they are satisfied with, and with added fees, lost of site time, and no control of the construction on site, the adversarial relationship can become dangerous and costly. In addition, P11 argues, it "feels like all of the problems we need to solve today with sustainability requires teamwork and everyone being on the same page." The standard diagram of a triangle with a dashed line between the architect and the contractor is problematic to say the least.<sup>47</sup> There are of course challenges and unsolved issues, such as self-censorship in the design process and a lack of clarity in roles and responsibilities (for example, the American Institute of Architects has documents that protect architects, but this becomes muddier when

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<sup>44</sup> Anonymous. Interview with practicing architect by author. April 16, 2020.

<sup>45</sup> Anonymous. Interview with practicing architect by author. April 16, 2020.

<sup>46</sup> Ibid.

<sup>47</sup> Ibid.

working for the same company).<sup>48</sup> With coordination beginning early on in the design stages, the design team may not end up with as "daring" or ambitious a building, but there is a better chance that the client will be happier and the project team will have a much better relationship. These types of intangible outcomes are hard to quantify, but they remain one of the most impactful elements in the industry.

Slowly but surely, the industry is starting to solve some of the intangible issues when it comes to collaborative contractual frameworks. For example, P12 noticed that while contractors can rapidly estimate conceptually in their heads, they struggle with what comes before that - the creative, iterative, and often cyclical design process. Designers often want to look at a range of possibilities, but the contractors want to count things quickly and estimate/solve rapidly.<sup>49</sup> P12 states that it takes time to get the "linear" people to hold their assumptions, refrain from "designing" (constraining) the project, be experts on what they are needed to be experts on (ie. existing site conditions/utilities or cost implications), and let the design team design. Part of P12's responsibilities is to make sure the team members are problem-solving within their expertise, to inform the trade-offs and the conceptual design(s). On the architect's side, P12 states that the designers need to work on being open to assessments and constraints offered by other members of the team; to see these constraints as challenges and possibilities and be open to hearing feedback on the design.

"Contracts don't need to get in the way," stated P13. Design-build projects, they argue, are typically driven by "sophisticated" people. People choose their actions, and people disincentive collaboration. Regardless of the contractual framework, the key element as stated by P13 is that the contractor needs to be brought on early because of their construction

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<sup>48</sup> Ibid.

<sup>49</sup> Anonymous. Interview with organisation manager within education-based owner by author, April 20, 2020.

knowledge. Though the owner will need to spend more upfront (so the Contractor has the potential for more profit, which is incentivising), this is inherently good for the project and resulting relationships as it lends itself to "project thinking," which is needed for true collaboration.<sup>50</sup> While collaborative contracts like design-build and its variants certainly seem like the way of the future, the right people with the right values and mindsets will always be needed in order to yield a successful outcome.

The "typical" delivery method as mentioned by several interviewees is known as design-bid-build, and it has been a consistent contractual framework in the AEC+ industry for a while, potentially because of the misinformed notion that this method saves the most money. P03 stated that design-bid-build still does happen and can be successful. P05 argues that because the contract does not influence whether a project is a successful one or not, good projects, such as Project 5-B (done through design-bid-build), do exist.

One of the final types of contractual strategies mentioned by a few of the interviewees is IPD, or Integrated Project Delivery. It is not a project delivery method in of itself, but more of a set of guiding methodologies. As defined by the AIA, IPD "is a project delivery approach that integrates people, systems, business structures, and practices into a process that collaboratively harnesses the talents and insights of all participants to optimize project results, increase value to the owner, reduce waste, and maximize efficiency through all phases of design, fabrication, and construction."<sup>51</sup> There appears to be many benefits to this "collaborative, values-based process [which delivers] high-outcome results to the entire build team,"<sup>52</sup> so why are IPD strategies used more frequently? P11 states that this is probably due to the higher upfront costs from bringing in consultants much earlier in the design process, as well

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<sup>50</sup> Anonymous. Interview with AEC law professional by author. April 24, 2020.

<sup>51</sup> AIA National and AIA California Council, "Integrated Project Delivery: A Guide," 2007. n.p.

<sup>52</sup> AIA National and AIA California Council, "Integrated Project Delivery: A Guide," 2007, pp. 1.

as doing many coordination iterations. Additionally, many owners cannot immediately see the intangible benefits of better relationships and a better process, or how it can result in a better project overall. The lack of IPD incorporation may also be due to the fact that it requires strong project management and talent across the disciplines. Moreover, because the contractual relationship originates with the owner, the push for integration and collaboration typically has to begin with them.<sup>53</sup>

### *6.2.2.3 Interdisciplinary Integration Strategies*

Though it may be a challenge to implement interdisciplinary collaboration strategies in a non-collaborative contract, design and builder teams all over the region have found various means and methods of integrating their projects through stakeholder involvement, co-location, and education. In Project 1-B (P01) for example, incorporating design and sustainability charrettes (also referred to as “eco-charrettes”) led to a lot of enthusiasm from various stakeholders and user groups, and it expanded the design process so that it was no longer the design team designing in isolation but an iterative feedback loop.<sup>54</sup> Eco-charrettes helped influence and realise the values of the stakeholders, which pointed to solar energy as a logical process for the project - “it had to be that” stated P01. For Project 2 (P02), involving the contractor at a high level early in the design process and looking at ways for the team to operate differently have led to aggressive co-location strategies and a VR (virtual reality) booth where anyone can come in to work with the model and take part in BIM. P02 states that this high degree of integration this early on bodes well for long-term communication on the job and relationships based on respect that goes both ways. Additionally, these strategies help

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<sup>53</sup> Anonymous. Interview with AEC law professional by author. April 24, 2020.

<sup>54</sup> Interview with architect with leadership role at an architecture firm; focused on sustainable design by author, April 13, 2020.

incorporate a high degree of ownership for all parties, especially with the emphasis on education, communication, and sharing knowledge.<sup>55</sup>

Project 3 (P03) saw the value of co-location but needed a different approach. For this project team, they met once a week at the design team's office and worked all day. Each day had six to seven sessions or meetings going on, which focused on addressing issues from last week and looking at what items the team needed to work on for the next week.<sup>56</sup> These meet-ups continued through the course of the project, first starting at the architect's office and then moving to full co-location at the job site during early construction. The owner has not required early "full" co-location to a job site on any of their projects because they realise that it can be hard for workers and consultants; people feel remote and disconnected from their home office because they are not there and are required to be a part of the project.<sup>57</sup> They have found that it is better to require collaboration in contracts and not mandate what that collaborative process looks like. How it happens is up to the team and team members themselves. Co-location is a good strategy for shifting to more interdisciplinary work, and P04 argues that people need to work with and get involved with individuals and groups in a different context; it is a "multidisciplinary world" more and more, and specialists are not as in demand. They state that "you should be able to talk to lawyers as a contractor and be able to understand the basics of insurance as a designer."<sup>58</sup>

A key integration strategy for Project 5-A (P05) mandated that the groups who were awarded the project had a team kick-off, a partnering meeting, and common goal setting

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<sup>55</sup> Anonymous. Interview with technology manager at a construction company by author, April 06, 2020.

<sup>56</sup> Anonymous. Interview with organisation manager within education-based owner by author, April 13, 2020.

<sup>57</sup> Anonymous. Interview with organisation manager within education-based owner by author, April 13, 2020.

<sup>58</sup> Anonymous. Interview with sustainability consultant with construction law background by author, April 23, 2020.

conversations. It was important to be a part of the team selection process beforehand so conversations about process and means and methods could happen, even though the plans, specifications, and design were mostly set already.<sup>59</sup> Because various team members were involved with the interview process, this helped develop a better team mentality from the start. This was somewhat similar to Project 5-B (P05), which had a more traditional process but included the contractor early on for advice and participation in design meetings. There have been few challenges on integration aspects, and the overall process of explorations with the architect and the client have certainly made the project more successful, argues P05.

With Project 6, P06 identifies the structural system and curtain wall enclosure as the two areas which needed interdisciplinary collaboration the most, because they held big design risks and aspirations. Everyone on this project team acknowledged that they spoke different languages but they needed to speak the same language for the project; this takes a special team with high emotional intelligence to speak to each others' passions and talents.<sup>60</sup> In a way, this is similar to the organisation that P09 helps lead; the team(s) are already remote and multidisciplinary - it rarely makes a difference who they are working with because the goal of the organisation is the same.<sup>61</sup> When working on multiple projects and getting large amounts of stakeholders, the group needs to be able to present it and provide a clear path for input and feedback. This typically comes in the form of "smart" tools which allow people to collaborate in real time on topics of communication or analysis.<sup>62</sup> According to P11, a main goal of integration technology is (and should be) the "single source of truth" idea, where new technologies, particularly those regarding 3-dimensional models, are used to create one BIM where every

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<sup>59</sup> Anonymous. Interview with senior management at a construction company by author, April 20, 2020.

<sup>60</sup> Anonymous. Interview with design partner at an architecture firm by author. April 08, 2020.

<sup>61</sup> Anonymous. Interview with researcher with professional industry experience by author. April 08 and 17, 2020.

<sup>62</sup> Anonymous. Interview with researcher with professional industry experience by author. April 08 and 17, 2020.

member of the project team can see each other's impact and model elements, and what is in the model is a true reflection of what is built. However, the current technologies and processes are not quite there yet. P11's firm experimented with having "component designers" during the design process in the model but stated that it is too messy of a process, citing issues with permissions and the cloud software. Designers might design and shift elements until the very end of the phase, and the problems that can cause sets up diminishing returns for the team.<sup>63</sup>

#### *6.2.2.4 Impacts and Challenges, Policies and Regulations*

There is a significant policy and regulation side to new processes and initiatives. In Project 1-B (P01), one of the obstacles to implementing sustainable energy strategies was that the building occupants paid a flat rate to the owner based on the size of the project, so any potential energy savings would not be realised by the occupants. If the incentives changed so that these members would benefit (in addition to the owner, who benefits regardless), the sustainable initiative would have a bigger impact and the architect could alter the cost model to potentially incentivise certain ideas and technologies.<sup>64</sup> Another universal challenge that most projects come across is the issue of money - projects, especially public ones, almost never have enough.<sup>65</sup> In Project 3, P03 stated that if the project need can be met in a less costly way and the result is getting something else that is needed (ie. space for more program), then why not do it? This ties into the statement made by P05, where they point out that public entities are a challenge because they have a lot of different players, stakeholders, users groups, etc. Some members are used to things being a certain way (not wanting new equipment or operations),

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<sup>63</sup> Anonymous. Interview with practicing architect by author. April 16, 2020.

<sup>64</sup> Interview with architect with leadership role at an architecture firm; focused on sustainable design by author, April 13, 2020.

<sup>65</sup> Anonymous. Interview with organisation manager within education-based owner by author, April 13, 2020.

and that challenge of needing to get the users involved early to work through that process & go through committees of approval takes time. Additionally, each group has its own autonomy and an equal amount of influence, and they fight amongst themselves.<sup>66</sup> In Project 5-B (P05), part of the challenge was with new systems and technologies which were new to both the owner and the design team members, and the city and permitting process had no precedents to draw from. P05 states that “you need people willing to try new things and push for it and push through it and be inventive and think outside the box, and if you don't have that, you have to drag your team members instead of them pushing.”<sup>67</sup> For Project 5-C (P05), the project had two separate phases, two design teams, two owners, and two contractors with their subcontractors - all of which were funnelled through the owner/tenant contract (meaning that there were none between architects or contractors). Much of the discussion revolved around time and schedule, number of models to coordinate, rights to 3D models, as-builts, and project turnover, as it was hard to find a good transition point.<sup>68</sup>

With Project 6 (P06), the main issue was that no one had ever implemented this project delivery method in this fashion, from a design team or owner. When people are uncertain or unsure on the structure or if they'll have input, that raises anxiety levels.<sup>69</sup> The required size and project schedule were difficult and some time was lost while the owner selected the site, but the end date was the same. The owner wanted all the possible client and stakeholder input but on a shorter schedule.<sup>70</sup> Another challenge with the owner can be seen in Project 7, where P07 recognises that putting the architect under the contractor does increase upfront costs. The fees on the design team raise the question of whether or not the owner is getting the value for the

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<sup>66</sup> Anonymous. Interview with senior manager at a construction company by author, April 20, 2020.

<sup>67</sup> Anonymous. Interview with senior manager at a construction company by author, April 20, 2020.

<sup>68</sup> Anonymous. Interview with senior manager at a construction company by author, April 20, 2020.

<sup>69</sup> Anonymous. Interview with design partner at an architecture firm by author, April 08, 2020.

<sup>70</sup> Anonymous. Interview with design partner at an architecture firm by author, April 08, 2020.

money they spend.<sup>71</sup> Contractors tend to get a lot of questions from private developers on the possibility of implementing a more collaborative contract framework, but this would be a big “leap of faith” on the developers’ part because they are working towards a different set of performas than the public sector.<sup>72</sup> Public owners get the benefit of budget certainty, which has not always been the case in the past. According to P08, this is an investment that the owner takes on, and they have to see value in the process and intangible results.

Some of the challenges faced by teams are not as concrete and deal with the more intangible side of things - relationships, organisation, and decision-making processes. For P09’s organisation, this meant trying to understand the relationship between collective decisions and leader-lead decisions while being structured as a horizontal hierarchy. When do leader-lead decisions need to be made? How do people feel like they've been informed and understood, but confident that a decision has been made?<sup>73</sup> People need clarity and good organisational structure to share information and provide feedback so that they feel confident and prepared to act.<sup>74</sup> Once the organisation grew to 600+ people, the leadership team stopped being able to communicate effectively and started to explore how they could make a network that functions well.<sup>75</sup> This came in the form of regional "hubs" with in-person meetings, which allowed people form relevant relationships with local professionals and to decide how they could get involved.<sup>76</sup> Hosting this organisation to a new online communication platform enabled clear organisation around a specific topic and a means of sharing knowledge and resources. For Project 9 (P09),

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<sup>71</sup> Anonymous, Interview with researcher with professional industry experience by author, April 22, 2020.

<sup>72</sup> Anonymous, Interview with researcher with professional industry experience by author, April 22, 2020.

<sup>73</sup> Anonymous. Interview with researcher with professional industry experience by author. April 08 and 17, 2020.

<sup>74</sup> Anonymous. Interview with researcher with professional industry experience by author. April 08 and 17, 2020.

<sup>75</sup> Anonymous. Interview with researcher with professional industry experience by author. April 08 and 17, 2020.

<sup>76</sup> Anonymous. Interview with researcher with professional industry experience by author. April 08 and 17, 2020.

while the team is working well together, the biggest challenge has been the expectations and different languages; the differences in the meaning of something causes conflict. Templates for communication, collection and organisation of information, and brainstorming need interactive and live frameworks of categories and topics so that other people can come in and fill in set amounts of information (based on their experience/other factors) and understand what work has already been done.<sup>77</sup> In terms of processes and approaches, most of the challenges from a practitioner's standpoint is based around trying to change project culture and firm culture.<sup>78</sup> In a collaborative environment, research has shown that it can take anywhere from six months to a year getting people aligned on the terms.<sup>79</sup> According to P10, this means potentially getting through 80% of the design process before a contract is solidified and having to operate with high levels of trust. Changing the norm of the typical project process causes a lot of work around the change.<sup>80</sup> P10 continues to emphasise that this becomes even more of a challenge if the necessary investment in team building and leadership is not done; the IPD intent will fall apart. Individuals from all disciplines need to commit to different norms (ie. being respectful, changing practices of firm norms). For instance, implementing and enacting a co-location strategy allows for people to be available and overhear conversations happening, but what happens if you have multiple co-location projects? This is a current challenge with firms and projects in organising work. Another challenge is time - time invested in building the team, creating shared goals and understanding, and holding more meetings means more time spent upfront, which potentially compresses design time.<sup>81</sup> Time also needs to be spent onboarding new team members so they are able to join into the project and also benefit from the team

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<sup>77</sup> Anonymous. Interview with researcher with professional industry experience by author. April 08 and 17, 2020.

<sup>78</sup> Anonymous, Interview with researcher with professional industry experience by author, April 22, 2020.

<sup>79</sup> Anonymous, Interview with researcher with professional industry experience by author, April 22, 2020.

<sup>80</sup> Anonymous, Interview with researcher with professional industry experience by author, April 22, 2020.

<sup>81</sup> Anonymous, Interview with researcher with professional industry experience by author, April 22, 2020.

building/expectation setting phase. In a similar manner, time for offboarding is important. Team members may not agree with the expectations, culture, or environment, and they need to be successfully replaced on the project team in order to avoid issues further in.<sup>82</sup> There are also issues with different layers of communication and collaboration - the management layer might be connected and transparent, but the project detailers may not get the same experience. The challenge then becomes getting the teamwork to filter down to other levels of the project while still respecting everyone's time and obligations.<sup>83</sup>

According to P09, codes and regulations in the built environment are meant to protect life and reduce risk, similar to practice. They meant to respond to familiar risks from in the past, such as fire or water-borne sickness, and they have not yet evolved to incorporate future or “intangible” risks, like climate change.<sup>84</sup> Currently, the industry and regulation are not placing enough effort on focusing on the risks that are on bigger scales or are upcoming. For example, the codes and regulations around water reuse and recycle are incredibly difficult to work with. On Project 8 (P08), the reuse of blackwater is a big issue in terms of regulation and maintenance issues, so the project is not reusing/recycling blackwater. While Seattle is working on catching up to greywater reuse, they are still behind with blackwater.<sup>85</sup> Another code challenge on this project was around the gender-neutral restrooms. The project team needed to meet with the code official and ask for variance while documenting why the variance was needed. Thankfully, this project influenced the regulations and projects will have a significantly less difficult time incorporating gender-neutral bathrooms into their designs.<sup>86</sup> However, the code has not caught up in regards to communal spaces. An interconnecting stair important to

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<sup>82</sup> Anonymous, Interview with researcher with professional industry experience by author, April 22, 2020.

<sup>83</sup> Anonymous, Interview with researcher with professional industry experience by author, April 22, 2020.

<sup>84</sup> Anonymous. Interview with researcher with professional industry experience by author. April 08 and 17, 2020.

<sup>85</sup> Anonymous. Interview with practicing architect by author. April 16, 2020.

<sup>86</sup> Anonymous. Interview with practicing architect by author. April 16, 2020.

the project and tenants needed to incorporate many meetings with code officials to get it permitted, and it was only done by limiting the use around the stairs. Tenants want to connect across levels and the code needs to find a way to incorporate that.<sup>87</sup>

With Project 7 (P07), most of the code issues pertained to the mechanical systems and the building height. In this regard, the delivery model helped immensely because it changed how the mechanical systems were designed and arranged, and the contractor could work with the mechanical design-builder to make the systems fit. This meant that they could shrink the mechanical systems and get them as tight as possible (2" away from the beams in some areas) because they were on early.<sup>88</sup> Compared to a typical system where the designers get a vague idea of size and spacing and have to factor in safety factors, and installers get something different altogether, the collaborative system is much better for all parties involved. Codes and regulations also have an impact on where and what developers can build. According to P11, too restrictive of regulation drives away development. Additionally, the increase in regulations means that architects have more forms and documentation requirements to satisfy, which in turn means more work and professional responsibility at the same fee price/structure as before. While regulation is needed to drive the process forward, architects are not protected by it nor do they benefit from it, states P11. They just get squeezed.

#### *6.2.2.5 Risk and Risk Mitigation*

Challenges are not limited to codes and organisational structure, they include risks, liability, and insurance as well. But what is risk? As P04 stated earlier, define your terms: risk could mean delivering project late, incurring costs or not generating profit, dealing with worker injury and safety, taking on a difficult project and breaking down the relationship with client, or

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<sup>87</sup> Anonymous. Interview with practicing architect by author. April 16, 2020.

<sup>88</sup> Anonymous, Interview with researcher with professional industry experience by author, April 22, 2020.

getting sued, a lean claim, or having the project shut down... so what is risk?<sup>89</sup> According to P04, risks can mean many things: a common example is a design or construction professional not taking a project and then not making enough money, but other examples involve business risk, competitive bidding situations, and financial challenges. There are exceptions, but cost is always a significant aspect. As stated by P02, "there's always a question of cost around anything we try to do - if it doesn't cost less, then why do it?" Other problems arise when the main informants on risk, the lawyers, consistently advise clients not to take projects because sustainable design is considered significantly riskier, though arguably this is from misinformation and a lack of education.<sup>90</sup> Arguably, one of the key driving factors behind why more collaborative contracts and sustainable projects are not happening is because of the embedded fear of risk leading to loss and lawsuit. Some companies can take on business risks under a certain value or balance it against other risks, like climate change.

Another thing to consider is who is in a position to negotiate and who is responsible for a project goal. For example, when looking at sustainable initiatives, which party takes responsibility for the project meeting the rating system requirements? According to P04, the "entity who's best able to manage a risk (and has experience/insurance with that risk) should own it, but usually what happens is that the party who's in the worse bargaining position owns it." The design risk should be under the design team since the designer has control over how the project is designed. To force a contractor to own a design risk does not make sense, and will more than likely cause unnecessary tension and conflict within the project team. Typically, when the contractor has risk, the contracts are designed to push risk down to the subcontractors who are smaller and in a less beneficial bargaining position (due in part to the incredibly

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<sup>89</sup> Anonymous, Interview with sustainability consultant with construction law background by author, April 23, 2020.

<sup>90</sup> Anonymous, Interview with sustainability consultant with construction law background by author, April 23, 2020.

competitive industry).<sup>91</sup> This forced relationship does not benefit anyone in the long run, and leads to the issue of accountability. How do you hold people accountable and how do you determine who is accountable? Having the necessary discussions early on while providing incentives and safety nets to encourage people to work together without the fear of being penalised or blamed is a huge component of encouraging collaborative contracts.

Even after determining the accountable party, the next question is how to manage the risks. In P04's experience, some of the necessary steps are to tighten the contracts by defining ambiguous terms and not using standard form contracts for sustainable projects, in addition to paying attention to specific project goals, making sure insurance coverage is where it needs to be (higher if the risk is higher), and identifying project-specific language. Additionally, education on relevant issues help potentially avoid lawsuits by sharing knowledge, identifying responsibilities early on, and making sure people understand how BIM and other technologies can impact a project.<sup>92</sup> P04 argues that good firms take "risk" and that lawyers have a responsibility to understand the power they have in terms of advising risk. Big leaps in design, technology, and systems come from innovation, and incremental changes are not enough. In terms of climate catastrophe, significant changes and leaps are needed and our industry just is not doing it.<sup>93</sup> Risk and old structures are preventing us from getting there. Sustainability (defined by P04 as including sustainable design and buildings achieving sustainable goals) has a high perceived risk because it is newer, buildings have been built and designed a certain way for a long time, and integrated/high performing buildings are challenging because goals are

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<sup>91</sup> Anonymous, Interview with sustainability consultant with construction law background by author, April 23, 2020.

<sup>92</sup> Anonymous, Interview with sustainability consultant with construction law background by author, April 23, 2020.

<sup>93</sup> Anonymous, Interview with sustainability consultant with construction law background by author, April 23, 2020.

illegal, there is added risk of cost, and there is a lack precedent.<sup>94</sup> This risk often outweighs the potential perceived benefit. However, P04 concludes by saying that the risks of not innovating are so much greater than our perceived risks of sustainable design.

IPD and collaborative practices are not commonplace because "we're fearful of change and the owner must be willing to take risks," according to P13. The fear comes from new versus traditional methods, as well as the refined relationships - the owner must trust the architect and the contractor to treat the owner fairly. Some of the potential issues with that relationship is that the designer may design conservatively to protect themselves, degrading the project, or the contractor may price conservatively. There is also a big investment of significant amounts of money (typically millions of dollars) with a lot of uncertainty, hence why many owners are typically conservative.<sup>95</sup> Overall, P13 states that owners are not ready; they need to see more successful projects. However, with the recession from the pandemic, P13 speculates that people are going to become risk averse.

### 6.2.3 Collaboration and Sustainability

#### 6.2.3.1 Sustainability

Sustainability is a highly discussed and debated topic in the AEC+ industry today. The "value" sustainable practices and initiatives have depends on both firm and discipline culture, and it is often compared to other "competing" project goals when deciding what rating systems, strategies, initiatives to pursue. According to P04, "sustainability" is ripe for symbols (globes, leaves, etc) that ideally mean something and convey that message properly, However, only having one thing that tries to convey so many different concepts has potential for consequences

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<sup>94</sup> Anonymous, Interview with sustainability consultant with construction law background by author, April 23, 2020.

<sup>95</sup> Anonymous. Interview with AEC law professional by author. April 24, 2020.

borne out of misunderstandings. Outside of rating systems, part of the conversation around sustainability has been about exploring the potential to “internalise” the externalities, or the impact that the design, construction, and operation of a building has on its physical and intangible surroundings.<sup>96</sup> What could that look like in practice? Is it planting trees or donating money? Is it an expectation for a carbon neutral building? How does this get incorporated and/or enforced on a policy and code level? And even if we could adequately answer those questions, who would the reparations go to?<sup>97</sup> If an example building changes a site in any meaningful way and there is a penalty from that, who is now responsible for mitigating that change? To summarise their speculation, P04 asks, “if you internalise the externality, who do you give it to? The environment?” and refers to “Should Trees Have Standing” by Christopher D. Stone (1972) where the author humanises nature for the purpose of suing on its behalf.

In the Impacts and Challenges section above, one interviewee observed that with too restrictive regulations, developers will no longer try to build in those areas. On the other hand, P04 references a high-performing buildings act which stated that projects “have to hit LEED, but if you tried really hard and didn’t get it, that’s okay.” Laws or policies are needed to mandate project benchmarks, but what happens if (they) don’t meet it? Why isn’t the industry trying to use legal means to “incentivise” sustainability by mitigating the perceived large amounts of risk?<sup>98</sup> Not only is this a consistent problem, it is also unique to the laws that regulate architecture and construction with regards to benchmarking (ie. percentage reductions).<sup>99</sup> For the most part, we don’t know what happens if we do not hit the targets set by various sustainability initiatives

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<sup>96</sup> Anonymous, Interview with sustainability consultant with construction law background by author, April 23, 2020.

<sup>97</sup> Anonymous, Interview with sustainability consultant with construction law background by author, April 23, 2020.

<sup>98</sup> Anonymous, Interview with sustainability consultant with construction law background by author, April 23, 2020.

<sup>99</sup> Anonymous, Interview with sustainability consultant with construction law background by author, April 23, 2020.

because they aren't typically measured or clearly stated, and when the expectations, goals, or penalties are not well defined, something (like a rating system) will define it instead. Is that okay or does it raise more questions?<sup>100</sup>

From a firm culture or organisational standpoint, sustainability values and initiatives vary from firm to firm and from discipline to discipline. For P01, the firm has taken a strong stance on what they call "living design" and are dedicated to reshaping the approach and idea of sustainability at an architecture firm. This does not mean taking away from energy or water initiatives but instead broadening the definition and taking everything into account (like materials, resilience, human health, and others).<sup>101</sup> This approach refreshes the strategies and incentives, and it gets a new generation of talented "living designers" in the discipline to help create an appeal and feeling of excitement. In P01's firm, each individual office has a sustainability leader, and because their process is still new, they are able to question what it looks like and what shape they want it to have for organisational structure and funding.<sup>102</sup> For P02, they argue that the construction industry does not really hold sustainability or green building to a high value. While some conversations with sustainability are happening (such as where does the firm stand and where do they want to go), there is not a lot of enthusiasm for pushing the sustainability message in construction. Contractors used to have sustainability directors to show that they cared and were passionate about strategies, but they typically no longer have those positions. Some environmentally supportive programs are supported, such as LEED and Salmon-safe, but these are not pushed a lot.<sup>103</sup> Market and firms are so busy that the

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<sup>100</sup> Anonymous, Interview with sustainability consultant with construction law background by author, April 23, 2020.

<sup>101</sup> Anonymous. Interview with architect with leadership role at an architecture firm; focused on sustainable design by author, April 13, 2020.

<sup>102</sup> Anonymous. Interview with architect with leadership role at an architecture firm; focused on sustainable design by author, April 13, 2020.

<sup>103</sup> Anonymous, Interview with technology manager at a construction company by author, April 06, 2020.

initiative to have sustainable projects and goals isn't there; people aren't focusing on it now whereas the industry had traction before in the mid-2000s. P02 states that they believe the accredited projects and certified individuals are fewer in construction than they were in the past. When people at this construction firm were asked if they cared about sustainability, no one really seemed to have a positive attitude (perhaps from dealing with difficult LEED projects and cost penalties).<sup>104</sup> P03, part of an ownership organisation, stated that while sustainability was “definitely in the conversation,” it was not always the “winner” of every decision. Some values work well together and some are competing; “a lot of sustainability measures don't quite pencil yet.”<sup>105</sup> There are choices and tensions on every project, and many are not easy; for example, looking at the ease of maintenance versus sustainability (ie. cleaning out filters, managing wetlands). The owner can set green building standards as a company, but it is important to provide a way to appeal for an exception. Water systems have a high maintenance demand - adding another burden that doesn't pay for itself in water or money is detrimental to a project.<sup>106</sup>

From their experience, P04 states that while contractors can “green up” their own operations, they are typically handed the designs and they have to build what they have been given. The options for the contractor to advocate or collaborate are significantly fewer, unless the project has a collaborative delivery model.<sup>107</sup> While there are certainly contractors in the Pacific Northwest who care deeply about sustainability, much of the push for the use of sustainable rating systems and other related initiatives on projects comes from the architect. According to P06, sustainability is definitely a core value of architecture; members of the

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<sup>104</sup> Anonymous, Interview with technology manager at a construction company by author, April 06, 2020.

<sup>105</sup> Anonymous. Interview with organisation manager within education-based owner by author, April 20, 2020.

<sup>106</sup> Anonymous. Interview with organisation manager within education-based owner by author, April 20, 2020.

<sup>107</sup> Anonymous, Interview with sustainability consultant with construction law background by author, April 23, 2020.

discipline are pushing more and more for green practices and initiatives since the design profession contributes a good deal to the built environment's carbon footprint. For P06's firm, sustainability is baked into the firm culture (because of the founding partners), which makes choosing projects and clients a bit easier - people have more climate and health awareness.<sup>108</sup> Because "this is what we've always been doing" (making smart choices about materials and building orientation, for example), the process of incorporating new tools and technologies isn't "new" but intrinsic to how they work.<sup>109</sup> This is similar to what P08 had to say about their firm, where it is considered the architect's ethical responsibility to do good and be responsible stewards of the built environment, and they do this by having ambitious goals and embedding sustainable ideas and practices in everything they do. This is certainly not the case for all architectural firms, who occasionally layer on sustainability at the end of a project instead of integrating that from the beginning.<sup>110</sup> Furthermore, the main push for sustainability actually depends on the client and the market climate. For many developers, green building might be important, but it is not the *most* important; the client needs to make smart decisions for their future users and operators.<sup>111</sup> In communities where fiscal incentives and the return on investment (ROI) are the predominant factors in decision-making, sustainable measures need a good ROI in order to be implemented. In the case of most Seattle Developers, these developers typically do not keep their buildings forever; their performance changes and that affects where they can put themselves in the market. Developers who keep buildings know their on the bill for maintenance and operations, in addition to other impacts.<sup>112</sup> Clients not paying as an owner must focus more on what the market demand is asking for, and since the current Seattle market

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<sup>108</sup> Anonymous. Interview with design partner at an architecture firm by author. April 08, 2020.

<sup>109</sup> Anonymous. Interview with design partner at an architecture firm by author. April 08, 2020.

<sup>110</sup> Anonymous. Interview with manager and leader at an architecture firm by author. April 16, 2020.

<sup>111</sup> Anonymous. Interview with design partner at an architecture firm by author. April 08, 2020.

<sup>112</sup> Anonymous. Interview with design partner at an architecture firm by author. April 08, 2020.

has transitioned to valuing more than just the lowest price point, developers are encouraged to give more value to bike spaces, open spaces, and other elements typically considered for green buildings.<sup>113</sup>

For P07, they stated that their firm definitely considered sustainability a core value and even cited it in regard to the renovation of their main office. This firm also has several clients and projects that are pursuing or value sustainable initiatives, like the Salmon Safe practice; in addition, their firm is one of the few Seattle contractors to be a part of it.<sup>114</sup> The PNW is considered to be more conscientious than other regions in the US and has several region-specific strategies and initiatives. P08 argues that the more sustainable buildings that are built, they become examples that push the industry forward. They give the example that the materials industry changed with the Red List and transparency demands to eliminate bad chemicals in materials specified by architects caused a shift in the industry.<sup>115</sup> For both the material manufacturers and architects, this shift lessens the research and the upfront costs so that the owner's priorities and budgets no longer have to be so high, and the architects know what materials to specify from previous projects.<sup>116</sup> Sustainability initiatives, like photovoltaic panels, will improve in efficiency and cost with time and implementation.

As far as an average research-focused company, P09 states that sustainability is being treated seriously, but in the past, it has not been considered one of the cornerstones, though that has changed with the most recent project. Typically, companies of this caliber focus on leadership, innovation, and diversity, with sustainability further down on the list.<sup>117</sup> According to P09, we as an industry are not taking the amount of leadership that should be taken, especially

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<sup>113</sup> Anonymous. Interview with design partner at an architecture firm by author. April 08, 2020.

<sup>114</sup> Anonymous. Interview with project manager at construction company by author. April 22, 2020.

<sup>115</sup> Anonymous. Interview with manager and leader at an architecture firm by author. April 16, 2020.

<sup>116</sup> Anonymous. Interview with manager and leader at an architecture firm by author. April 16, 2020.

<sup>117</sup> Anonymous. Interview with researcher with professional industry experience by author. April 08 and 17, 2020.

in terms of carbon impacts. If we ignore or neglect to solve climate issues, argues P09, the other ideas and strategies will not matter; right now, most plans are based on what is possible, not what is necessary.<sup>118</sup> This relates to the issue of values in the decision-making process. P12 described Project 12's decision-making in regard to sustainability as how it relates to the values of the project. Much of the story behind the project is focused around water and human health, so the team used LEED as a marker in addition to Fitwel (incorporating a bike room, changing rooms - more of a wellness-based rating system).<sup>119</sup> This was easier to implement due to the fact that Washington state requires some form of LEED for these types of projects. The decision-making for this project (and others by the same owner) was significant when weighing the competing interests of low water costs and the values of the project; for the most part, the financial aspects typically outweigh the potential benefits of water reuse/recycling.<sup>120</sup> When many priorities become competing interests, like in this example, they get weighed with the ROI and the project goals in order to allow the project leadership to make an informed decision.<sup>121</sup>

Part of the discussion, in a similar manner to the ideas previously mentioned, is how sustainability is defined by those who value it. For P11, sustainability is defined by the impact the firm can make on projects and processes. According to P11, the built environment only has a small ability to impact social sustainability; architects can advocate, but those decisions happen at policy level where planning and regulation occur. However, there are several areas that architects can impact - on the economy level, designers can maximise materials,

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<sup>118</sup> Anonymous. Interview with researcher with professional industry experience by author. April 08 and 17, 2020.

<sup>119</sup> Anonymous. Interview with researcher with professional industry experience by author. April 08 and 17, 2020.

<sup>120</sup> Anonymous. Interview with organisation manager within education-based owner by author, April 20, 2020.

<sup>121</sup> Anonymous. Interview with organisation manager within education-based owner by author, April 20, 2020.

relationships, and the design itself.<sup>122</sup> This ideally provides a more efficient way of working through better contractual relationships, which are better for business, certainty, and a reduction in burnout and lawsuits. At the ecology level, material manufacturing processes can be optimised, which reduces rework and the amount of materials involved.<sup>123</sup> In terms of owners and sustainability, many clients are starting to have their own internal policies and constraints, and they look to the building structure as the main area of impact. This is interesting from a design and construction standpoint because it makes policies for the project teams, who then have to figure how they can make these constraints work.<sup>124</sup> A discussion is needed with the ownership to see if they are on board with doing something different - the decision is always a cost/benefit analysis. With a firm that focuses on what resources and processes it can influence, they can be transparent about their impact for both projects and sustainability as a whole, especially with an in-house sustainability team.<sup>125</sup>

In a project-specific lense, most interviewees had strong opinions about the relationship between sustainability and projects. P01 stated that most of time, it depends on whether or not the sustainable initiatives are a program requirement, because this adds what they refer to as the “third leg to the stool” - the “legs” being schedule, budget, *and* sustainability. In order to effectively determine the “value” of the decisions within each “leg,” it is important to get true data through better tools, like parametric modelling.<sup>126</sup> For Project 1-A (P01), reaching LEED Platinum was a developer-led decision, and other stakeholders were involved as well. Sustainability carried weight through the architect’s method of creating a form of “currency” as a

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<sup>122</sup> Anonymous. Interview with practicing architect by author. April 16, 2020.

<sup>123</sup> Anonymous. Interview with practicing architect by author. April 16, 2020.

<sup>124</sup> Anonymous. Interview with practicing architect by author. April 16, 2020.

<sup>125</sup> Anonymous. Interview with practicing architect by author. April 16, 2020.

<sup>126</sup> Anonymous. Interview with architect with leadership role at an architecture firm; focused on sustainable design by author, April 13, 2020.

way to measure the value for LEED platinum decisions.<sup>127</sup> In a similar manner, Project 3 (P03) valued a green rating system that matched the values of the project; in this case, Fitwel. This owner does not mandate specific sustainability systems, but they can be pursued by individual projects.<sup>128</sup>

According to P05, the use of sustainable practices and initiatives have been limited because there is a lot of risk using new things, and typically that risk is pushed onto the general contractor. In three different projects, P05 compared the use of two rating systems and the impacts each had on the project, including how each owner's values and policies influenced the overall outcomes. P06 used Project 6 to emphasise how the involvement of stakeholders during the design process drove the overall sustainability initiatives. This later set expectations for other projects done by the same owner.<sup>129</sup> P08 specifically mentioned that in Project 8, the sustainability working team was instrumental in coming up with a set of goals used to set the design guidelines.<sup>130</sup> For Project 9, P09's organisation is focused on developing useful tools and applicable knowledge about the impact of the specific project type on carbon emissions. A unique issue with the rating system came up in Project 12 (P12) where the requirements stated that signage needed to be placed and was meant to encourage people to take the stairs. However, it was the owner's concern that this would send the wrong message to people whose different abilities meant that they cannot use the stairs; instead, the team decided to put a

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<sup>127</sup> Anonymous. Interview with architect with leadership role at an architecture firm; focused on sustainable design by author, April 13, 2020.

<sup>128</sup> Anonymous. Interview with organisation manager within education-based owner by author, April 13, 2020.

<sup>129</sup> Anonymous. Interview with organisation manager within education-based owner by author, April 13, 2020.

<sup>130</sup> Anonymous. Interview with manager and leader at an architecture firm by author. April 16, 2020.

creative, playful spin and relocate the majority of the signage.<sup>131</sup> According to P12, one of the biggest influences on this owner's decision was the question, "is this the right thing to do?"

P13 states that sustainable projects are inherently risky because they typically involve atypical or novel technologies or elements. However, the use of collaborative contracts and projects can spread risk across players; this can also be done for sustainable projects.<sup>132</sup> They also argue that owners and contractors need to be involved in the design process early on for more innovative solutions and high-performance strategies to be successfully implemented into the project.<sup>133</sup> The interviewee emphasised that the key element of any successful project, especially a sustainable one, is communication and collaboration, stating that "collaboration is the only way to do deeply sustainable projects."<sup>134</sup>

With regard to sustainable practices and BIM, the key takeaway according to P10 is that the team (especially the design team) have to think in terms of the "bigger picture" - one system or discipline does not have complete control over the energy consumption of a particular building. This mentality holds true for BIM and energy modelling as well, so the different disciplines who work with the main components (envelope, HVAC, telecommunications, etc) need to be in the room together to talk through the results and interact.<sup>135</sup> If some of the players are missing (for example, excluding structure and architecture and only coordinating MEP), this became a huge hindrance because some of the ideas could not be implemented or coordinated with the rest of the design team; there was a lack of optimisation in the project's systems.<sup>136</sup> One study by P10 focused on high performing versus non-high performing projects of the same

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<sup>131</sup> Anonymous. Interview with organisation manager within education-based owner by author, April 20, 2020.

<sup>132</sup> Anonymous. Interview with AEC law professional by author. April 24, 2020.

<sup>133</sup> Anonymous. Interview with AEC law professional by author. April 24, 2020.

<sup>134</sup> Anonymous. Interview with AEC law professional by author. April 24, 2020.

<sup>135</sup> Anonymous, Interview with researcher with professional industry experience by author, April 22, 2020.

<sup>136</sup> Anonymous, Interview with researcher with professional industry experience by author, April 22, 2020.

program type and found that the projects which really made an impact in energy consumption were the same ones that had all of the necessary disciplines (including operations and maintenance, the architect, the lighting designer, structural engineers, etc) in the model(s) and who furthered the design by working together.<sup>137</sup> Other examples had high aspirations but did not engage or integrate the energy model; this meant that the basis of the model was built around a lot of assumptions and was always a bit uncertain; very few members of the project team could engage or understand it.<sup>138</sup>

#### *6.2.3.2 Technology*

The advancements and nearly-widespread availability of different types of technologies have rapidly changed the AEC industry in the past decade or so, and this includes the tools and technologies for sustainable systems and practices. According to P10, early studies suggested technologies like BIM as a tool for advancing collaboration and sustainability, speculating on how designers and builders could make better, more efficient, and less "wasteful" buildings? However, early technologies were fairly limited; in Project 1-A (P01), parametric modelling and analysis was not yet possible, and only minor 3D studies were done for rough daylighting, using the mechanical engineers for energy explorations.<sup>139</sup> Comparatively, eight years after that project was completed, Project 1-B utilised in-house parametric modelling and parallel coordinate plots to present client values and explore priorities (for example, the amount of solar heat gain, or the added benefit of integrated solar panels). Across both projects and firm-wide, there aren't many collaboration platforms outside of Autodesk's Revit and Navisworks, which are not necessarily sustainability-focused.

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<sup>137</sup> Anonymous, Interview with researcher with professional industry experience by author, April 22, 2020.

<sup>138</sup> Anonymous, Interview with researcher with professional industry experience by author, April 22, 2020.

<sup>139</sup> Anonymous. Interview with architect with leadership role at an architecture firm; focused on sustainable design by author, April 13, 2020.

In Project 2, P02 emphasises the value of modelling a lot of elements to analyse and strategise. In particular, AR (augmented reality) and VR (virtual reality) softwares are used to coordinate and work with the client and design team to verify certain building elements.<sup>140</sup> 3D laser scanning and Autodesk products (Plangrid, Assemble, Revit, Navisworks, etc) are other commonly used softwares by both designers and builders. Estimators and engineers using mostly standard CM software with different added technologies.<sup>141</sup> A key element of softwares and technologies is to provide clear documentation around the use of tools on jobs, which is to be agreed upon by all parties.<sup>142</sup> Aggressive BIM execution plans to shift some of the contractor involvement to the design process; in that way, the team only has to coordinate once.<sup>143</sup> One of the big issues that can arise with interdisciplinary technology use is incompatible software. It becomes a problem when one group on the team, for example, the designers, create their own software to design in and it does not work with the rest of the team's software.<sup>144</sup> When important elements, such as the enclosure and interior architecture, are in incompatible models and it is written in the contract to use the model for dimensions, software issues can become incredibly problematic. In Project 2, the contractor decided to create their own interior architecture model to collaborate (in a compatible software), which is more work but necessary for confidence in the alignment, constructability, and measurements.<sup>145</sup> However, they still need to be able to import and export the relevant 3D geometry from the architect's model to check the alignment. This contractor is aggressive in their collaboration approach, and the design individuals want to collaborate, but the contracted architecture firm as a whole does not have a

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<sup>140</sup> Anonymous. Interview with technology manager at a construction company by author, April 06, 2020.

<sup>141</sup> Anonymous. Interview with technology manager at a construction company by author, April 06, 2020.

<sup>142</sup> Anonymous. Interview with technology manager at a construction company by author, April 06, 2020.

<sup>143</sup> Anonymous. Interview with technology manager at a construction company by author, April 06, 2020.

<sup>144</sup> Anonymous. Interview with technology manager at a construction company by author, April 06, 2020.

<sup>145</sup> Anonymous. Interview with technology manager at a construction company by author, April 06, 2020.

strategy in place because it is not how they typically work.<sup>146</sup> There are instances where different technology platforms can still work together, like in Project 5-A (P05). The steel structure and connections for this project were developed in Tekla while the MEPF was coordinated (with the structure) in Navisworks. Getting the owner onboard by demonstrating the potential as a communication tool for working through problems took time but was definitely worth it, stated P05. After several years of advancing technologies, Project 5-B used 3D scanning and 4D technology to coordinate the steel bracing for an existing building and assisted with the fabrication and shop drawings.<sup>147</sup>

Technology challenges are not limited to 3D software. For P03, this owner uses whichever document and file sharing system the contractor decides on, meaning that the members of their team have to learn or relearn a different sharing program each time they change projects. However, some programs and their uses remain the same throughout the industry, like the use of Bluebeam for mark ups, reviews, and problem-solving sessions.<sup>148</sup> Additionally, when the platforms are the same, like they were for Project 5-C, it helps to have technology for virtual coordination with out of state team members.<sup>149</sup> In Project 6 (P06), the whole project team (designers, builders, and owner) had access to a common sharing platform for both internal and external communication.<sup>150</sup> In this scenario, the client can see what the architect is thinking, which was important because the project schedule had to move so quickly. In Project 8 (p08), Revit was used in a unique way; instead of the contractor, the engineers, and the architect each having their own model, there was one single model created by assigning

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<sup>146</sup> Anonymous. Interview with technology manager at a construction company by author, April 06, 2020.

<sup>147</sup> Anonymous. Interview with senior manager at a construction company by author, April 20, 2020.

<sup>148</sup> Anonymous. Interview with organisation manager within education-based owner by author, April 20, 2020.

<sup>149</sup> Anonymous. Interview with senior manager at a construction company by author, April 20, 2020.

<sup>150</sup> Anonymous. Interview with design partner at an architecture firm by author. April 08, 2020.

elements to the party most fit to be in charge of it.<sup>151</sup> This collaboration effort took a lot of coordination on who designs, owns, and builds it, but it also eliminates the "waste" of duplicating efforts and elements.<sup>152</sup> In the end, the team had one consolidated model with no duplicated elements, and the client saw the benefit of being able to log on and see the most up to date information.<sup>153</sup>

For P09, because the data and processes surrounding sustainability systems is still so limited and unexplored, part of their organisation's goal is to develop tools for professionals to use on projects. For example, in Project 9, one team works with Revit (using the Revit model and an add-in called *Tally*) and another with a web-based tool called the Embodied Carbon in Construction Calculator (or EB3) for creating a whole building life-cycle assessment to study the impact carbon has on the design.<sup>154</sup> Outside of these project-specific teams, the organisation P09 leads works with owners, architects, environmental materials experts, and engineers to focus on more tools that everyone can access. Most interfacing is done with PDF (in 2D) because everyone is able to use and understand it; the further away from practice P09 gets, the less likely 3D modelling is used. However, from a collaboration perspective, when there are multiple people working on something, there is a comfort with knowing that the team members have the most up-to-date information.<sup>155</sup> P10 started focusing their research on people and why/how people collaborate through technology, especially with BIM. Some of the main topics they focus on are teaching communication, how to translate from one discipline to the next, and how to pick up shared problems and creatively solve them.<sup>156</sup> The initial questions were

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<sup>151</sup> Anonymous. Interview with design partner at an architecture firm by author. April 08, 2020.

<sup>152</sup> Anonymous. Interview with design partner at an architecture firm by author. April 08, 2020.

<sup>153</sup> Anonymous. Interview with design partner at an architecture firm by author. April 08, 2020.

<sup>154</sup> Anonymous. Interview with researcher with professional industry experience by author. April 08 and 17, 2020.

<sup>155</sup> Anonymous. Interview with researcher with professional industry experience by author. April 08 and 17, 2020.

<sup>156</sup> Anonymous, Interview with researcher with professional industry experience by author, April 22, 2020.

concentrated around how BIM was supporting collaboration; the results showed that it supports a shared understanding and takes out the negotiation that teams have around problem definition (by visually communicating what the issue is).<sup>157</sup> This helps everyone clearly communicate what the challenges and constraints are (physical and spatial), take the negotiation time away, and change the conversations from blaming to problem-solving based on costs and risks.<sup>158</sup> However, though (visual) BIM is a widely-used tool, it has its limitations. It is not great at supporting interaction or "messy talk," which is when teams brainstorm together with malleable means to inform shared discovery, knowledge exchange, critical engagement, and finally synthesis.<sup>159</sup> People need malleable media (like whiteboards, paper and pens, trace paper, etc) to draw together, brainstorm new ideas, and problem-solve together.<sup>160</sup> As they draw together and gesture together, it helps explain their ideas and create a shared understanding. Here, by team members exchanging disciplinary knowledge, such as code or composition, they can then work through the problem by asking questions of each other.<sup>161</sup> Good collaboration leaders ask clarifying questions and frequently engage with the others.<sup>162</sup> While there is an increasing amount of data and knowledge on this topic (and this thesis aims to contribute to that, in a way), other types of collaboration, like technical information exchange (common data environment/shared databases), haven't been discussed or researched as much, but are becoming more and more important to the industry.<sup>163</sup>

Integrated, detailed, and cloud-based models are becoming commonplace in the advancing professions. For Project 11 (P11), the use of cloud-based Revit with geo-location

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<sup>157</sup> Anonymous, Interview with researcher with professional industry experience by author, April 22, 2020.

<sup>158</sup> Anonymous, Interview with researcher with professional industry experience by author, April 22, 2020.

<sup>159</sup> Anonymous, Interview with researcher with professional industry experience by author, April 22, 2020.

<sup>160</sup> Anonymous, Interview with researcher with professional industry experience by author, April 22, 2020.

<sup>161</sup> Anonymous, Interview with researcher with professional industry experience by author, April 22, 2020.

<sup>162</sup> Anonymous, Interview with researcher with professional industry experience by author, April 22, 2020.

<sup>163</sup> Anonymous, Interview with researcher with professional industry experience by author, April 22, 2020.

was incredibly helpful for the large-scale project, which had one master model and the whole related network. Using the maximum Level of Detail (or LOD) on fully integrated BIM models by specialised teams with architect oversight allow for better, smoother, and faster in-house manufacturing processes. With Virtual Design and Construction (VDC) and virtualising things, P11 argues that the end result is a better building because there is better craftsmanship from the factory (versus hand-building in the field). Additionally, P11 states that the technology is kind of taken for granted; communication is so important, so project management tools and coordination software is increasingly essential. For example, Project 12 (P12) used BIM 360, an Autodesk cloud-based system, to coordinate the project's one federated model. The contract agreements and technologies made this an easier process than the typically GCCM process of insurance issues with BIM, partially because everyone is working in the same model and partially because the contracts help: the owner only contracted the contractor, and the architect was contracted to the contractor.<sup>164</sup> Multi-user sharing platforms are also better than linear approval systems because it is easier for the management teams to coordinate and everything can be quickly packaged up at the end of a project.<sup>165</sup> In terms of operations and maintenance, the facilities groups of these projects can utilise the software by collecting all the necessary assets in the 3D model with information linked to them. This data can be exported to a spreadsheet software and imported to a facilities management software for knowledge sharing and issue tracking.<sup>166</sup> True optimisation is still a few years out as many maintenance staff are not able or willing to keep up with high-tech technology, such as a 3D model on a tablet. However, P12 assures that being able to link elements and their preventive maintenance plans

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<sup>164</sup> Anonymous. Interview with organisation manager within education-based owner by author, April 20, 2020.

<sup>165</sup> Anonymous. Interview with organisation manager within education-based owner by author, April 20, 2020.

<sup>166</sup> Anonymous. Interview with organisation manager within education-based owner by author, April 20, 2020.

or specific issues (ie. a confined space plan) allows the staff to go with as much information beforehand as possible and is highly valuable to their team.

#### *6.2.3.3 Education and Advocacy*

Education and advocacy for collaboration, communication, and values, particularly sustainability, is necessary to continue pushing the AEC+ industry forward. According to P01, new groups of talent specifically look for sustainability as a value with a firm because of their passion and dedication to that issue. They continue to say that it is not just the younger professionals who care; because the “older” generations are seeing that “it” (high-performance building) can be done, they are also becoming more passionate.<sup>167</sup> For P04, their goal is education in both academia and the profession. They aim to work with clients on a project/product basis, by helping them look at risks, analyse them, and manage them with insurance or budget changes. They also want to focus on training and education by sharing what they know and have learned through seminars, conferences, training, and other means.<sup>168</sup> Higher education hinders progress in many ways by making it difficult to create interdisciplinary spaces, always talking to the same people in the same program, and having different class schedules or graduation times for certain programs. This is actively detrimental as other people (ie. public health majors) can contribute a lot to the ongoing conversations.<sup>169</sup> Architects face different problems than property managers, for example, so educational training would be tailored but not isolated. For a professional context, if the architecture program is grouped with the arts, then those students lack the experience they need with talking to future contractors and

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<sup>167</sup> Interview with architect with leadership role at an architecture firm; focused on sustainable design by author, April 13, 2020.

<sup>168</sup> Anonymous, Interview with sustainability consultant with construction law background by author, April 23, 2020.

<sup>169</sup> Anonymous, Interview with sustainability consultant with construction law background by author, April 23, 2020.

owners, as well as with lawyers, public health officials, and insurance brokers.<sup>170</sup> P04 aims to help change the industry by teaching graduate students to challenge themselves and understand the current issues.

Part of P04's frustration is that not only are lawyers not a driving force behind sustainability, they have no ethical obligations for pushing sustainable goals. As an individual with a construction law background, P04 argues that for the most part, lawyers are a part of the problem because they scare people away from sustainable construction and operations. The current framework is not helping people solve larger issues or shift the focus from only financial gain to valuing other ideas (ie. the environment).<sup>171</sup> The best way of achieving this is through education and higher education. Good mentors teach people to solve problems that might not even exist yet instead of just telling people how to do things.<sup>172</sup>

#### *6.2.3.4 Lessons Learned*

A fairly standard method of sharing gained knowledge from a project, client, or market sector is to put together a “lessons learned” document, where team members can educate others by describing the challenges they faced and what they learned from it. In this regard, interviewees were asked if they were to change or add anything to describe what that would be. Part of the benefit to having shared knowledge and advanced technologies is not having to “reinvent the wheel,” so to speak, every time someone has an idea or wants to try something new.

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<sup>170</sup> Anonymous, Interview with sustainability consultant with construction law background by author, April 23, 2020.

<sup>171</sup> Anonymous, Interview with sustainability consultant with construction law background by author, April 23, 2020.

<sup>172</sup> Anonymous, Interview with sustainability consultant with construction law background by author, April 23, 2020.

P01 addressed the issue of a conservative approach to sustainability, arguing that even with the recent advancements (or even, because of), architecture is expensive. At the end of the project, there is a large building that has to work long-term, and there can be big problems.<sup>173</sup> Sometimes the right technology isn't available or there yet for big "pie in the sky" ideas.<sup>174</sup> Additionally, a lot of money, investments, and time are put into a project, and people typically give this with the expectation of getting a working building at the end.<sup>175</sup> P01 ends on an aspirational note, stating, "I believe that firms are going to be recognised more for not being conservative and for encouraging and educating owners and clients." P02 claims that they are happy with focusing on BIM and technology because it will always be needed in the AEC industry because having the newest, best, and most efficient methods of doing things are always valued. Though they feel a general lack of universal industry knowledge from deeply concentrating on technology, they feel it has been a rewarding path so far.<sup>176</sup> They state that they feel valued at the companies they have worked at, from leading the design through BIM and construction with VDC/BIM and associating the value of BIM with their own increased value, position, and abilities.<sup>177</sup> However, they would recommend gaining more construction experience and not being siloed so someone can "gain the perspective [they] need" to have the breadth of experience needed for a career path.<sup>178</sup> You need to force yourself out of your comfort zone to change.

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<sup>173</sup> Anonymous. Interview with architect with leadership role at an architecture firm; focused on sustainable design by author, April 13, 2020.

<sup>174</sup> Anonymous. Interview with architect with leadership role at an architecture firm; focused on sustainable design by author, April 13, 2020.

<sup>175</sup> Anonymous. Interview with architect with leadership role at an architecture firm; focused on sustainable design by author, April 13, 2020.

<sup>176</sup> Anonymous, Interview with technology manager at a construction company by author, April 06, 2020.

<sup>177</sup> Anonymous, Interview with technology manager at a construction company by author, April 06, 2020.

<sup>178</sup> Anonymous, Interview with technology manager at a construction company by author, April 06, 2020.

For P03, they stated that a "contractual relationship increases the odds of being successful; it gives a high performing team both tools and incentive to work a different way, it rewards that, but is not a 'magic bullet.'"<sup>179</sup> Just because firms or teams work well in other contractual relationships does not mean they will work well in progressive Design-Build contracts.<sup>180</sup> Higher performing teams work together to develop or "guide" the design to be within budget through an iterative cost modelling process, not by following the typical process of doing a bunch of work, finding out it costs too much, and needing to do value engineering exercises.<sup>181</sup> P03 asked, "who likes designing something that you're excited about, that the owner likes and finding out it costs too much? " With a good team and a contractor on earlier, they can help realise design intent with greater reliability and certainty.<sup>182</sup> The contractor needs to be genuinely involved in the process.

Not many other professions have a tangible, impactful result that lasts as long as a building. By being an architect, contractor, or engineer, you design and build something that will last a long time and many people will touch. By creating and demanding interdisciplinary teams, the more learning and sharing knowledge can happen; only talking to one type of group or the same audience is not helpful, especially in contractual relationships that are traditionally set up to be adverse.<sup>183</sup> Integrated project delivery is almost what we have to do because the

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<sup>179</sup> Anonymous. Interview with organisation manager within education-based owner by author, April 13, 2020.

<sup>180</sup> Anonymous. Interview with organisation manager within education-based owner by author, April 13, 2020.

<sup>181</sup> Anonymous. Interview with organisation manager within education-based owner by author, April 13, 2020.

<sup>182</sup> Anonymous. Interview with organisation manager within education-based owner by author, April 13, 2020.

<sup>183</sup> Anonymous, Interview with sustainability consultant with construction law background by author, April 23, 2020.

traditional model does not work for sustainability or collaboration; when will people be forced to build that way? Arguably now, P04 argues; they have to build that way now.<sup>184</sup>

Each client has their own challenge, and always something will go awry; a project is never perfect, advised P05. They also pointed out that it is relatively easy for a designer to say "let's use this material/product/technology" and it'll be better, because typically the contractor is the one stuck with telling the owner that the salesperson was wrong.<sup>185</sup> Part of the contractor's expertise is understanding the details of costing, and "being the bearer of bad news when someone's excited about it" sucks.<sup>186</sup> Giving people the information and full story they need in order to make the best decisions is so important, but it is necessary to remember that not all people are the same.<sup>187</sup> Different projects have and need different approaches, especially public versus private projects, and typically contractors are successful in one or the other.<sup>188</sup> The public sector is better at upfront discussions and seeing the value of upfront costs, but they also have stricter finances and more responsibility.<sup>189</sup> Private developers can have layers to get to a key player, but there is usually someone who can make immediate decisions.<sup>190</sup> P05 states that these aspects make a difference because the decision is made quickly and firmly, and because private developers building more often, they typically have more technical knowledge and decision-making processes that they rely on. In contrast, the Public sector might have one or two big projects a year, and they typically have less technical knowledge and structure for

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<sup>184</sup> Anonymous, Interview with sustainability consultant with construction law background by author, April 23, 2020.

<sup>185</sup> Anonymous. Interview with senior manager at a construction company by author, April 20, 2020.

<sup>186</sup> Anonymous. Interview with senior manager at a construction company by author, April 20, 2020.

<sup>187</sup> Anonymous. Interview with senior manager at a construction company by author, April 20, 2020.

<sup>188</sup> Anonymous. Interview with senior manager at a construction company by author, April 20, 2020.

<sup>189</sup> Anonymous. Interview with senior manager at a construction company by author, April 20, 2020.

<sup>190</sup> Anonymous. Interview with senior manager at a construction company by author, April 20, 2020.

decision-making process, and paired with more influential stakeholders, this adds to the complexity.<sup>191</sup>

P06 spoke to the variety of solutions, strategies, and relationships, stating that the profession (architecture) is trying to step up and really have a public attitude about carbon, the environment, and equity, but it has yet to find a powerful way of sharing its message. They also spoke to finding your voice as a leader on a team; every team has things that don't go the way they thought they would, and the goal is focus on making the best decisions at the best time for the best reasons.<sup>192</sup> Own your mistakes and move on. On a similar note, P07 emphasised valuing the relationships and partnerships with the design team, saying that being on good terms with them over the course of the project increases the odds of the project being successful. The contractual relationships can constrain a project and it is a hard enough job without making it combative.<sup>193</sup> The key partnership of a project is the contractor and the architect, so these teams need a similar or complementary culture.<sup>194</sup> Onboarding the trade partners early on for a basis of design helps with budget certainty and in reverse-engineering the process.<sup>195</sup> Reverse-engineering starts with the budget and designs backwards to the budget so there is no need for a value engineering effort and the owner's value-add items can be included or designed closer to budget, savings, or contingencies; overall, this leads to a better design process or better systems, or both.<sup>196</sup> However, it is important to remember that with novel relationships or contract methods, there will be a learning curve that you go through as the process is exposed. It is mandatory that the project team understands what is required to develop trust and respect between members, and everyone has to work to break the old

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<sup>191</sup> Anonymous. Interview with senior manager at a construction company by author, April 20, 2020.

<sup>192</sup> Anonymous. Interview with design partner at an architecture firm by author, April 08, 2020.

<sup>193</sup> Anonymous. Interview with project manager at construction company by author. April 22, 2020.

<sup>194</sup> Anonymous. Interview with project manager at construction company by author. April 22, 2020.

<sup>195</sup> Anonymous. Interview with project manager at construction company by author. April 22, 2020.

<sup>196</sup> Anonymous. Interview with project manager at construction company by author. April 22, 2020.

process and share in-progress stuff in order to work together.<sup>197</sup> Using the contractual relationships to share risk is key, as well as striving towards the same goals.<sup>198</sup>

For P08, their lessons learned related to the use of collaboration tools regardless of who the client was or what project delivery method was employed. This included trying to push for transparency and collaboration regardless of contract type as well as helping develop a roadmap for how the team is going to work together and how decisions will be made.<sup>199</sup> Other aspects included respect and accountability for their actions, making decisions as teams, and putting these elements on paper to help onboard new team members or reset when things become difficult.<sup>200</sup> Additionally, P08 stated that designers need some time at the beginning of the process to have exciting concepts without super restrictive parameters (structural system, landscape setbacks, structural bay, etc).<sup>201</sup> Also, having the whole team physically in the same space can sometimes inhabit productivity, so it is important to know when to come together and when to go separate ways and get work done.<sup>202</sup> Having a contract that doesn't set up members to blame each other is crucial.<sup>203</sup> From an owner's perspective, P12 stated that the contractors needed to get comfortable with ambiguity, being in the design/planning phase, and trusting the process, while the design side needed to learn how to take the "constraints" or other information given by the contractor and incorporate it without being "offended."<sup>204</sup> They also were excited to learn more about design and how to support that iterative process, and worked with the team to develop a system that allows the constraints to inform the design without crushing creativity.<sup>205</sup>

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<sup>197</sup> Anonymous. Interview with project manager at construction company by author. April 22, 2020.

<sup>198</sup> Anonymous. Interview with project manager at construction company by author. April 22, 2020.

<sup>199</sup> Anonymous. Interview with manager and leader at an architecture firm by author. April 16, 2020.

<sup>200</sup> Anonymous. Interview with manager and leader at an architecture firm by author. April 16, 2020.

<sup>201</sup> Anonymous. Interview with manager and leader at an architecture firm by author. April 16, 2020.

<sup>202</sup> Anonymous. Interview with manager and leader at an architecture firm by author. April 16, 2020.

<sup>203</sup> Anonymous. Interview with manager and leader at an architecture firm by author. April 16, 2020.

<sup>204</sup> Anonymous. Interview with organisation manager within education-based owner by author, April 20, 2020.

<sup>205</sup> Anonymous. Interview with organisation manager within education-based owner by author, April 20, 2020.

On a financial point, P11 stated that they learned the importance of finance and the bottom line to make any sort of change through their career. Project teams need to look for efficiency, because practice is all about cost.<sup>206</sup> With the financial elements of the project and of the client, it is necessary to ask, “What is the client looking for?” Additionally, both designers and builders need to know what the constraints on the project are; policy, budget, or schedule - as soon as the constraints are figured out, the building starts to form.<sup>207</sup> P14 had something similar to say, noting the significance of understanding where the client’s purchasing power lies. For example, workplace designers have quite a bit of control over ensuring a specific material use due to frequent design-assist opportunities, so it stands that workplace projects which prioritize high-achieving materials drive up the demand in the manufacturer’s lens, further making procuring these materials that much more approachable for public projects down the road.<sup>208</sup>

#### 6.2.3.5 Collaboration

“Give a shit. You’re creating these permanent or almost permanent structures that displace communities, have a high environmental cost, ship materials, extract materials. You’re changing the fabric of the community... Care about that. Look at the bigger picture of what you’re doing or what you’re not doing and what you could be doing - you could be utilising these tools and creating communities that are more transit-oriented, more diverse, more accessible. Reframe your thinking to care about what you’re doing.” - *Interviewee*

Collaboration is an essential component in successful projects, and collaborative teams are better equipped to solve complex problems, particularly in regard to new tools and technologies in regard to sustainability. Different firms, partnerships, and projects will have different standards for collaborative practices, but it is important to note that there are common

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<sup>206</sup> Anonymous. Interview with practicing architect by author. April 16, 2020.

<sup>207</sup> Anonymous. Interview with practicing architect by author. April 16, 2020.

<sup>208</sup> Anonymous. E-mail message to author, May 19, 2020.

themes throughout all, like communication, emotional intelligence/soft skills, and respect, to name a few. According to P08, collaboration is something everyone in the industry and beyond should be talking about. They argue that there is a lot of relatively watered-down architecture in the United States because of the "sue-happy, litigious society, and [that] contracts don't support collaboration like they do in other countries."<sup>209</sup> America is not seeing the progressive work like what is being done in other countries. There needs to be a focus on finding other ways to break down these barriers.<sup>210</sup> One potential step in the right direction could be a novel delivery method - a "progressive" design-build contract that incorporates the values of an integrated project delivery. P12 states that this type of contractual relationship is valuable not only because of the focus on expectation and goal setting (which is great when there is a high volume of stakeholders) but also because it improves multiple outcomes - sustainability, safety, productivity, and process. With a bigger focus on a more collaborative environment, versus the litigious one, there is a better chance of getting to the best end goal and not promising something that cannot be built.<sup>211</sup> This type of project delivery method lends itself to support creative innovation through channelling the team efforts towards a set few goals and using each other's knowledge and experiences to push the design to a better place.<sup>212</sup>

"Contracts don't matter as much as relationships." According to P13, collaborative people should be in OAEC roles, and more literature is needed to demonstrate the positive effects of IPD contracts. Changing the default methods for the industry will be challenging. For the public sector, much of the struggle will come from the public procurement process and

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<sup>209</sup> Anonymous. Interview with manager and leader at an architecture firm by author. April 16, 2020.

<sup>210</sup> Anonymous. Interview with manager and leader at an architecture firm by author. April 16, 2020.

<sup>211</sup> Anonymous. Interview with organisation manager within education-based owner by author, April 20, 2020.

<sup>212</sup> Anonymous. Interview with organisation manager within education-based owner by author, April 20, 2020.

"lowest bidder" mentality.<sup>213</sup> In terms of government and legislature, they do not understand that it is a better process, they only worry about the "tax payer getting the best deal" and contingencies to protect themselves.<sup>214</sup> P13 speculates that it will take decades for the public sector to catch up because of these state and federal government issues, however, higher education and medical facilities are spearheading the shift to more collaborative practices. They are able to do this because they already collaborate with themselves.<sup>215</sup> According to P02, more owners are already pushing collaboration, in addition to an increase by contractors, who use it for marketing and as a story-telling platform for their company. Owners want the coordination process to happen once, not multiple times in half-measures by the design team (get sort of close) and then in construction (high detail needed for fabrication).<sup>216</sup> Even if this process initially appears more expensive than a typical coordination process, because the owner only pays for it once, the argument for a significant value is there if the cost is managed.<sup>217</sup> Tools like aggressive BIM Execution Plans are needed in addition to owner requirements to shift some contractor involvement to the design process.<sup>218</sup> Collaborative projects get the contractors involved early, meaning that there is early construction expertise (pricing, installation), and the contractor understands and participates in design more (ideally leading to better design). P13 states that this helps make the design function and provides a sense of ownership among team members. In addition, the general atmosphere is much better because the project team environment is based on human relationships, meaning actions and decisions are typically more fair and even-handed.<sup>219</sup> This is in contrast to the "corporate mentality," where team members of

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<sup>213</sup> Anonymous. Interview with AEC law professional by author. April 24, 2020.

<sup>214</sup> Anonymous. Interview with AEC law professional by author. April 24, 2020.

<sup>215</sup> Anonymous. Interview with AEC law professional by author. April 24, 2020.

<sup>216</sup> Anonymous. Interview with technology manager at a construction company by author, April 06, 2020.

<sup>217</sup> Anonymous. Interview with technology manager at a construction company by author, April 06, 2020.

<sup>218</sup> Anonymous. Interview with technology manager at a construction company by author, April 06, 2020.

<sup>219</sup> Anonymous. Interview with AEC law professional by author. April 24, 2020.

different "sides" or disciplines typically blame the "other guy" to maximise their own profit at a great destruction of others or overall good.<sup>220</sup> These distortions are harmful to the project.

Some common tools used in both typical and IPD projects alike are charrettes. Charrettes are working meetings where the design team (architect) meets with the client, the stakeholders, or both to determine priorities, goals, and opportunities. P01 describes their firm's two-step charrette process as beginning at conceptual design and following up around design development to refocus. The second meeting is important for stakeholders who can then reintroduce ideas with more targeted themes.<sup>221</sup> In a similar manner, this firm also does "eco-charrettes," which are charrettes specifically concentrated on potential sustainability initiatives.<sup>222</sup> The design team first focuses on divergent thinking (expanding out), then on convergent thinking (narrowing down) as a way of "back-casting" instead of "forecasting."<sup>223</sup> This allows the group to prioritise on the vision and what strategic steps are needed to get there. This process purposeful ignores precedents and what has already happened in order to really allow the full design potential, before integrating the constraints.<sup>224</sup> However, it is imperative that the design team avoid becoming closed off to suggestions from others, especially team members. P09 says that in order to have true interdisciplinary engagement, project team members must be able to hear other points of view, without passing judgement, and be willing to try paths that may not necessarily seem efficient at first. This can be hard when (quick) decisions are needed or valued, so the team needs clear communication and expectations.<sup>225</sup>

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<sup>220</sup> Anonymous. Interview with AEC law professional by author. April 24, 2020.

<sup>221</sup> Anonymous. Interview with architect with leadership role at an architecture firm; focused on sustainable design by author, April 13, 2020.

<sup>222</sup> Anonymous. Interview with architect with leadership role at an architecture firm; focused on sustainable design by author, April 13, 2020.

<sup>223</sup> Anonymous. Interview with architect with leadership role at an architecture firm; focused on sustainable design by author, April 13, 2020.

<sup>224</sup> Anonymous. Interview with architect with leadership role at an architecture firm; focused on sustainable design by author, April 13, 2020.

<sup>225</sup> Anonymous. Interview with researcher with professional industry experience by author. April 08 and 17, 2020.

Individual understanding when shared becomes shared knowledge, but shared knowledge can be intangible and ambiguous, so a big hurdle is figuring out how to disseminate knowledge effectively, quickly, and respectfully.<sup>226</sup>

P10 states that those who are good at collaboration are good at asking clarification questions. Misunderstandings will happen on a team, even with a cultivated shared understanding (defined as linguistic cues of questions and of acknowledgement).<sup>227</sup> To P04, innovation is directly related to how you teach people to solve problems and how they work together - and collaboration is needed for innovation. To prove their point, they said, "contractors can't build more sustainable buildings unless they're designed that way and the owner wants them."<sup>228</sup> No longer should architecture firms have to "sneak in" sustainable goals that do not cost more - the ethical values of the profession demand more.<sup>229</sup> On a similar note, collaboration is attractive. P13 points out that there is better shared profitability and better projects because IPD takes away incentives to NOT collaborate. In older delivery methods, people do not take blame or responsibility. With the right collaborative contracts, the shared risk/reward system encourages people to solve the problem because the reward is based on how well each person (and the team) come up with a solution.<sup>230</sup> According to P13, most "sophisticated" firms no longer focus only on profit because they know that relationships are critical to the AEC+ industry.<sup>231</sup> This is demonstrated in how people are trained, especially in

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<sup>226</sup> Anonymous. Interview with researcher with professional industry experience by author. April 08 and 17, 2020.

<sup>227</sup> Anonymous, Interview with researcher with professional industry experience by author, April 22, 2020

<sup>228</sup> Anonymous, Interview with sustainability consultant with construction law background by author, April 23, 2020.

<sup>229</sup> Anonymous, Interview with sustainability consultant with construction law background by author, April 23, 2020.

<sup>230</sup> Anonymous. Interview with AEC law professional by author. April 24, 2020.

<sup>231</sup> Anonymous. Interview with AEC law professional by author. April 24, 2020.

cases where the mentality is that mistakes mean blaming others.<sup>232</sup> We must change the culture going forward.

#### 6.2.4 Conclusion

Collaboration is an essential component in successful projects. Communication about goals, values, and definitions are necessary for successful integration. Interdisciplinary teams are able to identify areas of risk and challenge and take better steps to mitigate them. Collaborative teams are better equipped to solve complex problems, particularly in regard to new tools and technologies in regard to sustainability. If the notion that sustainable projects are inherently “risky” from an economic standpoint is true, but sustainable practices are valued by many people and industries, then integrated teams for sustainable projects help make these projects a reality.

### 6.3 Viability Studies

The possibility of this product being implemented directly relates to the current and near future regard to sustainability, technology, and collaboration. With an impending recession and vast social upheaval in the United States, I believe there are two significant, potential outcomes. The first is that we regress again and become frugal as private developers and owners refuse to take any risks and build only the most economically viable building, ignoring the environmental and social aspects, while the public sector sees less and less funding. This is, of course, an extreme, but it is completely possible. In this scenario, owners will not pay the higher upfront costs for early collaboration nor will they see worth in sustainable rating systems or technologies

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<sup>232</sup> Anonymous. Interview with AEC law professional by author. April 24, 2020.

unless there is some kind of financial return or significant market demand. Here, this framework is so unlikely to be implemented because the economic value of it is not immediately seen.

On the other extreme, with the civil unrest and growing concern for the environment and human health, it is possible that we will see a stronger push to balance these values. In a global, capitalist society, it is unlikely that we will see the removal of the economic aspect in our lifetimes, but there are reasons to shift away from it. According to one article, the hyperfocus on economic growth was problematic long before the 2020 pandemic and subsequent economic recession, and as a result there is now a “degrowth” movement which argues for reduced production of goods, working hours, and GDP for the goal of reducing carbon emission.<sup>233</sup> With this mentality, one focused less on strict economic value (profit and return on investment, mainly) and more on the social and environmental aspects, this framework would be ideal. It would give priority to people and planet first, emphasising the significance of the current climate crisis.

In both scenarios, there are still challenges around technology, cultural and discipline values, legal issues, and contractual relationships. The framework does not seek to make a “one size fits all” solution, but to instead suggest that the project team (or firm or organisation, should it be applied in that manner) come together to agree on such issues such as responsibilities and conflict resolution. In a way, this does happen when project managers negotiate contracts, but instead of the risk being pushed down to the party least capable of managing it, the team can collectively work out where each risk is best placed. This would then become the project team’s “Values Agreement.”

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<sup>233</sup> Love, Shayla. “COVID-19 Broke the Economy. What If We Don’t Fix It?” June 16, 2020.

## *6.4 Product Proposal*

The Values Agreement is a written document which outlines the collective agreement of the project team (or firm or organisation). At a minimum, it should cover goals and expectations, relationships between parties (contractual or otherwise), the decision-making process; risk, liability, and insurance requirements, and conflict resolution. Additionally, it could include values statements from the design team, contractor and subcontractors, and the owner or other relevant stakeholders, as well as a “technology use” section for coordinating and collaborating BIM. A Values Agreement would be a contract that the team members would have to agree to and uphold in order to realise the best possible project given the constraints and parameters. In this way, it can serve as a baseline for a variety of project teams with varieties of projects, and it can be referred to as the project progresses. There would certainly be an adjustment period for the AEC+ industry, but once this method became commonplace (if not required, like a legal contract), the strategies for innovation and collaboration would be implemented in any project process.

## **Chapter 07: Synthesis**

### *7.1 Product Philosophy*

The ideas for the Values Agreement are based from the research in the previous chapters, particularly from the semi-structured interviews. While one interviewee stated that a "contractual relationship increases the odds of being successful [by giving] a high performing team both tools and incentive to work a different way, [it is] not a ‘magic bullet.’"<sup>234</sup> Additionally, a different participant emphasised the focus on team building and leadership, enforcing the idea that "contracts matter, but only to a point - no matter what contract, you need to do the hard

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<sup>234</sup> Anonymous. Interview with organisation manager within education-based owner by author, April 13, 2020.

work of team building."<sup>235</sup> In one example project mentioned above, while the team is working well together, the biggest challenge has been the differing expectations and different languages; the conflicts in the meaning of a word lead to issues and arguments. On a similar note, another interviewee states that in order to have true interdisciplinary engagement, project team members must be able to hear other points of view, without passing judgement, and be willing to try paths that may not necessarily seem efficient at first. This can be hard when quick decisions are needed or valued, so the team needs clear communication and expectations.<sup>236</sup>

The common theme in these statements is expectations and their ability to help or harm the project. Ideally, the differences in discipline culture and language would be addressed through interdisciplinary projects at a higher education level, but without that reform, it will need to be addressed at a project level. Expectations about project outcomes, decision-making structures, ownership, risks and risk mitigation, technology, and communication are huge on a project, but even if they are talked about, they typically are not written down, agreed upon, and communicated to the rest of the team. This might be a single conversation between the owner's representative and the architectural project manager, and that is not enough. Additionally, expectations typically tie to the values of various project team members, which, as previously stated, affect the project team and project outcomes or goals. It may be the difference between an owner asking for a "green" building that meets a minimum LEED level, an architect designing a high-level, high-performing "green" building, and a contractor building to a code or regulation that is not at the same "green" building standard. With a Values Agreement, these conversations about goals, expectations, and values would occur earlier and with a wider breadth, incorporating multiple levels of project managers, workers, and stakeholders.

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<sup>235</sup> Anonymous, Interview with researcher with professional industry experience by author, April 22, 2020.

<sup>236</sup> Anonymous. Interview with researcher with professional industry experience by author. April 08 and 17, 2020.



## 7.2 Goals and Objectives

The last three goals as stated in the beginning of this study are as follows:

- This study aims to propose a workflow or design process which may address some of the challenges and opportunities suggested by the research.
- This study intends to understand how values factor into design decisions, particularly ones that weigh more into the ecological or social value (versus economic).
- This study chooses to focus on and analyse the ways in which interdisciplinary collaboration can potentially implement new or modified methods for design, construction, and operation, based on a reevaluated values system.

These objectives align with the product proposal of the previous chapter, stating that the Values Agreement would be a written document which outlines the collective agreement of the project team, firm, or organisation. While the size and scope of the Agreement would vary from project to project (group to group), the minimum it should cover is the goals and expectations, relationships between parties (contractual or otherwise), collaboration or integration strategies, the decision-making process; risk, liability, and insurance requirements, and conflict resolution. Additionally, it could include values statements from the design team, contractor and subcontractors, and the owner or other relevant stakeholders. The “technology use” section for coordinating and collaborating BIM could be excluded if such expectations were outlined in the project team’s BIM Execution Plan (or BIM Ex Plan). Other potential uses could include outlining the sustainability initiatives and targets, or the specific values of certain parties. The goal is to have a document that everyone has seen, read, and can refer to when problems arise. Though that seems a bit daunting and impossible for the more sizable projects with hundreds of subcontractors, labourers, and designers, communication and management technology is

rapidly advancing. Emails and document sharing are two aspects of project management and documentation that are already common in today's processes. With the Values Agreement, it is in a single, accessible location and eliminates the need for repetitive emails, RFIs, or time spent searching for specific information buried in multiple locations.

Another goal is to incorporate some requirement or incentive to collaborate early on and often. Strategies can range from weekly meetings to full project team colocation, depending on the variety of factors involved. Multiple participants emphasised the benefits of having everyone physically present either in working meetings or in a co-location environment, particularly because it became much easier to form relationships of respect and trust, as well as have the necessary conversations face-to-face and in a much more efficient manner. In many regards, typical contracts and agreements often forget the "people" aspect of things. One interviewee stated that their research "tells us that more collaborative delivery tends to lead to better outcomes; more collaborative delivery leads to more collaboration that leads to better outcomes." There may be some adjustments when shifting to new or modified processes, but the benefit is exponential; the real currency in the AEC+ industry is relationships, and good relationships are better for business.

Lastly, one of the primary goals is to emphasise the importance of this information and alternative process. The processes for coordination and collaboration the AEC+ industry uses today are based in old ways of thinking about and doing things, and if it is to address the significant issues which impact every aspect of the lives of millions of people, new or modified processes *must* be implemented and prioritised. This idea is not outside of the realm of possibility with a few adjustments to the industry and is based on the research done both by the author and by others who came before. Many researchers and professionals in the AEC+ industry desire a more collaborative environment with respect and understanding; no

participants of this study claimed to enjoy designing something over budget or having to inform the team that the design does not meet the schedule or budget constraints. Collaboration simply eliminates many of the issues the professions see today, but our “litigious society” and overemphasis on economic value have not allowed our system to evolve in such a way. This Values Agreement is a step in the right direction, but bigger, more impactful change comes from changing our processes and our values.

### *7.3 Concepts*

The main framework for the Values Agreement is similar to that of the theoretical framework presented in Chapter 03. Ideally, the Agreement would consist of six main sections:

- 1) Mission Statement
- 2) Values, Goals, and Expectations
- 3) Decision-making and Conflict Resolution
- 4) Sustainable Goals and Initiatives
- 5) Communication and Collaboration
- 6) Agreement to Uphold Values

These of course could vary in length and number, depending on the project size or if it was adapted for a firm or organisation. Subsections would help to further organise the information presented, as well as provide a way to easily navigate the digital document. Some example subsections could include breaking down the specific structure, roles, and responsibilities of the governance structure in the third section, as well as outlining specific steps to take or individuals to go to for various conflicts and issues. Similarly, section five would be an appropriate place to outline team communication, collaboration strategies, and the importance of respect and trust in the team environment. Potentially, the Values, Goals, and Expectations section would have a

statement or two outlining the need for team-building exercises and early collaboration initiatives. This agreement could be modified to include any number of other categories, such as Technology, but it is worthwhile to make sure that information is not needlessly duplicated or worse, conflicting in separate locations. Having one document or location where this information is shared and “live” allows for the team to always have access to it and know that it is the most updated version of the Values Agreement.

#### *7.4 Parameters and Considerations*

The term “agreement” is often used with regard to contracts and legally binding documents. As demonstrated by the research in Chapter 06, two of the biggest factors for being able to safely and legally incorporate this type of agreement is 1) clearly defining terms, expectations, processes, ownerships, responsibilities, and other areas where miscommunication often occurs, and 2) working with relevant insurance and legal parties to ensure that the risk being placed on various parties is appropriate. The significance of the first factor has been repeatedly discussed, but the significance of the second is arguably more impactful. In the conversation with a participant of a law background, they stated that lawyers often hurt more than they help, even though they are of the opinion that law is supposed to be a helping profession. In the conversations that contractors, architects, and other professionals have with their legal teams, it is important to find the balance between protection and innovation. It is important to understand and value the business and risk aspects, of course, but our industry has focused too long on those as the most important. Shared risk/reward systems provide a better process for mitigating risk and significantly lessens the sue-happy mentality that traditional methods support. Additionally, it is up to the design and building professionals to work with their legal teams to begin to push back on the processes and systems that are relics of a

mentality that does not belong in a collaborative future. Changing the system starts with a shift in the values, and if collaboration, innovation, and a passion for sustainability become the primary focuses as opposed to “don’t get sued” and “make the most profit,” the built environment and society as a whole will be better for it.

## **Chapter 08: Conclusion**

This study began with an interest in BIM technology and sustainability, and it evolved into a research project focused on the benefits and challenges of collaboration in the built environment. Simply put, the current built environment struggles with competing and often contradictory values which hinder progress towards better practices focused on people and the planet. This is significant because these values, both personal and professional, are key factors in project decision-making, collaboration methods, and sustainable practices, and overemphasis on the economic values results in buildings with a dictatorial focus on economic gain and risk avoidance. This mentality inherently reinforces top-down practices and relationships, making true interdisciplinary collaboration difficult if not impossible. Narrow communication pathways, closed-loop discussions, and forced and/or unbalanced relationships all have a significant and serious negative impact on our designs and our relationships, yet this is the traditional method that owners, contractors, and architects, and other professionals willingly employ. The illusion of safety and certainty prevents innovation and risk-taking, leading to a continuation of buildings which are detrimental to the health of both humans and the environment. Many professionals and individuals who work within the AEC+ industry desire and idealise a more collaborative process for planning, designing, building, and operating projects, but the legal, contractual, and developer standards still prioritise economy over equity and environment. The changes will not come from outside of the industry but from within, with project teams and firms or organisations

pushing for more collaboration, innovation, and sustainable practices. New frameworks and contractual arrangements are needed to appropriately balance the risk and reward and to also enable and encourage true collaboration and early communication between project parties. Additionally, more incentives and requirements for sustainable development is needed in the built environment as a whole, in order to successfully transition from an economy-focused society to a market demand for “green,” high-performing buildings.

In this study, the research concluded that collaboration is an essential component in successful projects, in addition to clear communication about goals, values, and definitions for successful integration. This is partially because interdisciplinary teams are able to identify areas of risk and challenges, and they are better suited to take the necessary steps to mitigate or eliminate them. These collaborative teams are better equipped to solve complex problems, particularly with new tools and technologies in regard to sustainability initiatives and systems. Currently, the notion that sustainable projects are inherently “risky” from an economic standpoint has a significant weight in decision-making and planning, even though sustainable practices are valued by many people and industries. However, integrated project teams of sustainably-driven projects help make these projects a reality because of their expertise, experience, and knowledge. The AEC+ industry needs to shift its values and radically challenge the old, because sustainable initiatives and systems are bigger than their economic value. As the built environment demands a better, more integrated process of planning, design, construction, and operation, challenges and opportunities in technologies and strategies will arise. In order to create a valuable and impactful future that incorporates the challenges of the climate crisis, what we prioritise and value in our built environment, and our societies, will need to change.

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