

Holistic Product Design Education to Promote Sustainable Systems

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“The global economy institutionalizes a global ignorance, in which producers and consumers cannot know or care about one another, and in which the histories of all products will be lost.” Wendell Berry (2002, p.244)

ABSTRACT

With the expansion of high-material and high-energy throughput lifestyles of a small portion of the total population on Earth, the carrying capacity of the planet has already been exceeded by 1.6 times, denying the majority living in poverty the resources and energy required to improve their lives. While many design researchers have been warning that the lack of moral and social responsibility of designers in society is creating increasingly complex ecological and social issues, designers themselves are not sure which actions would lead to sustainable lifestyles. There is a need for clear guidelines to improve current methodologies. This paper presents a summary of the major paper I have written for my Master's degree followed by personal reflections on its implementation as a curriculum I developed and taught to design students. This curriculum frames sustainability as an emergent property achieved through a holistic and systemic design approach that more fully encompasses ethical and socio-economic concerns.

Keywords: Sustainability, Design, Systems, Education, Curriculum.

INTRODUCTION

Despite noble intentions of improving people's lives, product designers are faced with ethical dilemmas regarding the social and environmental impact of their designs. The unsustainable lifestyle of a wealthy minority of the world's population has already exceeded the regenerative capacity of Earth which frames sustainability as a moral and ethical issue about how we choose to regard the rights of poor populations to live a dignified life, as well as the condition of the planet we leave for future generations.

There is an almost universal acceptance of the myth that economic growth is the only way to achieve prosperity for humanity, which is compounded by the unwillingness of economists to make any moral or ethical judgment regarding the nature of economic activity by according the same status to all wants and needs. This has removed any personal responsibility from economic decisions and resulted in environmental and social degradation, leaving product designers entangled within a reductive capitalist economic model that is driven by short-term profits

and denial of long-term accountability.

An overview of several contemporary design methodologies and toolkits provides insight into the importance of providing a moral and ethical framework for the inclusion of additional considerations. Teaching design students the moral and ethical basis of sustainability through discussions of topics such as the value of nature, economic growth, social equity and dignity have proven to be essential systemic considerations in the move towards a sustainable future in which all life can flourish on Earth, forever.

DESIGNERS SHAPE OUR WORLD & DEFINE OUR FUTURE

Design is a visionary and purposeful activity that Buchanan (1985) describes as a persuasive argument on how people should live. A quick survey revealed that students in my undergraduate course could not imagine living without a cell phone and expected any future designs to be based on the assumption that users would have cell phones. In their lives, phones are seen as an integral part of their daily activities, an extension of their personality, and a starting point for any future projects. Indeed, as Buchanan suggests, the smartphones have already persuaded these students on the impossibility of living any other way.

Alternatively, design has been defined as “the creator of sources of wealth by satisfaction of material needs and creation of meaning” (Heskett, 2017), however we often fail to ask whether those systems of meanings ultimately enrich or impoverish our lives or societies. Fry (2009, p.100) has written extensively on how design introduces socio-cultural values and breaks traditional practices as it enters into other cultures, often at the price of undermining existing socially and environmentally sustainable practices. Such designs ultimately limit future alternate possibilities, as they lock societies into a particular path. (Fry, 2009, pp.101-102).

Since the dawn of time, humankind has created artefacts that have enhanced human life and allowed humans to flourish physically and spiritually. Milani (2000, loc.41) and Sassatelli (2007, p.4) believe that mankind's original creations began as a regenerative relationship that respected nature and its processes, but also instilled a sense of belonging. This relationship was reshaped and redefined by the Industrial Revolution through the fragmentation of the

creation process into small steps that only required creativity in the initial phase (Bürdek, 2005), limiting the role of designers in participating in the entire creation process.

CONSUMPTION AND SUSTAINABILITY

All species on Earth, humans included, need to consume in order to live. In an interview at the 2016 Sustainable Consumption Research Action Initiative (SCORAI) conference, Bill Rees said that consumption is a complex issue and it's unfortunate that for too long, people have been made to feel guilty about it, since every living thing has to consume to survive (SCORAI, 2016). Rees went on to add that the question that needs to be addressed is the appropriate level of consumption since we are in a world that produces a finite quantity of resources and can only absorb a finite quantity of waste.

The 2016 Living Planet Report (WWF, 2016) states that since the mid-20th century, human activities are endangering environmental systems. The report claims that by 2020, the demand on nature is projected to become 75% more than what nature can renew (WWF, 2016, p.83) and that the well-being of humans, and populations of all other life-forms, is being jeopardized (WWF, 2016). According to the report, renewable resources are being used 1.6 times faster than renewal rates. Carbon dioxide is also being released faster than can be sequestered by nature (WWF, 2016, p.60). 12% of the world's population uses 85% of its water (World Centric, 2018).

According to World Centric (2018) 17% of the world's population consumes 80% of the world's resources, leading to an estimated 30,000 – 60,000 deaths from hunger each day (WC, 2018). It is estimated that the material consumption of the world's richest is ten times that of the world's poorest (IRP, 2016) leading to the conclusion that only by reducing consumption by the world's richest can the world's poor have access to resources they desperately need for the basic necessities of life and hopefully climb out of poverty. Neither our economic systems nor our product design profession has had the courage to question the necessity or cost of our current trajectory of environmental destruction.

Throughout recent history, in a move to hide impacts of the enormous amounts of waste generated from unsustainable lifestyle in affluent societies, there has been a tendency for the most waste-generating activities to “move upstream” from household to industry. This move has greatly helped hide the waste endemic to mass consumption societies; pacifying the consciences of those who worry about the environmental impact of our economic activity.

For a consumer purchasing a laptop, they may never realize that it generates four thousand times its weight in waste, and that only about 1 percent of all materials processed and converted into products for North American markets continue to be still in use six months after sale. For those brushing off these statistics by pointing to recy-

cling, it must be noted that only 2 percent of the total waste stream is recycled (Hawken, Lovins & Lovins, 2013). Hawken et al. as they have pegged the throughput (amount of material or items passing through a system or process) of each American at 1 million pounds per year (Hawken et al., 2013, pp.51-52).

VIEWS OF NATURE SHAPE WORLDVIEWS

Faber (2008) has argued that for the majority of human existence, nature was seen as a “fountain of life”, having a purpose in constantly developing higher life forms, allowing humans the chance for self-reflection, an attitude shared in the works of Goethe, Wordsworth, Schelling and Thoreau (Faber, 2008, p.5).

Our modern political thinking, according to Fry (2009) is greatly influenced by Thomas Hobbes who in the 17th century A.D. believed that nature had to be overcome and held in check, “maintaining the divide between civilized human beings and animality” (Fry, 2009, p.9). With the intention of learning the laws that governed nature so it could be controlled, Faber (2008) believes that this led the majority of scientists to stop regarding nature as the “fountain of life”, but as a source for the material needs of humans (Faber, 2008, p.5). This type of thinking has dominated discourses on progress, and even relationships with other creations, resulting in the environment, resources and even other humans being regarded as resources there for the taking of the powerful.

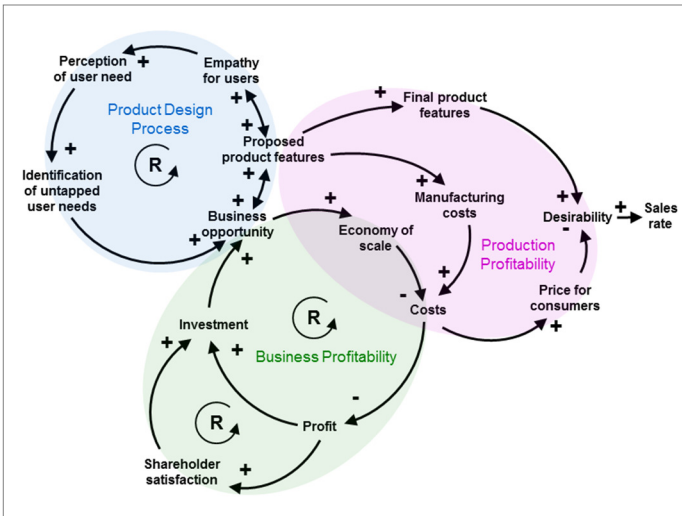
Once both nature and other humans are degraded to the status of resources for personal gain, we are confronted with the issue of intergenerational justice in which actions or inactions of the current generation are impacting the future of subsequent generations. One important ethical question that needs to be asked is whether humans are entitled to dignity, defined by Ehrenfeld as the ability to live “one's life according to one's values, free from domination” (Ehrenfeld, 2008, p.51).

The ethical dilemmas surrounding views on the value of nature, humans, and justice are just some of the dilemmas faced by designers as they continue to create even more products for those leading unsustainable lifestyles.

DESIGNERS ARE PLAGUED BY ETHICAL DILEMMAS

Buwert (2015) observes that throughout history, product designers have “consistently expressed social, political, ethical concerns and aspirations” (Buwert, 2015 p.4.2). Through a series of interviews with product designers in 2013/2014, Buwert was able to illustrate the conflicted realities that plague designers as they are faced with wanting to act ethically, but being unable to do so. Willis (2013) believes that a fundamental problem with design activism is that despite the best of intentions, product designers are often unable to define the preferred change they hope to achieve. Drawing on the often-cited definition of design by Herbert Simon (1969) which defines design as an activity

Figure 1: Causal loop diagram: Ideal product design process. This diagram is a simplified depiction of the design / manufacturing process in which price/desirability ratio is the only regulatory mechanism affecting the sales rate of products. Designers are really only involved in the product design process loop, based on: Dastgheib-Beheshti, S., 2017, p.46.



that changes existing situations into preferred ones, Willis notes that designers are unable to define a desired future beyond improvements to “functionality, performance, convenience, efficiency, aesthetic appeal, and so on.” Willis notes that they refer back to parameters identified by the client (Willis, 2013, p.1). Orr believes that the inability to distinguish what can and what should be done renders designers vulnerable to do whatever is asked without the strength to question whether it is the right course of action (Orr, 2002, p.63), highlighting the importance of moral considerations in design solutions.

DESIGNERS ARE TRAPPED WITHIN REDUCTIVE ECONOMIC SYSTEMS

Over the past 50 years, product design thinkers and historians such as Victor Papanek (1972), David Orr (2002), John Heskett (2005), and Tim Brown (2009) have been warning that the lack of moral and social responsibility of designers, is creating increasingly complex ecological and social issues. Brown (2009) points to the importance of product designers recognizing their personal responsibility in creating larger problems that are created through failure to understand the full social implications of their product designs, including resource use and consumption (Brown, 2009, p.104). However, designer involvement in the entire product lifecycle is often very limited, and opportunities for understanding full social implications hidden by industry’s drive to short-term profit. Looking at the fundamental structure of the product design industry, Boehnert (2014) identifies a deep-rooted structural problem in which product designers are limited in what they can do by the systemic bias of capitalism which operates on highly reductive economic feedbacks (**figure 1**). Even when product designers want to address ecological concerns, they are trapped within a system that only sees short-term profit, and denies long-term social and ecological consequences (Boehnert, 2014).

CONSUMPTION AND WELL-BEING

Returning to the Rees’ comments on consumption, given the finite nature of resources production and waste absorption, what is the appropriate level of consumption? If consumption is meant to increase material and spiritual well-being, do the benefits keep pace with more consumption?

Ecologists and economists such as Easterlin (2001, 2010), Binswanger (2006), and Victor (2008) have noted that economic growth does not necessarily increase well-being since often environmental externalities and other adverse social effects of economic growth rise faster than personal incomes, outweighing the benefits of increased private consumption (Daly & Farley, 2011) (Victor, 2008).

Easterlin’s finding indicate that with increases in income over one’s lifetime, material aspirations tend to increase proportionately, while measures of happiness or satisfaction shift inversely. Simply put: the more money we make, the more things we want, and the less happy we are from our new acquisitions. These findings are also verified by Layard (2006) (**figure 2**), while other studies have shown that the findings hold true for a number of developing countries for 10 years or more (Easterlin et al., 2010) as economic growth does not result in the promised happiness.

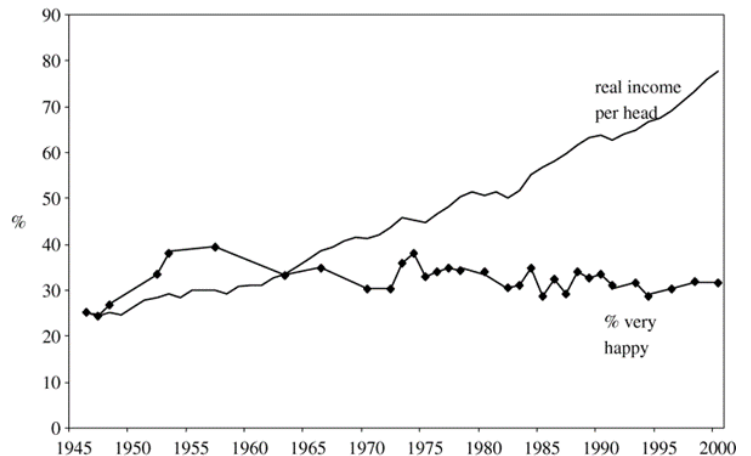


Figure 2: Income & Happiness in the United States, Layard (2006)

This leads us to an important question: If added consumption beyond a certain point does not make people happier but only increases the throughput of resources and energy rushing through the economy, why are we continuing to produce and consume more? For this we need to take a closer look at the economic principles that promote perpetual economic growth as the only way to ensure prosperity for all humanity.

RELYING ON THE MARKET ECONOMY

One of the most fundamental economic concepts that drives market economies is the relationship between supply (how much the market can offer) and demand (the quantity desired by consumers) as shown in **figure 3**. Consumer demand for products increases as price decreases (demand curve), while producers want to produce more of expensive

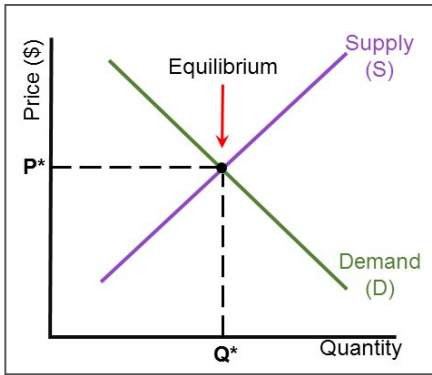


Figure 3: Supply and Demand Curve

items as they will make more profit (supply curve). The location where consumer demand and producer supply intersect is where the market achieves equilibrium as the amount of goods being supplied equals the amount

of goods being demanded and defines both the price and quantity (Hayes, 2018). Neoclassical economists believe that a single mechanism: price, is capable of regulating markets by being the fulcrum that balances supply with demand (Daly & Farley, 2011, pp. 234, 457).

ABSENCE OF ETHICAL OR MORAL JUDGMENT IN ECONOMICS

According to Nadeau (2015), neo-classical economics is based on assumptions that market-based economic systems are by varying degrees, closed, self-correcting, self-sustaining, and capable of perpetual growth. The convenience of these assumptions becomes clear since they allow all calculations to be mathematized, with the added “bonus” of not having to make any moral judgements on how money is spent (Brown & Timmerman, 2015) or what the economy produces.

Keynes (1931) has pointed to the unwillingness of modern economic theory to recognize the subjective nature of hu-

man desires as the most notable failure of modern economic theory since it accords the same status to all wants/needs, effectively resulting in an absence of any accountability on the consequences of economic decisions. This approach, Ehrenfeld argues, effectively strips away any sense of personal responsibility towards the degradation of the environment and undignified and unhealthy living conditions our consumption causes (Ehrenfeld, 2008, p.33).

In his 2014 writings, Piketty has taken a strong position, dispelling the claims that the rigorous mathematical theories used by mainstream economists are value-free, saying that they only serve to “disguise the fact that these theories sanction and perpetuate economic inequality, mitigate against equitable distribution of scarce environmental resources, and enhance the wealth, power and influence of financial elites” (Piketty as cited in Nadeau, 2015). One way economics fails to efficiently allocate resources is through market failures such as externalities.

“Externality” refers to the economic concept of a cost or benefit on another party not involved in the production or consumption of a good that is not reflected in the price (Sagoff, 2007, p.35). Pollution, environmental degradation and loss of bio-diversity are examples of negative externalities that are observable rather quickly while it may take decades for some other externalities such as climate change or Ozone depletion to manifest.

When prices don’t contain and ‘internalize’ these externalities (figure 4) they are considered market failures, but more importantly, we have to wonder who is paying the price? In most cases, we find that externalities are socialized and borne by society, while the profits are privatized and paid to shareholders.

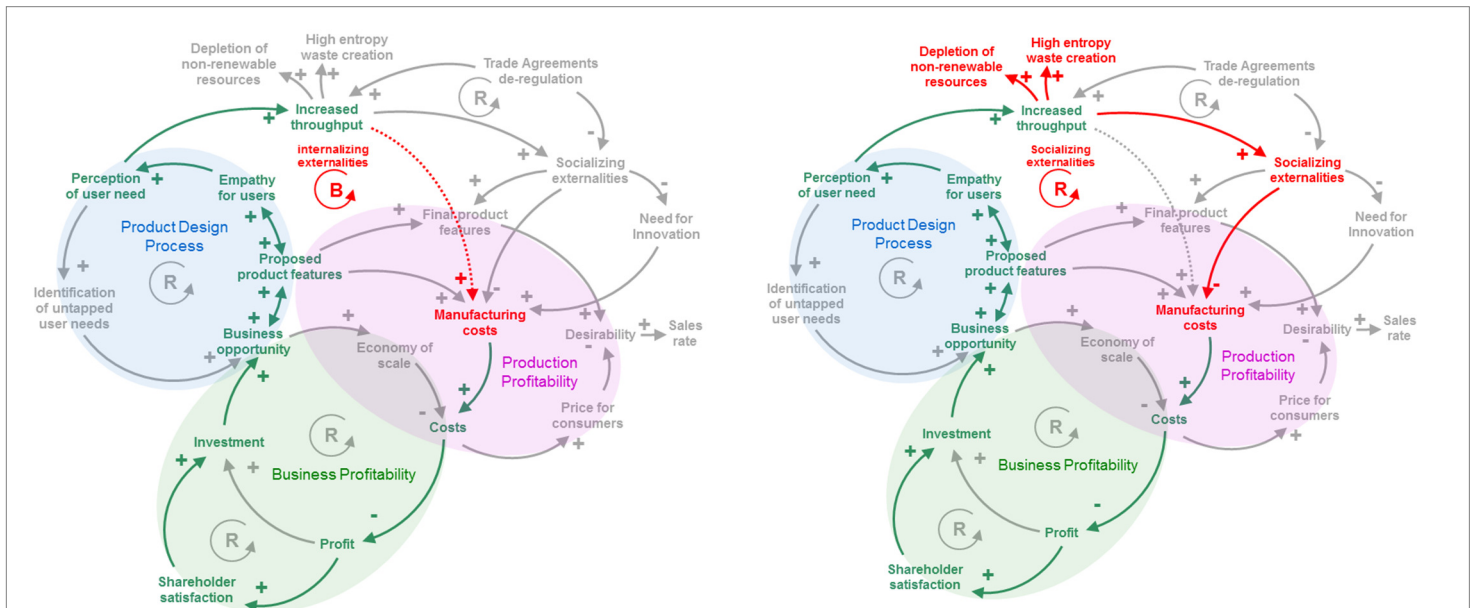


Figure 4: Comparison of the result of allowing increased throughput to be reflected in product costs, from Dastgheib-Beheshti, S., 2017, pp.49-50: Figure on **LEFT** shows the **BALANCING** effect when the externalities are internalized which results in decreases in throughput. Figure on **RIGHT** illustrates the **REINFORCING** feedback which occurs when externalities are socialized. The diagram expands on some of the elements hidden from product designers such as the effects of increased throughput and deregulation through trade agreements.

SHORTCOMINGS IN THE DESIGN PRACTICE

Through previous discussions, two main areas of interest have been identified in current design practice:

1. Current design practices are based on reductive capitalist models which exclude any considerations about externalities, throughput and the long-term effect of products on society, culture and the environment. The focus is on short-term profit with price seen as the only mechanism that balances supply and demand within markets.
2. There is a lack of moral judgment or ethical concerns regarding economic activities. Armed with the main goal of increased production as the only way of solving problems, there is an absence of any kind of judgment on whether the economic activity is good or moves society in the desired direction.

I will now proceed with comparing these findings with criteria contained within eight design methodologies.

THINKING LIKE A DESIGNER

My investigation of the framing of sustainability in current discourse began with a comparative study of 3 different methodologies which over time, expanded to include 8 diverse books and toolkits. Design thinking is one method that has created much excitement within design as well as in other disciplines. The abductive problem-solving methodology used by product designers to leap towards solutions based on incomplete data has been recognized as one of the few methods suitable for tackling complex problems with high levels of uncertainty (Kelley & Kelley, 2013). Design thinking proponents aim to make this type of problem solution methodology accessible to designers and other disciplines through the creation of toolkits which are a collection of design management, communication and other individual tools that can be applied individually or in conjunction with others.

In a comprehensive study of design thinking discourses, Johansson, Woodilla & Çetinkaya (2013) conclude that

there is not a unique meaning to the phrase, and identify two distinct streams as 'designerly thinking' as "ways to describe what designers do in practice" (Johansson et al., 2013, p.123) and a 'design thinking' management stream.

Designerly thinking has been around for over 40 years (Johansson et al., 2013, p.123), and has a strong academic foundation based in contributions from product designers as well as others in related fields. One of the eight methodologies reviewed in this paper, Cross, is an example of designerly thinking. Schindlholzer's methodology begins by utilizing a strong academic foundation to the initial sections of his study.

In 1974 Koberg and Bagnall published *The Universal Traveller*, one of the earliest forms of systematic design thinking which attempted to apply Cybernetic (human control systems) principles to problem solving. Other design thinking examples reviewed in this paper include toolkits by IDEO, Stanford University, as well as a book by Kelley & Kelley. Martin's book and Ogilvie & Leitke's toolkit target business and management respectively.

In what may seem to be a harsh statement, Johansson et al. conclude that without considering the embodied knowledge that is so important for product designers to tackle issues, most design thinking methodologies reduce problem solution to a purely cognitive activity with commonality only in the lack of analytical structure (Johansson et al., 2013, p.132).

COMPARATIVE STUDY OF METHODOLOGIES AND TOOLKITS

In an attempt to gain a broad overview of many of the design methodologies being used to establish commonalities and identify weaknesses. **Table 1** illustrates that each promotes a different message for a different audience. **Table 2** further summarizes the detailed analysis of each methodology (Dastgheib-Beheshti, 2017, p.70-110), identifying pros and cons of each methodology.

	Toolkit / methodology	Background	Core concept	Message	Audience	Examples utilized
1	Koberg & Bagnall Toolkit: <i>The Universal Traveller: A soft system methodology</i>	Architecture	Cybernetics: study of human control systems	Complex problems can be solved through a logical & orderly process.	Entry-level problem definition and solution	Based on an analogy of traveling
2	Cross Book: <i>Design Thinking</i>	Design Research	Understanding how successful designers think	sophisticated cognitive ability that cannot be directly observed	Design research	Grounded theory based on observations and interviews
3	Kelley & Kelley Book: <i>Creative Confidence</i>	Product Development & Management	Design-driven innovation	Creativity can lead to routine innovation	Future innovators	Business case studies
4	IDEO Toolkit: <i>Handbook for Human-centered design</i>	Non-profit design firm	Human-centred Design	Knowing users creates better products & services	New and experienced practitioners	Case studies, testimonials, anecdotal evidence, some empirical evidence
5	Stanford University Toolkit: <i>"Bootleg bootcamp methods cards"</i>	Educational institution	Use design to develop creative potential.	Make impact with design	Undergrad / graduate students and the public.	Real-world projects
6	Roger Martin Book: <i>Design of Business</i>	Management consulting	Business model as knowledge funnel.	Costs fall as knowledge moves through funnel.	Managers	Anecdotal evidence
7	Toolkit: <i>Designing for Growth</i> Ogilvie & Leitka	Business innovation and management	Systematic approach to problem solving	Profitable business growth	Business	Case studies
8	Schindlholzer Toolkit: <i>Design Thinking Coaching</i>	Business science and innovation	Unified approach for developing new products or services especially at the "Fuzzy front end"	Innovation through coaching	Information & communication technology sector	Methods engineering and two case studies

Table 1: Comparison of Product Design Methodologies/Toolkits, from Dastgheib-Beheshti, S., 2017, pp.14-15

Table 2: Comparison of the pros and cons of each product design methodology - from Dastgheib-Beheshti, S., 2017, pp.16-18

	Pros	Cons
Koberg &	<ul style="list-style-type: none"> • Casts a wide net to diverse fields for essence of problem solution methodologies • Applicable in personal and professional life 	<ul style="list-style-type: none"> • There is often very little academic rigor to prove the efficacy or usefulness of a technique
Cross	<ul style="list-style-type: none"> • Utilizes grounded theory (systematic generation of theory from systematic research) • Points to designers willingness to embrace ambiguity and uncertainty • Shows holistic, interconnected overview essential to successful solution • Designers often re-framing problem to create new patterns, based on embodied knowledge. • Defines design intelligence as the concept of dualities of problem & solution developing concurrently: an emergent property larger than each component • Ability to shift between abstract and concrete thought • Ability to operate across different levels of scale (high-level systemic to low-level physical scales) • Innovation come from practical experience and draw from technology transfer from other fields. 	<ul style="list-style-type: none"> • Does not show techniques on how one can apply findings • Proficiency in generating solutions seems tied to personal passion • There is no consideration for issues of social equity or whether they are addressed by designer but leaves the door open that these may be part of the “re-framing” that the designer can include in the evolving problem definition/solution process. • Besides a few examples, does not delve into the necessity of innovation or the designer’s role in bringing about change
Kelley & Kelley	<ul style="list-style-type: none"> • Creative thinkers realize several possible solutions before converging on one • Creativity can be achieved through step-by-step process, with the ability to tackle increasingly complex issues with experience. • Successful solutions are those residing in the “sweet spot” between technical feasibility, business viability and desirability by people • Successful innovation reaches peoples motivations and core beliefs • Building empathy for users is a critical step in the success of solving it. 	<ul style="list-style-type: none"> • No value judgment on the validity of core beliefs or worthiness of the problem to be solved. • Encouraging the view that any problem is valid and can be solved creatively • Empathy for end-user does not extend through the supply chain and does not include others impacted by process.
IDEO	<ul style="list-style-type: none"> • Free, online resource designed to be used to create social impact. • Easy to understand and detailed descriptions for tools • Many tools/methods include supplemental worksheets that simplify the process. • Uses cross-disciplinary teams where designer is a part but not driver • High level of participatory practice research • Builds empathy for users in all phases • Problem remains grounded in desires of community being engaged • Business orientation to problem solution 	<ul style="list-style-type: none"> • This kind of focus on the human-centered element becomes very reminiscent of the concept of human domination of nature through the ages and an anthropocentric thinking that has led to our crisis in sustainable living. • No value judgment on validity or long-term consequences of project • Framing problems as a business opportunity often leads to a return to the reductive model of capitalism in which profit is seen as the motive.
Stanford University	<ul style="list-style-type: none"> • Free, online resource designed for beginners. • Human-centered design process • A variety of techniques and methods to try to capture ideas and harness creativity • Immersive process which builds empathy in all stages • Creates specific actionable items • Constant re-evaluation of whether problem framed correctly • Based on the idea that every business opportunity is good 	<ul style="list-style-type: none"> • Empathy limited to direct users of products • Does not account for subtle cultural differences, often unaware of the potential damage it may cause based on culturally-insensitive assumptions • People and communities impacted by the resource extraction, production and disposal of product or service considered
Martin	<ul style="list-style-type: none"> • Business model based on ability to design and redesign itself in changing environments in ever faster cycles. • Uses easy-to-understand concept of funnel, with costs falling as innovative ideas progress through funnel. • Successful businesses need to create a dynamic balance between analytical mastery and intuitive originality • Balance of exploration and exploitation needed for successful business. • Personal knowledge system comprised of stance (worldview), tools (theories, processes, rule of thumb) and experience (allows us to develop skills and sensitivities). • Creative acts convert mysteries to heuristics (rule of thumb) through intuitive thinking, and develop algorithms (processes) to solve them. • Innovation dilemma seen as a difference and incompatibility between validity and reliability. • Validity’s goal: produce outcomes that meet a desired objective and often include subjective and judgmental aspects- progresses real knowledge • Reliability’s goal: produce consistent and predictable outcomes (Systems like Total Quality management, Six Sigma, streamline business and enable objective data analysis to extrapolate scientific predictions. • Removal of redundancies in systems makes them fragile • Dominant forms of traditional scientific logic: inductive and deductive reasoning are not adequate to solve problems grounded in uncertainty and in turn, need abduction (logical leaps of mind) to make connections. • Presents a model of design thinking as “an ongoing cycle of generating ideas (abduction), predicting consequences (deduction) and generalizing (induction)” 	<ul style="list-style-type: none"> • Touches on many important concepts like redundancies that lead to resilience, but fails to follow up by convincing readers why they should promote them as product development moves through reliability cycle. • The notion of algorithms or processes to solve the mysteries once the scope of the problems have been narrowed down through creativity, seems to assume that creativity only need to be applied to certain sections and portions and does not need to be a continuous part of the process. • The concept of utilizing creativity in business cycles with ever increasing speeds leads to the question of who benefits from this increased pace? Is this increased speed leading to an improved quality of life or just a higher throughput (rate which materials are cycled through the economy)?
Ogilvie & Liedtka	<ul style="list-style-type: none"> • Can be utilized by anyone in a business setting • A systematic process for profitable business growth since maximizing productivity and re-engineering processes are no longer working. • Simplified toolkit with clearly identified tools, instructions as well as project management aids. • Combining business thinking (rational, objective, quantifiable, precise) with design thinking (human experience, messy, qualitative, uncertainty). • Only toolkit that actually addresses the value chain • Identifies “target customer”, clarifying its intent • Customer co-creation is seen as the means to tap into wants and needs from customers 	<ul style="list-style-type: none"> • Utilizing actual designers is no longer necessary since this handy toolkit will teach you all you need to know about the various steps. • There is no value judgment on the need for the product or consequences. All business opportunities are seen as valid. • Value chain is seen only in terms of upstream and downstream opportunities that add value to the business portion of the product and not as having any ethical bearing. • Real innovation within various phases seems to be possible by just following toolkit, so it is reduced in importance
Schindholzer	<ul style="list-style-type: none"> • Tools and instructions are well-written and easy to understand. • Provides academic basis that has been mostly lacking in design thinking • Recognizes that design thinking need hands-on coaching and facilitation to yield actual results in early stages of innovation • In order to meet scientific rigor, bases his work on method engineering principles which includes repeatability and traceability of changes, as well as strong orientation towards customer needs. • Identifies uncertainty, lack of focus, ambiguity of services as some factors that can pose challenges in the early stages of innovation • Sees innovation as non-linear iterative process. • Recognizes complexity of design thinking and the need for coaches to meet scientific rigor standards • Utilizes participatory action research method 	<ul style="list-style-type: none"> • At some point Schindholzer cannot continue with the scientific approach and has to accept the anecdotal methods developed by other methodologies. • Does not propose any ethical judgment on validity of activity

As each methodology utilized its own particular terminology and examples, it became clear that in order to obtain a meaningful comparison, a common framework would need to be established. I began by outlining 5 categories that captured the roles and needs of all stake holders identified through analysis of methodologies as well as from previous discussions:

1. Methodology: Tools and strategies to aid abductive reasoning
 2. Conceptual framework of problems: Aspects related to the creation of meaning (cultural wealth)
 3. Economic aspects considered: criteria related to the creation of money (economic wealth)
 4. Product lifecycle: Ecological impacts of product
 5. Moral dilemmas faced by designers: moral and ethical considerations of social, economic and environmental impacts.
- Based on past discussions and the consideration of long-term consequences, 36 criteria were identified and grouped into categories in **table 3**. While there is overlap between various categories and criteria, the resulting chart offers a good starting point in identification of gaps that need to be addressed.

Table 3: Identification of gaps within 8 design solution methodologies - from Dastgheib-Beheshti, S., 2017, p.35.

Methodology		Koberg & Bagnall	Cross	Kelley & Kelley	IDEO	Stanford University	Martin	Ogilvie & Liedtka	Schindlholzer
Legend: ● Always ○ Sometimes (blank) Never/ Not applicable									
Methodology	1. Includes flexible tools & methods	●	○	●	●	●	○	●	●
	2. Offers clear process	●	●	●	●	●	○	●	●
	3. Places importance on personal experience / embodied knowledge	●	●	●	●	●	●	○	●
	4. Provides a multi-disciplinary approach	●			●	●		○	●
	5. Uses participatory action research method (includes stakeholders)				●	●			●
	6. Team-based (collaborative) method		○		●	●			●
	7. Evidence provided through rigorous academic study	○	●						●
	8. Evidence provided through anecdotal evidence	○		●	●	●	●	●	
	9. Multi-level approaches (large systemic and smaller details)	○	●		●	●	●	○	○
	10. Fosters critical thinking	○	●	●	●	●	●	●	●
Conceptual Framework	11. Grounded in needs defined by community				●	●		●	●
	12. Desirability of product important	○	●	●	●	●	●	●	●
	13. Technical feasibility important	○	●	●	●	●	●	●	●
	14. Business factors (production and distribution should be feasible)		●	●	●	●	●	●	●
	15. Fosters empathy for users	○	○	○	●	●	●	●	●
	16. Constant re-framing (making personal) of evolving problem /solution	●	●	○	●	●	○	●	●
	17. Establishes provenance of product creator to user	○							○
	18. Looking at wider context of problem (structural reasons)	○	○		○	○	○	○	○
Economic Aspect	19. Sees problem as business opportunity	○	○	●	●	●	●	●	●
	20. Promotes need for innovation to speed up business cycle		○	●	●	●	●	●	●
	21. Creativity is applied throughout process	○	●	○	○	○	○	○	○
	22. Product keeps money circulating in the community								
	23. Product internalizes all externalities								
Lifecycle	24. Takes a broad systemic approach to process	○	●	○	●	●	○	○	○
	25. Considers throughput of new product								
	26. Considers sustainability of product				○	○			
	27. Considers environmental impacts in value chain								
Moral Dilemmas	28. Ethical judgement about whether there is a need for innovation								
	29. Ethical judgment over possible cultural impact				○	○			
	30. Consideration: Long-term consequences (precautionary principle)		○		○	○			
	31. Consideration: Will it change behavior in society				○	○			
	32. Consideration: Will it result in promote flourishing within society?								
	33. Consideration: Will it result in human dignity for user?			●	●	●	○	○	○
	34. Consideration: Will it result in human dignity (manufacturing labor)?								
	35. Consideration: Will it result in human dignity (resource acquisition)?								
	36. Considers environmental impact from product lifecycle								

FINDINGS

While I was very encouraged to see that all 8 methodologies were all quite successful in valuing personal and embodied knowledge, utilizing multi-disciplinary teams, identifying issues, utilizing broad, multi-level systemic approaches, and universal in fostering empathy for users, I was more interested in understanding the reasons behind the reluctance to engage with other areas.

I believe this limited engagement stems from the limited roles defined for the “creatives”, be it product designers or multi-disciplinary teams engaged in abductive reasoning. Systemic creativity is encouraged and seen as a strategic tool to identify business opportunity, speed up innovation and the business cycle, and essentially increase throughput within the economy. This leads me to what I believe is the most important question that needs to be asked in any situation:

Who Benefits?

As a teacher and mentor to students of Design, these findings compel me to ask, *who benefits when*:

- there is no connection between the creator and user.
- the externalities created by a product are socialized.
- the throughput of materials and energy required to create a product is not a factor in the final price.
- ethical judgments about whether a particular innovation is beneficial or even needed never enter the equation, since the impartial market economy, through success or failure, will be the ultimate judge.
- the effect of a product on limiting future pathways of individuals and societies is not considered.
- there is no thought given to the environmental degradation and loss of dignity on those affected by resource acquisition, production, usage and disposal of products.

I will end the research portion of this paper the same way I began, with a quote from Wendell Berry (2002, p.244) which in light of the findings, gains new power and significance for designers:

“The global economy institutionalizes a global ignorance, in which producers and consumers cannot know or care about one another, and in which the histories of all products will be lost.”

APPLICATION OF FINDINGS TO TEACHING

I will now proceed with a personal reflection on the process and results of the application of the findings from my research in providing a holistic framework to 11 students. As an elective for third and fourth-year students with a keen interest in sustainability studying Environmental Design or Industrial Design, the ‘Sustainable Practices’ course curriculum was expanded from its original material and production-centered outline to allow students to develop a deep understanding of the moral aspect of sustainability and how it could be a part of their future professional practice.

Utilizing strategies from popular education, the class was organized as a circle with all facing each other. The concept of embodied knowledge within each person was drawn upon in each session. This was accomplished through the following strategies:

- **Weekly lectures** on topics that expanded the definition of sustainability beyond the familiar notions of materials and production methods. At the end of each session, the slides for the lecture, along with additional notes including references were posted on the course website, allowing students to further engage and follow up on topics that interested them.
- **In-class Readings** that expanded the topics being discussed were provided in hard copy and class time was used to read and discuss. This offered students the opportunity for additional insight and a common base to engage in discussions with their classmates.
- **Activities and games** provided deeper context and understanding. Small group size allowed for active participation that generated familiarity amongst students and facilitated even better communication. Minimal guidance and direction was given for each activity, allowing students to personally interpret the activity. The main debrief of each activity occurred at the beginning of the following class with an open discussion. Often students would comment on how they had discussed the activity and compared notes leading up to the discussion, or would offer examples from personal experience or observations to enrich the discussion.
- **Written reflections** at the end of each class allowed students to elaborate on what the topic discussed meant to them and how they could relate it to personal experience. The goal was to guide students in realizing that they had already encountered issues being discussed and allow them to identify and name them.
- **Re-design of an existing project or design of new one** based on learnings. Students revisited one of their past projects and revised it based on discussed topics. The project choice of the students was: 1 x thesis, 3 x new project, 7 x project from previous class. Interestingly, 6 students chose the same exact project

from the same class – the design of a 200 square feet tiny house, and were very worried that the results would end up looking similar. It was extremely rewarding to see, at the final presentation, how each project had become even more unique based on the criteria each student had prioritized.

- **Course text:** Three books were used in formulating lectures and the referenced sections were noted in the reference list at the end of each week’s slide presentation and online posting. These textbooks were selected based on the breadth of information they contained:

Design for environmental sustainability (2008) by: Vezzoli, C., Manzini, E., offers a detailed, technical and philosophical approach regarding design, production and usage of products which can also be applied to environmental design.

Sustainability by design: A subversive strategy for transforming our consumer culture, (2008) by: Ehrenfeld, J. offers a philosophical and enriched understanding of the ethical and social issues that can lead to sustainability. It formulates arguments to discuss various stances on the definition of sustainability and advance the strong sustainability model through a systems thinking model.

Regenerative development and design: A framework for evolving sustainability, (2016) by: Mang, P., Haggard, B., & Regenes Group provides practical examples of sustainable built environments and how they were planned and executed. Videos of many projects are available on YouTube, bringing the examples to life for students.

ETHICAL DILEMMAS AND DEFINITIONS

In a survey at the beginning of the course, student defined sustainability through the following key concepts:

Energy	Renewable energy	1
	Energy efficiency	3
Material & Method	Recycling	2
	Extending lifespan	3
	Material choice	2
	Alternative methods	3
Environment	Minimize impact	2
	Beneficial to environment	2

In that same survey, and throughout the course, students expressed the same ethical dilemmas which Buwert had noted in his interviews with practicing designers.

The diverse backgrounds and social ties of students to other regions and countries provided interesting insights during class discussions While only just over a third of students (4/11) were born in Canada, the majority (9/11)

maintained ties to originating cultures and visited them. This allowed them to draw upon personal experiences and observations of the individual, social and environmental costs of rapid industrialization which they had observed over just a short period of time.

CONCLUSION AND DISCUSSION

The opportunity to teach sustainable design systems and see the difference it made in how students approached design project has been extremely rewarding and has motivated me to begin taking steps in framing subsequent courses as opportunities to conduct formal research.

Framing sustainability as an emergent property based on social behavior that could only be achieved through a holistic, multi-faceted approach through consideration of the following topics:

- Sustainability: possibility of all life to flourish on Earth, forever (Ehrenfeld, 2008)
- Nature: value and right to live.
- Choosing what we keep or sacrifice in the name of economic growth.
- Economic growth and happiness.
- Impact of design in behavior/ designed consumption.
- Technological lock-in / economic rebound effect.
- Social equity: environment, pollution, labor, dignity.
- Importance of local money flow.
- Design as system/sustainability as emergent property.
- Efficiency vs. Resiliency
- Product life cycle / supply chain.

I would have to point to the importance of our perception of nature as the single most important topic in the course. This topic was presented with two opposing views of nature: as mechanical or an organic web. The effects of these viewpoints became points of departure for many discussions as students applied it to how creatures, nature’s bounty and the environment were valued.

This understanding was achieved through a combination of lecture, ‘web of life’ game, and subsequent discussions and created a nice group dynamic in which students were engaged and active.

I began my research as a personal quest to understand the source of the persistent poverty, misery and environmental degradation that economic growth was supposed to eradicate. It has led me to the exciting discussion of the role of economics in shaping our worldview and defining our possible futures.

With an understanding that designers are complicit in the current trajectory and demise of our planet, education of

the next generation of designers takes on added significance. This experience has re-affirmed my belief that utilizing a holistic design approach based on systems thinking and strong sustainability models can provide design students with understanding of socio-economic constraints that allow them to move beyond ethical dilemmas towards impactful action.

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