Industrial Design After Industrialism: A Speculative Exploration of Furniture Design in a Post-Growth Future

Michaela LaForge

A Thesis
in the Department of
Design and Computation Arts

Presented in Partial Fulfillment of the Requirements
for the Degree of Master of Design at
Concordia University
Montreal, Quebec, Canada

October 2025

CONCORDIA UNIVERSITY
School of Graduate Studies

This is to certify that the thesis prepared

By: Michaela LaForge

Entitled: Industrial Design after Industrialism: A Speculative Exploration of Furniture Design in a Post-Growth Future

and submitted in partial fulfillment of the requirements for the degree of

Master of Design

complies with the regulations of the University and meets the accepted standards with respect to originality and quality.

Signed by the final examining committee:

______________________ Chair
Dr. Pippin Barr

______________________ Examiner
Dr. Alice Jarry

______________________ Examiner
Dr. Rilla Khaled

______________________ Thesis Supervisor(s)
Dr. Martin Racine

______________________ Thesis Supervisor(s)

Approved by ______________________
Christopher Moore — Chair of Department or Graduate Program Director

____
Dr. Annie Gérin — Dean of Faculty of Fine Arts

Abstract

Industrial Design After Industrialism:
A Speculative Exploration of Furniture Design in a Post-Growth Future

Michaela LaForge

Today's climate crisis can be attributed to contemporary consumer culture, in which consumers in the Global North are consuming far beyond the planet's spatial and temporal capacity, threatening our collective future. While the discipline of industrial design was born from industrialization and consumer culture, it will need to adapt with the ecological challenges to address the growing concerns of overconsumption. This research examines the role of the future industrial designer through a speculative design exploration within the framework of post-growth. It addresses how designers might reframe the design process to empower consumers with agency, skill, and responsibility over their objects.

Through research-creation, the research investigates methods of making across artisanal, industrial, and digital processes to envision what design practices might look like in a post-growth future. It proposes a framework of shared responsibilities of care between consumers and designers to aid consumers in re-engaging with their objects to reshape their relationship with them, and ultimately their relationship with consumption. Designers then act as translators of manufacturing knowledge from the producer to consumer, rather than the modern role of a translator of desires of the consumer to the producers, to reduce overall consumption habits and prolong the life of existing objects. Through rethinking how objects are designed, made, and maintained, it positions design as a mediator in the transition toward a post-growth future.

Keywords: post-growth, sustainable design, industrial design, consumer culture, consumer agency, emotional durability, speculative design, research-creation, methods of making, craft.

Table of Contents

List of Figures

Introduction

The discipline of industrial design is inherently based on consumption. The iterative process of reimagining and recreating objects requires a constant feedback loop of previous design cycles to improve the objects we create and further perpetuate the discipline. As Victor Papenek has famously said:

> "There are professions more harmful than industrial design, but only very few of them. And possibly only one profession is phonier. Advertising design, in persuading people to buy things they don't need, with money they don't have, in order to impress others who don't care, is probably the phoniest field in existence today. Industrial design, by concocting the tawdry idiocies hawked by advertisers, comes a close second." (Papanek, 2023, p. IX)

This is a damning statement that serves to discuss the moral and ethical obligations of the industrial designer in the wake of our ongoing climate crisis and has acted as an early springboard, when it was first published in 1971, for continuous discussions of the role of the industrial designer in this conversation.

A conversation, however, requires more than one party. While we, as designers, can discuss how to better utilize and optimize resources, create more accessible and inclusive products, create seamless experiences, and ultimately work towards creating the best possible version of the objects we can, we are still working within a system that operates under capitalism; a system that prioritizes growth above all else.

Industrial designers are a single component of this system but do not by any means dictate it. While we communicate through the objects we create, consumers respond through the objects they chose to consume, when an adequate choice is presented. Looking beyond this immediate relationship between object and person are the greater social, political, and economic systems we both, designers and consumers, live within. While we can argue that a designer should not be designing a plastic tchotchke that will be mass-produced in the millions, only to all be discarded within a year of use, we could also argue that consumers shouldn't purchase these objects instead. The object will be produced whether an ethically trained designer designs it, if there is money is to be made from it.

Especially with the rapid growth of artificial intelligence (AI) and generative AI (gen AI) entering the 3D visualization and modelling market in addition to the growing consumer market of digital manufacturing tools like 3D Printers, computer numeric controlled (CNC) mills, and laser cutters, anyone has the means to create virtually anything while transcending the spatial and temporal boundaries that historically impeded economic and industrial growth (Victor, 2008). With the rise of globalization and increased access to internet and translation services, we can also mass-produce anything from anywhere and sell to everywhere. At least if an ethically trained industrial designer is at the helm of production, they may be able to take steps to help minimize the damage being done. If that plastic tchotchke is made using one less milligram of plastic, over a production run of one million units, they are still saving a kilogram of material to be processed and transported. In this role, the designer may help minimize damage, but certainly not mitigate it.

It becomes a cycle of circular causality, where consumers continually consume, and producers continually produce. Producers will produce so long as profit can be made, and consumers will consume so long as they see a benefit to consumption. To continually make profits, producers increase their advertising to 'assist' consumers in seeing the benefits while simultaneously make efforts to increase their market size. This may be through a geographic market expansion to find new customers, a demographic market expansion by addressing a new customer base, or through strategies like planned obsolescence or designed obsolescence, where they are re-attracting the same market base through stylistic and functional updates or intentional failures, respectively. If producers cannot find demand, they will manufacture it. While these are predatory tactics by producers, consumers are not merely the victims in this cycle.

World War II left North American societies with an increased desire for uniqueness, individuality, and an increased capacity for machine production. Prior to the war, design was built for standardization, efficiency, and mass production. It was characterized by the optimism of industrialization for a more democratic future. Post-war, people were coping with the atrocities they witnessed and desired the feeling of hope after living with restriction and rationing since the Great Depression.

The industrial designer acts as a liaison between the producer and consumer, attempting to chase the desires of the consumer for the benefit of the producer. Rather than assigning the blame of this system on the designer, as Papanek does in his introductory paragraph (2023), I would argue that the designer is only one small component of this overall ecosystem surrounding objects. While I will not absolve the designer of their responsibilities as an educated and informed participant of this system, it is naive to suggest that designers alone can repair it.

My research seeks to explore a speculative future in which the relationship between the producers and consumers can be reconciled so that the system can better address the environmental concerns that are the result of over-consumption. Throughout my framework, I discuss industrial design in the context of contemporary consumer theory in the Global North and the social implications of our relationships with objects, the role of methods of making and agency of making in these relationships, designs role within the production-consumption cycle, as well as macroeconomic theories of capitalism and post-growth economies. This framework will act as the foundation for my speculative research-creation methodology, where I examine strategies that industrial designers may undertake to design for a post-growth society.

Research Question

What might be the role of the industrial designer in a post-growth future?

Objectives

1. To investigate the impact of methods of making on the aesthetics of consumer objects.
2. To explore opportunities for parametrization in artisanal and digital making.
3. To develop and evaluate a collection of post-growth furniture.

Theoretical Framework

The Consumer

Definition: What is Consumption?

Human existence relies on consumption. To survive, we must consume food and water, construct a shelter, and clothe ourselves for adequate warmth, among a myriad of other requirements to maintain our health and physical ability. To be is to consume. Consumption, however, has inconsistent and conflicting definitions.

Csikszentmihalyi defines consumption as such:

> "*Consuming consists of energy expended to improve the quality of life by means of increasing entropy*. In other words, consuming entails an exchange of psychic energy (usually in its symbolic form, i.e., money) for objects or services that satisfy some human need. These objects are relatively high in potential energy to begin with, but through the process of

> consuming they are broken down into useless things with low potential energy." (Csikszentmihalyi, 2000, p. 267)

One example proposed is the consumption of steak, where the producer is transforming a steer, feed, and other processes into the steak and the consumer is transforming the steak into both energy and bodily waste. The steak is always both a byproduct of and input for production. Beyond the physical consumption, this definition can be applied to ideas, concepts, and experiences, which can broaden the understanding of value beyond what can be purchased, like goods and resources, to metaphysical concepts like time, relations, and spirit. For example, Csikszentmihalyi argues that the psychic energy required to process media or hold a conversation with a friend is a valid input of energy to illicit entropy, where the output can be new knowledge, joy and the building of social relations.

In comparison, Graeber defines consumption as the using to completion or destruction of objects. He takes issue with the term being used to describe both the completion or destruction of a product and the act of using or engaging with a product, tangible or intangible. He uses the example of comparing the actions of singing karaoke or watching television to the action of eating food, where the former actions do not destroy yet the latter, eating, necessitates destruction.

Graeber argues that consumption historically has been defined in opposition of production, where if a worker is not producing through their labour, they are consuming. There is no state in which an individual is not doing either and through this definition we are centering modernist, neo-liberal ideologies (Bean, 2019; Graeber, 2011). It perpetuates an endless cycle of production and destruction because the only way we can reasonably produce more is to replace what has already been. It also defines people as only consumers or producers and capitalizes the human existence. Instead, if we are neither producing nor consuming, Graeber offers the term 'creative consumption' to describe the act of creating for the sake of self-fulfillment, rather than for the sake of production. Examples of creative consumption include creating music and watching television.

Although published prior to Graeber's article, Warde's (2005) definition of consumption provides a useful bridge between the definitions Graeber and Csikszentmihalyi propose. Warde indirectly builds on Csikszentmihalyi's definition as consumption as an expenditure of energy by describing consumption as a moment of practice. One doesn't consume for the sake of consumption; they consume to satisfy a separate aspiration. This third definition may unify Csikszentmihalyi and

Graeber's definitions by drawing the physical link between the expenditure of energy and action of destruction. For example, where Csikszentmihalyi's definition considers reading consumption due to the psychic expenditure of energy through the action of reading, processing, and understanding, Graeber's would argue that it is not consumption as nothing physical is lost in the process. Warde's definition, however, would argue that the practice of reading, as a means of mental energy expenditure, necessitates the production, and inevitable destruction, of physical objects to partake in the practice.

One of the primary reasons that Graeber criticizes previous definitions of the term 'consumption' is that by using the same term to describe the use of any product, whether it is destroyed or not, it frames all actions to be in opposition of production and orients any action as an economic action. However, it is through this attempt to distinguish the activities of 'creative consumption' from 'consumption' that paradoxically reinforces human existence as an economic activity, rather than detaching it. Human existence necessitates production and consumption, but it does not necessitate economic exchange. As Marx suggests, economic structures are modes of co-operation (Wolff, 2021) and while capitalism is the current mode of co-operation in the Global North, it is maintained through exploitation and institutionalized dependencies (Paech, 2012).

Beyond the social systems of economics, in framing consumption to be a strictly destructive activity, it risks removing the context surrounding the creation and destruction of objects. That is, the creation of one object necessitates the use and destruction of other created objects in a network of inputs and outputs until we return to the rudimentary input of energy and atoms. Consumption is not inherently the action of destruction, but an equalizing action in the lifecycle of objects and people.

Moreover, using Csikszentmihalyi's definition focused on the exchange of energy is more inclusive of non-human actors, including organisms and chemical reactions. While Csikszentmihalyi cites the second law of thermodynamics, it is also useful to consider the first law in which energy cannot be created or destroyed, only transferred. Consumption, in a definition that decenters the human, is the exchange or transfer of energy from one source to another. We consume and the byproduct is production. This lifecycle of objects exists outside of humanity to support the evolution of every other non-human actor. This same lifecycle has also supported humankind long before the concerns of manmade environmental destruction and the Industrial Revolution. Consumption is not inherently morally negative, but overconsumption can be. That is, the consumption of excess energy without appropriately returning the energy into the system is morally negative.

Motivation: Why do we Consume?

Historically, motivations for consumption were largely associated with Maslow's hierarchy of needs (Csikszentmihalyi, 2000; Maslow, 1943; Walker, 2006) and the cultivation of self-identity (Kilbourne, 1987; Warde, 2005; Whiteley, 1985). In the case of the hierarchy of needs, Maslow suggests that there are five sets of goals, physiological, safety, love, esteem, and self-actualization, that will dictate motivation and desire in the order of the hierarchy. Higher needs, such as love, esteem and self-actualization, will be ignored until the basic needs, physiological and safety, are met. These two categories, higher and basic needs, can also be described as growth needs and deficiency needs respectively.

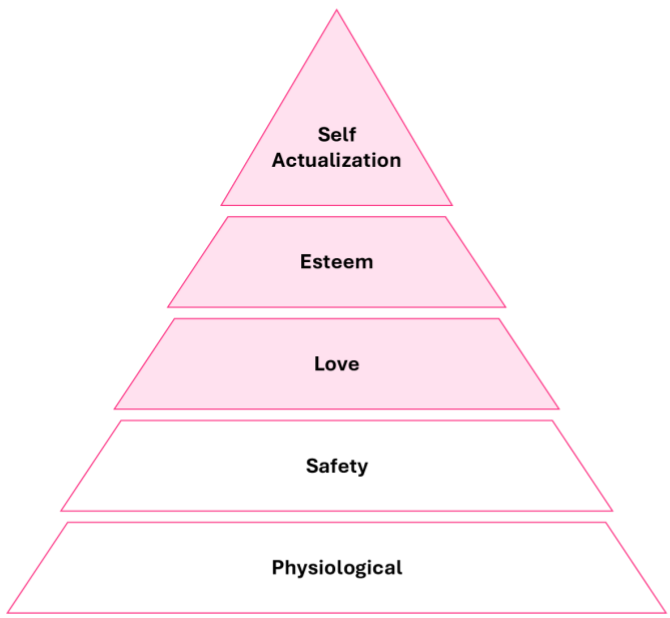

Figure 1. *Maslow's Hierarchy of Needs*. ***Note*****.** Adapted from the hierarchy of needs first presented by Maslow (1943).

While Maslow's framework is concerned with the motivation behind individuals, Kilbourne (1987) discusses the relationship between individual motivation and individual consumption habits. Kilbourne argues that while deficiency needs must be met through a level of consumption, for example, food, shelter, clothing, water, and the objects that make meeting these needs more accessible, contemporary Western industrialized societies are attempting, and failing, to meet their growth needs through the same means. Western industrial consumers are conflating the symbolic meaning and 'exchange value' of their products with their own exchange value, such that our objects become a 'social thing', "contributing to and sometimes governing social relationships between people" (Kilbourne, 1987, p. 226). Through consumption, we are seeking self-growth, however, in using consumption as an end to this goal, rather than as a means, we are relying on the relational qualities that objects hold. That is, when we rely on the symbolic meaning of objects to seek our unique identity and self-worth, we are limited to the abstract value we can find in what has already been created, and often mass-manufactured, while only valuing ourselves through the external validation from others.

This approach to self-actualization is inherently contradictory to Maslow's definition of what it means to be self-actualized; that being, objective perception of reality which reduces external influence, autonomous from social and cultural influence, and an understanding between means and ends or action and consequence. Kilbourne argues that we cannot achieve self-actualization according to Maslow's definition through the means we are pursuing and overconsuming, as an attempt to self-actualize, is a symptom of deeper societal problems. He concludes by saying, "Though many critics of the consumption process admonish us to consume less (saying the problem is overconsumption), the conclusion of his chapter suggests that it is not the quantity of consumption that detracts from self-actualization, but one's relation to the process of consumption." (Kilbourne, 1987, p. 233)

Csikszentmihalyi builds on Kilbourne's ideas and proceeds to map the other levels of the hierarchy as well. The deficiency needs are met through consuming existential objects, such as food, shelter, and clothing. Love and belonging uses consumption to fulfill social needs such as being with other people, conforming to societal views, and demonstrating care through gifts. Esteem consumption includes status objects that indicate social worth as well as skill-based objects, such as musical instruments and sporting goods. These objects are intended to fulfill the need to feel competent and superior. Consumption for self-actualization, in Csikszentmihalyi's opinion, is difficult to define, but can be ritualistic or a byproduct of a higher pursuit. The example he uses is purchasing airfare to learn from a Buddhist guru in India. It is to the benefit of a higher goal, in this case spiritual enlightenment, but is not consumption for consumption's sake. As with Kilbourne, consumption for self-actualization is the means rather than the end.

Warde (2005) expands on this notion of consumption as a means, by describing consumption as a moment of practice rather than a practice itself. That is, engaging in a practice, such as playing music or woodworking, necessitates consumption to participate. We do not purchase woodworking tools or accessories without the desire to be woodworker, and we only buy as much woodworking paraphernalia as we associate with the identity. As Warde states, "activity generates wants, rather than vice versa. Practices, rather than individual desires, we might say, create wants." (Warde, 2005, p. 137). Consumption does not stop at the required objects to participate, but extends to paraphernalia beyond objects with a direct use-value, such as branded clothing, books or manuals, decorative objects, etc. We consume because we want to be associated, and we consume more because we want to integrate a practice into our identity.

Where these definitions are focused on the utility of our consumed objects, it is worth considering the social and emotional aspects of our objects as well. In his paper, Belk (1988) discusses consumption habits through the role that our objects play in our personal identity, or what he calls, our 'extended self'. Belk frames possessions as essential in constructing our personal identity and sense of self by extending ourselves beyond our bodies. We use possessions to "learn, define, and remind ourselves of who we are" (Belk, 1988, p. 160) by exerting our control over the objects, creating them, or knowing them intimately. In using objects, we are expanding our own physical capabilities, in the case of tools for example, and we are using them to signal to others who we believe we are and who we want to be. This does not only occur at the individual level, but also on the familial, subcultural, and national levels. Similar to Warde's definition of consumption (2005), Belk argues that our degree of participation in any collective group dictates the possessions that we own. Through the careful curation of our possessions, we can signal to other people, through the aesthetics and utilitarian functions of our things, the mosaic of who we are. That is, the act of consumption is the curation of our projected experiences, beliefs, and actions.

Csikszentmihalyi classifies this curation, directly citing Belk (1988), as a higher level need for esteem and self-actualization and argues that if Maslow's hierarchy theory for behaviour accounts for all consumer motivation, then consumer choices and consumption levels should be more predictable. To account for this unpredictability, particularly evident in the post-World War II rise of modern consumption habits, the sociology and psychology of consumption need to be considered (Whiteley, 1985). Modern consumer culture began when the wartime manufacturing restrictions began to be lifted in the late 1940's to early 1950's. After years of scarcity and restrictions, in combination with rising economic prosperity and the notion that consumption was patriotic, young individuals began to exercise their newfound spending agency and purchase goods that's styling communicated the identity they were aiming to project. That is, after years of standardization and modernist efficiency, consumers began to desire objects that represented their hope, optimism, and independence. They were encouraged to consume more politically, as consumption rationalizes production and production creates jobs. The patriotic encouragement enticed consumers to show off their spending, while simultaneously signalling their economic wealth, demonstrating the social groups they associate with, and engaging in competition over their status in society. The act of consuming becomes a hobby in itself through browsing and window shopping, becoming a common way to pass time, and further cementing consumer culture into Western society.

The Producer

Production is often spoken in opposition of consumption. One cannot exist without the other because there is nothing to consume if nothing has been produced and nothing to produce is nothing needs to be consumed. But what is production and who is the producer? If consumption is the expenditure of energy, then production is the vessel in which energy is imbued into. It is a battery of sorts, holding the energy in a physical form until it is ready to be released again through the act of consumption.

Methods of Making

Carpo has identified three primary methods of making throughout history: artisanal, industrial, and digital (2023). Artisanal making is using hand and craft methods to produce goods. Each item is made individually by skilled labourers, rather than the use of machinery. Each object is unique as even with practiced muscle memory, no stroke can be recreated twice. Today, the exact definition of craft can be debated when we begin questioning what tools are acceptable as handcraft. In the context of woodworking, it's a question of whether the craftsperson must use a handsaw to be considered craft or whether a table saw counts as well. In this research, any tool that is positioned and moved by a person is considered craft or artisanal. The tool may aid the work, that is, the transfer of mechanical energy, of forming, cutting, and adding, but it cannot complete the operation autonomously.

Industrial manufacturing is the automation of the creation process, as beginning in the industrial revolution. It makes use of hyperspecialized tools and jigs to replicate processes and create duplicates of the objects. As automation progressed through the 20th century, less human input was required with the goal of complete elimination. Industrialized manufacturing operates on economies of scale to be profitable. The mass-production of industrialism allows for greater efficiencies that reduce the individual cost of production per object. That is, the more copies of objects that can be produced with a set of specified equipment, the less each individual copy costs.

The final method of making, and the most recent, is digital manufacturing. Digital manufacturing operates similarly to industrial manufacturing, however, the equipment required is more generalized. Where industrial making uses one set of equipment to create one copy of an object, digital making uses one set of equipment to create infinite unique objects. Examples of digital manufacturing include various CNC machines such as mills/routers, inkjet and laser printers, plasma and laser cutters, 3D printers, and lathes.

Artisanal

Historically, artisanal making was the only method of making. One example of organizing labour during this period can be seen in the British medieval guild system: a community organized, generational system to educate skilled craftsmen by entrusting young apprentices into the homes and guidance of a master to be trained into a journeyman over the course of (typically) seven years (Krugh, 2014; Sennett, 2008). The apprentice's role was to imitate the master to learn from repetition and hands-on learning. The relationship between master and apprentice was mutually beneficial. The apprentice offered their labour in exchange for knowledge, skill, and reputation. The master was able to benefit from their labour in exchange for wisdom and guidance.

This system began to fracture during the Industrial Revolution. The first wave of the Industrial Revolution began in 18th century England and was a result of the growing population from the Agricultural Revolution alongside major technological innovations such as the steam engine and spinning jenny. The development of new textile machinery required factories to house the equipment, necessitating labourers to congregate at a centralized worksite and subsequently lead to the growth of cities. The rise of mass production then led to the expansion of transportation routes and railway systems to move the comparatively high quantities of goods produced.

Industrialism led to the rise in urbanism and upward social mobility, but early industrialism suffered poor working conditions, long days labouring, public health and sanitation issues, and the loss of independence from employers. Wealth inequality grew between the working class and the factory owners, leading to political uprisings followed by shifts to more democratic governments and greater workers' rights. The initial lack of regulation and knowledge of the newly industrialized factories also lead to unchecked environmental damage through the rising use of chemicals, increased deforestation and mining practices, and high degrees of air pollution from burning of fossil fuels and coal.

The introduction of industrialization began fragmenting the handcraft process through the replacement of handwork with machine-work. Apprentices were no longer under the care of a master, alongside a small cohort of up to a few dozen people. Instead, the young workers became one of many in a large-scale factory with no trajectory to become a journeyman at all. The workers were replicating with machines, rather than learning to imitate by hand. Likewise, guilds were unsuccessful in their attempts to regulate the new industrial firms and trade unions took on the role of mediation between worker and employer (Li et al., 2023). Where guilds previously maintained standards of training quality and the transmission of knowledge between generations, the independence and decentralization of the industrialized firms allowed them to circumvent regulation.

One of the major impacts the Industrial Revolution had on the labourers was the division of labour. Adam Smith (1723-1790) advocated for the separation of individual tasks between the workers as early as 1776, where he argues that the repetition of a singular task maximizes the workers learning of the skill (Bellamy Foster, 1998). The worker would become more adept at their singular task leading to maximum efficiency in production. Additionally, the lowest skilled tasks can be assigned to the lowest skilled workers, freeing up the higher skilled workers to take on higher skilled tasks. Thus, the cost of labour can be reduced as lower skilled workers can be paid less. Beyond the separation of manual tasks, division of labour also separates the worker from the management of the work (Braverman, 1998; Carpo, 2023).

Scientific management, also called Taylorism, is a method of reorganizing the workplace through rational and scientific methods with the goal of complete optimization and efficiency. It was developed by Frederick Winslow Taylor (1856-1915) in 1909. As a continuation on Smith's division of labour, Taylor believed manual labourers to be "gorillas", for if they were not "stupid", they would not be manual labourers (Carpo, 2023). Because the workers are inept, they should be carefully managed and supervised, only performing the standardized tasks as prescribed by management. His goal was "to redesign work—and society—to eliminate skill" (Carpo, 2023, p. 51). Taylorism separates the worker from the entirety of the process they are participating in, so that they will also be separated from the conception of the work itself (Braverman, 1998). Without the mental model of understanding the entirety of the process, from conception through all steps of execution, they are unable to participate in the management of the task and are thus powerless to their managers who are monopolizing the knowledge. As technology advances and the degree of required knowledge to understand the process increases, so does the distance between the labourer and their autonomy (Carpo, 2023).

The lack of regulation in both training and workers' rights played a role in the burgeoning social issues caused by industrialization. One response to these issues was the Arts and Crafts movement (18^{th} to 19^{th} century), a romantic social and political movement that sought to promote traditional craftsmanship and values. The movement was influenced by Marxist socialist ideologies, particularly for William Morris (1834-1896), who "wanted workers to experience the joy of their work, rather than alienation" (Krugh, 2014, p. 44). He believed that workers were now slaves to the machines, and it was a moral imperative to return to the guild system so that workers could reconnect with their labour.

Beyond the impacts on the workers and communities, industrialization was creating lower quality goods. John Ruskin (1819-1900) believed that the excessive quantities of goods produced would "dull the senses" and the "uniform perfection of machined goods [issue] no sympathetic invitation, no personal response" (Sennett, 2008, p. 109). The more things one possesses, the less individual attention that can be paid to each item. The pleasure comes from obtaining, rather than operating.

While the Arts and Crafts movement was unsuccessful in bringing about a second guild era, it had lasting impacts on the transformation of craft from a vocational activity to a leisure one, leading to the rise of studio crafts, and positioning craft in political opposition to capitalist production (Krugh, 2014). Post-Arts and Crafts movement, engagement in craft remained a political activity: fascist Germany and Italy emphasized it as morally righteous; hippie counterculture of the 1960's-70's used it to signify independence from government and commercial institutions; second-wave feminism reclaimed traditional women's craft, such as textile and fibre arts, to explicate women's role in domestic labour; and punk culture and grunge in the 1980's-90's expressed their individuality and non-conformity through zines and fashion (Krugh, 2014). Throughout the 20^{th} century, craft is often placed in opposition to industrial manufacturing, seeing industrial manufacturing as a physical representation of the modern capitalist structure. It acts as a moral alternative to the sufferings believed to be caused by modernist values. Crafted objects are sought out for their authenticity, nostalgia, and relation to human connection (Bell et al., 2021).

Craft in the 21^{st} century is no different. Bolstered by digital connectivity, craft is presently being used in an attempt to economically separate from corporatist structures (Jakob, 2013; Krugh, 2014) as well as to seek out human connection through community and tangible interaction (Bell et al., 2021). Craft today is often anti-globalization and anti-sweatshop. There is a greater desire to understand the provenance of the objects we consume and learning to craft can feel more accessible due to the large number of online resources available.

While craft as vocation is still taught in formal institutions like technical colleges and universities today, informal education in a leisure capacity is a more common way to participate. The rise of social media encourages sharing and teaching, spreading the practice to those with little familiarity with it and generating new interest. Amateurs can see the successes, both artistic and economic, of large numbers of crafters in online spaces which motivates them to use their own craft practice to participate in the local economy. This, ironically, turns an anti-capitalist expression into a capitalist activity. As Krugh (2014) highlights, what begins as a blurring of leisure and labour, often turns into a Fordist enterprise of division of labour in order to maximize the economies of scale. Like the case of the Industrial Revolution, a local seller will make higher profits by systematizing their labour, otherwise they will be working excess hours for low wages for anyone to afford the quality work they are producing.

Industrial

The Industrial Revolution brought about vast changes in materials and technology, allowing goods to be produced more efficiently than ever before and laying the groundwork for modern consumption. When World War I occurred at the culmination of the second Industrial Revolution, it revealed the impact of industrialism on every facet of life, while clearing the stage, through decimation, to rebuild Europe with modernist values.

The post-war reconstruction efforts during the inter-war period in Europe provided the demand for modern design ideologies of functionalism and efficiency (Bürdek et al., 2015; Forgács, 2016). One such movement is the Bauhaus school in which the founding director, Walter Gropius, advocated for the unity of art and technology to pursue a democratic and socially responsible form of design. Through the responsible use of materials, functional objects could be reduced to their purest forms to create mass-produced objects that have the care of handcrafted ones. Socialist and democratic ideologies were imbued into the designs to physically demonstrate how they would impact daily life. The democratic approach to design wanted all people, particularly the working class, to benefit from ‘good design’. ‘Good design’, in this case, follows the imperative of ‘form follows function’. The primary goal is utility and through it, an aesthetic form will naturally emerge. Socialist design movements spread across Europe during this time, such as the Scandinavian socially-aware design (Dormer, 1990), the UK Utility Scheme (Helvert, 2016b), and the Moscow VKhUTEMAS (Forgács, 2016). These design principles included, but are not limited to, high-quality manufacturing, efficient use of materials, affordable, and the ability to assemble/disassemble.

Meanwhile, across the Atlantic, the United States was benefitting from the post-war industrial efficiencies without having to rebuild. Having increased their manufacturing capacities for the war efforts, the equipment was now free to move to consumer goods to absorb the productivity. In the late 1920's, producers turned to styling as a means to increase sales (Helvert, 2016a; Whiteley, 1985). Early American industrial designers were approaching the discipline with backgrounds in commercial arts and it was a natural transition to imagine objects embodying the advertisements themselves (Dormer, 1990). Manufacturers also began to realize that if products 'lasted' too long, consumers will have no need or desire to repurchase. This idea was especially prevalent during the economic down-turn of the Great Depression (Helvert, 2016a). Product lifespans can be reduced through planned obsolescence (obsolescence of style or technology) or designed obsolescence (obsolescence of durability and function). Where planned obsolescence relies on taste and the ethos of 'new is better', designed obsolescence uses intentional failure points to limit usage and designed 'black boxing' to inhibit repairs. Early obsolescence, although now seen negatively in respect to sustainability, was initially seen as vital for the economy: it ensured factories kept operating while providing consistent work to labourers.

Throughout the Second World War, it became apparent that the design of objects played a key role in the functionality and safety of the device. Ergonomics, honest design (Papanek, 2023), and 'scientific design' (Cross, 2006) began to take on greater importance in object creation, broadening the scope of industrial design beyond questions of style and positioning designers as integral contributors to the manufacturing process. War-time efforts did not need 'design for sales', but 'design for use'. Beyond designing for the efficient of use of materials, designers were required to consider the anthropometric data to ensure the controls of an aircraft are within reach of the average pilot or the cognitive processing required for understanding and acting on a control panel under duress. The war efforts demonstrated high-stakes scenarios that poor-functioning design resulted in deadly consequences.

Post-war, America found its mainland, once again, unharmed and with further increased manufacturing capabilities. The designer played the role of translator between consumers, manufacturers, data scientists, psychologist, etc. Not only were the objects created intended to be a "work of art" that enticed consumers to purchase, but they should also be based on objectivity and rationality, a product of modernist efficiency. At the same time, consumers were beginning to desire individual expression and hopeful and optimistic objects after being constrained by war-time rationing for so many years (Whiteley, 1985). Due to the increased communication capabilities and the growth of mass-media in the 1950-60's, pop and pop culture began to flourish, and so with it, consumer culture.

Beginning in the 1950's, America began transitioning to postmodern consumption habits, marked by the increase in white-collar works and the emergence of an information society (van Raaij, 1993). By 1956, there were more white-collar workers than blue-collar workers, meaning more people earned their employment from information than manufacturing. Where modernism emphasized logic and function, postmodernism prioritized self-expression and individualism. As the Americana monoculture fragmented, consumers began using their objects, and consumption, to identify with their subculture. Objects became representational of who someone is.

Since this shift, consumption has only increased as we are inundated with media, excess, and materialism at ever increasing speed due to the rise of the internet. Producers are only happy to meet the demand: producing more things that become obsolete faster with the rapid changes in technology.

<u>Digital</u>

Digital manufacturing is "when machines became electronic and started to function with a new technical logic, different from and in many ways opposite to the analog logic of yesterday's mechanical or electromechanical machines" (Carpo, 2023, p. 9). Digital manufacturing differs from mechanization through its computational (digital) logic in contrast to mechanizations analog logic. Where Henry Ford used conveyor belts to bring the work to the worker, digital manufacturing brings the tool to the material.

Digital manufacturing began with the development of mass-market computers in the 1950's-60's when researchers began using mathematic geometry data to control CNC mills (Carpo, 2023). While computing was still in its infancy, researchers at MIT began to develop the precursor software for 'Computer-Aid Design' (CAD) for the purpose of 'Computer-Aided Manufacturing' (CAM). In the 1970's-80's, CAD software was used in aerospace and automotive industries, but it wasn't until the late 1980's-early 1990's that computers were embraced by the design industry, due to the release of Autodesk's AutoCAD (December 1982) alongside the increasingly affordable personal computers that were capable of handling relatively complex imagery (The first IBM PC with MS-DOS was released in 1981 and Macintosh in 1984). With these advancements, designers were able to use PCs to develop images and drawings and aid architects and designers in managing their technical drawings.

A key outcome from this development was parametric design and mass-customization. Parametric design is a form of digital design that use coefficients (parameters) to mathematically generate an infinite range of objects with the same syntax, due to the commonality of its code, but are distinctly unique (Carpo, 2023). While parameterization is possible by hand, algorithmically calculating the relationships is far more efficient. Moreover, digital fabrication makes the construction of parametric objects possible. Where industrial fabrication relies on molds, jigs, and specialized equipment, digital manufacturing can adapt to the minute differences between each variation with little efficiency lost.

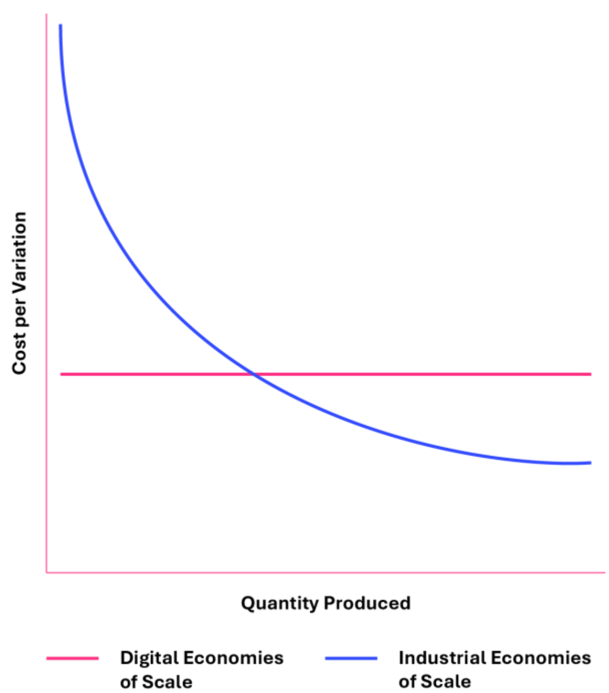

Figure 2. Interpretation of the comparison of Digital and Industrial economies of scale, based on Carpo (2023). ***Note.*** The pink curve represents a flatted economy of scale in a digital production economy, and the blue curve represents an industrial production economy of scale. Interpreted from Beyond Digital (Carpo, 2023).

It is through parametric design and digital fabrication that mass customization is possible. Like craft, mass-customization is the anti-thesis of industrialization. Industrialism relies on standardization and uniformity to achieve efficiency and economies of scale but with digital fabrication, the economies of scale has been flattened (Carpo, 2023). It becomes no more advantageous to create a standardized object than a unique one. Digital manufacturing offers the possibility of customization for everyone, democratically. There is especially potential in manufacturing related to healthcare and bodies. For example, a standardized fit for a prosthesis or dental implant isn't possible due to human anatomy, but 3D scanning and digital manufacturing offers a custom fit with an exceptional degree of accuracy. In addition, with the interconnected nature of digitalism and the internet of things, scanners and cameras can identify objects and apply digital manufacturing techniques to them. Responsive CAD can be seen in sustainability initiatives that can optimize irregular material usage through sensors and matching algorithms (Haakonsen et al., 2024).

Mass-customization can lead to greater sustainability concerns if consumer habits don't change. Recycling and reuse initiatives presently struggle with managing an excess of uniquely shaped objects with various combinations of materials and assembly methods. When objects are overly customized, like a prothesis, the object cannot be readily reused in the same capacity. It either needs to be broken into its constituent parts or creatively reused via upcycling. Other objects, like furniture or clothing, are still usable when not entirely customized and have more opportunity to be re-adapted, reconfigured, or re-tailored to fit the needs of the new owner. Alongside functional customization, mass-customization allows objects to be aesthetically customized as well via colour selection or engraving, for example. Aesthetically customized pieces can hold greater emotional attachment to the object, as the owner feels they have had a part in its creation (Atakan et al., 2014), but it may also decrease the value to new owners who acquire the object secondhand, as it might not feel like 'theirs' if someone else's name is written on it.

Beyond the opportunities that digital manufacturing offers on large scale production, it can also be used on smaller, more local scales. The rise of desktop CNC machines, laser cutters, and 3D printers allow individuals to participate in small-scale manufacturing (relative to mass-manufacturing facilities) using digital technologies, also called 'personal fabrication' (Bandoni, 2016). Often operating in community facilities called Fab Labs, or fabrication laboratories, this equipment can make it possible to "*make almost anything*" while being accessible "for *almost* anybody" (Bandoni, 2016, p. 212), once again leaning into democratic design principles.

The benefit of this equipment, in combination with the digital communication age occurring concurrently, is that it allows rapid sharing and learning opportunities. Similar to the present resurgence of craft practices, social media and blogs serve as a digital sewing circle (Krugh, 2014). It encourages community and, like the guild systems before it, preserve the 'knowledge capital' (Sennett, 2008) by transmitting the information from the present masters to new apprentices. When Fab Labs are well managed, they have the opportunity to address unsustainable manufacturing methods by providing the option to manufacture only what is needed, when it is needed, and where it is needed (Bandoni, 2016). Instead of having to create the demand to justify manufacturing mass quantities of the object, the object can be justified to make for a single use-case. It avoids the environmental harm of the global supply chain and can be used to manufacture with materials that are found locally, like native species of woods, bioplastics, or clays. It also offers opportunities for local self-expression, providing a cultural benefit, rather than conforming to a manufacturing monoculture.

The Designer

Somewhere between production and consumption lies the industrial designer. In this system, the designer plays the role of the intermediary between the two participants of the cycle. They act as a translator between the desires of the consumers and the possibilities of production. Designers are tasked with creating the aesthetics, ergonomics, semiotics, and heuristics of a product; creating a product that feels good to use to entice consumers to purchase and demonstrate their value to producers, legitimizing their role in the economic process.

With the rising concern about the environmental impact of consumer culture, designers have been interrogating their role in this system. Several of the responses to this concern are outlined below, each offering a distinct perspective on what 'better' means in design and how to reach it.

<u>Responsible and Ethical Design</u>

In 1971, Victor Papanek releases the first edition of his book, Design for the Real World, in which he emphasizes the ethical duties industrial designers have to be "ecologically responsible and socially responsive" when creating new objects (Papanek, 2023). Papanek highlights how various design decisions are not only bad for human health but have the potential to maim or kill their users, devastate the environment, and provide nothing of value in general. In the present, designers are using their skills as translators for the benefits of large corporations to "[persuade] people to buy things they don't need, with money they don't have, in order to impress others who don't care"

(Papanek, 2023, p. IX) rather than designing what people truly need, referring to Maslow's hierarchy. Moreover, much of the design efforts are going towards frivolities for the Global North rather than aiding in providing necessities for people living in poverty in low- and middle-income countries. Under the current capitalist system, designers are drawn towards corporate design jobs that offer prestige and higher pay but ultimately offer no public good. It is this type of work that reduces the design practice from critical social ideologies to banal frivolity (Clarke, 2016). He sees these corporate interests in direct opposition of consumer rights and advocates for these rights to be supported through design practice. The commoditization of design has removed any social ideologies from the practice pushing designers to the whims of consumer culture at the expense of consumers themselves.

As a solution to the irresponsible design, Papanek proposes a tithing system of sorts for designers to offer 10% of their time designing for public good. These designed solutions should be small-scale, low-cost and locally adaptable. Instead of importing 'one-size fits all' solutions of technology and products, designers should be working with communities to solve unique need-based challenges. Because the designer's role is to synthesize information between various disciplines, they are in a unique position to help address the public needs with a broader understanding of the ecological impacts the proposed solutions may carry and the sociological and psychological impacts it may impose on the societies it is being introduced to.

Although the book received strong negative reactions upon publishing, particularly from American industrial designers, it marks a clear shift in design ideology from design as industrial capitalist commodities to design as social good (Clarke, 2016; Jackson, 1993). It is a foundational text in what became the sustainable design discourse for its discussion surrounding consumerism, waste, and ecology.

<u>Life Cycle Assessment</u>

A life cycle assessment (LCA) is a rigorous scientific methodology used to quantify the environmental impacts of a product, cradle to grave, standardized by ISO 14040 series (*Environmental Management*, 2006; Hauschild et al., 2018). The quantification includes all aspects of production and disposal, such as the acquisition of raw materials, production and distribution of fuels and electricity, use and maintenance of the product over its lifespan, and the recovery and disposal of used products. As the methodology is standardized internationally, it allows for direct comparisons across several environmental markers, such as climate change, freshwater usage, toxic health impacts, depletion of resources, etc., to avoid “burden shifting” (Hauschild et al., 2018). Materials and processes are becoming increasingly complex, and a multifaceted approach highlights the tradeoffs between the various options.

For example, if we are designing the packaging of a liquid soap, and we must choose between a plastic or glass container. Where the glass in infinitely recyclable, it requires high amounts of energy to do so. In addition, the added weight of the glass will increase the fuel requirements to transport it. It is also more fragile than plastic, so will require more protection in the shipping process, which could be a material like cardboard or bubble wrap. Plastic, while it outperforms glass in energy and transportation, has a low recycle rate, and is most likely sent to the landfill, creating a longer lasting impact. If the glass can be refilled, then it becomes more worth the extra energy expenditure. If it can’t or isn’t, then on a single-use basis, plastic has a lower environmental impact. This then leads into the greater service of the soap company and whether it supports refill or recycling efforts, as well as a greater conversation about consumer behaviour. The LCA is used to measure the quantifiable impacts of the materials to aid these greater discussions, particularly when two options have their sustainability drawbacks.

The resulting metric does not act as an absolute score, but rather a relative number used in the assessment of systems and processes. It is a tool in facilitating decisions and understanding the impacts of the decisions across the products lifespan. The quantitative values recorded for comparison are often “best estimates”, which account for average operating values and exclude outlier events, such as oil spills or nuclear disasters, to present the most-likely case scenario. LCA can also require judgement-driven weighting of the various environmental impacts. The weighting is useful for comparing various options within the study but are reliant on the values of the practitioners and stakeholders and so become context dependent.

<u>Cradle to Cradle</u>

Cradle to Cradle (2002) discusses an alternative manufacturing approach from the present ‘cradle to grave’ ethos to promote ‘effective’ design practices. Current manufacturing is focused on the creation and distribution for objects, but once the product leaves the facility, the manufacturer no longer takes responsibility for it. It is left up to the individual consumer to determine how the product will be disposed of when it is no longer of use to them. While products can be repaired, it is not in the manufacturers best interest, financially, to encourage the practice. This disposable culture encourages constant new purchases and perpetual consumption. Without this, the economy cannot grow indefinitely, risking our current economic system.

Instead, Braungart and McDonough proposes the ‘cradle to cradle’ method, in which designers and manufacturers take back the responsibility of the products end of life by designing the lifespan of the product to include its ‘rebirth’. Taking inspiration of biological lifecycles, this method proposes using materials and processes that are not only “less bad” than present manufacturing systems, but actively good for the planet and organisms that inhabit it. For example, developing a natural upholstery textile that’s trimmings can be used as a compost material, and the factory effluent can be used as influent. They refer to this as ‘waste equals food’, taking a cyclical approach to consumption, where the outcome of consuming resources is the production of the product in addition to perpetually usable resources. Every output is equally an input. Biological materials can become food for the biosphere and natural world. Technological materials, materials that have been processed beyond their naturally existing state such as metals, polymers and chemicals, can be returned to the industrial process, or ‘technosphere’, through recycling and upcycling. Not only is this approach environmentally sustainable, but it is also highly efficient, maximizing the outcomes of the process. When each product is able to be used effectively, there is no waste left to manage.

This concept of designing products for lifecycles is not entirely novel and Braungart and McDonough cite many historical examples of this methodology, acknowledging that it is often done out of necessity rather than desire. One example provided is the indigenous practices surrounding buffalo hunting. While the text was not specific in their example, I will provide the example of the Niitsitapi/Blackfoot people of the southern Canadian and northern American prairies. The meat, fat, and marrow of the bison are used for food, the hide is used for clothing and shelter, and the bones for tools. Although this list is highly simplified, the materials harvested from the bison played a vital role in every aspect of life. The materials are highly valuable, and the bison itself is considered a gift from the Creator for sustaining life. With the impending climate crisis and impacts on public health, it is worth considering that society today should be adopting similar principles out of necessity as well.

Design for X

In addition to designing for effectiveness, as outlined by McDonough and Braungart, there are many other ‘Design for X’ or ‘DfX’ methodologies to encourage more sustainable design practices. Many are incorporated into design for efficiency but are also discussed independently as a primary area of focus as well. Such examples include design for modularity, design for disassembly, design for repair, design for efficiency, design for resilience, etc.

Design for modularity and disassembly follow a similar ethos of designing objects that can be assembled and disassembled which leads to the additional benefits of customization, repairs and maintenance, appropriate end-of-life disposal, and efficiency in transportation logistics. IKEA highlights these principles to design their flatpack furniture in their sustainability strategy (*IKEA Circular Product Design Guide*, 2024), with the added benefit of being economically efficient and saving costs on logistics, transportation, and labour.

Design for repair builds on the previous approaches of providing the consumer the agency over their object but focuses on the consumers agency over the lifespan of the object by opposing proprietary tools and 'black box' assembly methods. Also called 'Right to Repair', this is a political movement for the legal right to modify and repair objects how the owner sees fit, whether it is done independently, with a third-party, or by the manufacturer, without automatically voiding the products warranty. Design for repair aims to increase product lifespans by encouraging maintenance and repairs, particularly to electronic devices and vehicles, and reduce consumption habits over the lifespan of the consumers.

Design for efficiency refers to the efficient use of energy and materials to maximize the outputs. Following the foundational 'reduce, reuse, recycle' ethos, design for efficiency is an attempt to achieve the economic goals of growth with reduced material inputs. The example of designing a plastic tchotchke with one less gram of plastic is one method of achieving efficiency—engineering products and materials to require less overall material for the minimum required strength.

Design for resilience (Walker, 2023) discusses durability to increase the objects longevity, both by reducing the manufacturing volume required by making objects physically last longer but also addressing the consumption habits and materialism that causes people to dispose of their products early, such as trends and obsolescence. Design for resilience can oppose design for efficiency as it questions the 'minimum required strength' needed. For example, a plastic Monobloc chair can be made from less plastic overall and still functionally be a chair, but the reduction in plastic reduces the overall weight it can support and is much quicker to break, resulting in more overall waste. Arguably, a Monobloc chair wouldn't be celebrated as a resilient design, however it does lead to the discussion of class and care (Guixé, n.d.; *Monobloc*, 2022). Who can afford a resilient design made of sustainable materials and when faced with a less 'valuable' object, who is treating the object as disposable versus providing the object with care?

Overall, DfX strategies are varied and disparate. It must be acknowledged that there cannot be a one-sized fits all approach to sustainability and thus use a combination of DxF principles can be used to prioritize certain requirements. To appropriate McDonough's and Braungart's (2002) vocabulary, DfX approaches are aiming to be "less bad" while still operating under contemporary manufacturing principles. When employed in mass-production, it is typically for the economic benefit of the company, and, with some exceptions, are typically not aiming to address the overall consumption habits.

Emotional Durability

Emotional durability is the theory in which people form enduring empathetic bonds to their objects, increasing its personal value and thus becoming more likely to be cared for, maintained, and repaired (Chapman, 2009; Walker, 2006). It turns the sustainability discussion towards the behavioural issues causing overconsumption rather than purely looking at sustainability as a material issue. Like cradle to cradle, emotional durability examines product lifespans and how the continually shrinking lifespans, via functional and psychological obsolesce, are contributing to excess waste and over-production. Rather than looking at how the product lends itself to repair and recycle, emotional durability is asking why certain objects are repaired over others and what intangible characteristics lead consumers to prolonging the objects life.

A study by Jonathan Chapman (2009) investigated the feeling of value respondents associated with domestic electronic products (DEPs), and identified six characteristics of emotionally durable objects: *narrative* of the personal history shared with the object; *detachment* with the product resulting in low expectations and thus high success rate of use; the *surface* physically ages well and develops unique character; *attachment* through a strong emotional connection; *delight* in actively and presently exploring the product, often with newer products; and an associated *consciousness* of the product displaying quirks or personality that is only learned over time. Chapman asserts that our products are "symbols of what we are, what we have been, and what we are attempting to become" (Chapman, 2009, p. 34) and through the acquisition and ownership, we incorporate them into our identity. We discard objects that no longer speak to our identity and cherish those that represent what we aim to be. It wouldn't matter how sustainably produced an object is, if the owner does not cherish and maintain it, it will become waste anyways.

Walker (2006) looked toward objects in museums as objects that endured throughout history, as their survival indicates physical longevity or cultural importance and therefore care. He classified the enduring objects into three categories, or combinations of such: functional, social/positional, and inspirational/spiritual. Through their endurance, Walker infers that these objects satisfy human needs, also citing Maslow's hierarchy of needs and mapping closely to Csikszentmihalyi's (2000) examples in each category. Walker places functional objects as fulfilling lower needs of survival and safety, social objects fulfill love and belonging, and inspirational objects satisfy esteem and self-actualization. Also, similar to Csikszentmihalyi, Walker identifies that existing within this hierarchy of needs does not produce rational or predictable consumption patterns. Technology changes too rapidly for an electronic object to be considered functional for long. Social positioning trends change too rapidly for objects to remain 'in style'. Desires for objects are constantly changing the objects are physically more durable than they are emotionally.

One reoccurring theme in emotional durability is the separation between the consumer and the provenance of the object. Just like how people seek out craft objects for their authenticity and local connections (Bell et al., 2021), people may regard their objects as more disposable or less valuable because we, as Western consumers, have become so separated from the manufacturing processes (Walker, 2006). Moreover, the manufacturing processes have become so divorced from the cultures that they are servicing that the mass-produced objects become "culturally bland". In an attempt to create a product that is appealing to everyone, mass manufactured products cannot include aesthetic elements that would resonate deeply with a small population.

Beyond the aesthetic separation between objects and cultures, the separation between producer and consumer alienates the consumer from understanding the how the product is fabricated. The consumer is left to judge the objects value solely on the market price of the good, rather than the value of all of the inputs that make a product what it is. Where LCA numerates this evaluation, producing objects locally intuits it. Emotional durability is not explicitly for craft production but operates under similar values of provenance and closeness of association. When objects are manufactured locally, consumers can see the factories and operations of the production. Like the experience of seeing an Amazon warehouse up close, it provides a more intuitive sense of scale of just how many things occupy the space, how many people it takes to operate it, and how few people this entire operation is serving. The separation of Western consumers and offshore production obscures the raw material and skilled labour inputs into the product, allowing the consumer to mentally devalue it.

Emotional durability addresses sustainable consumption concerns by advocating for the production of objects that connects with consumers on a deeper level. Because there is a high degree of diversity among consumers, this cannot be achieved through industrial manufacturing. Emotionally durable design calls for the local production of goods and services to maintain and repair them. In using local production, the consumer can understand the provenance of the object and have the opportunity to gain a deeper understanding of how the object is constructed, seeing the entirety of the labour and resources that go into it. Through maintenance and care, the consumer can build their relationship with the object, understanding its quirks and nuances, while celebrating the object for how it has aged with them.

The System

The cycles of consumption and production are deeply engrained into Western society because the current economic system is based off of perpetual growth (Paech, 2012; Thorpe, 2012; Victor, 2008). One of the primary metrics used to measure the state of a nation is through gross domestic product (GDP), which is the total market value of goods and services produced within a country and is often conflated with progress of the country itself. The task of measuring a nations growth began in the 1930’s with Simon Kuznets (1901-1985) to better understand the Great Depression, coinciding with Keynesian ideas on government market intervention and employment rates.

John Maynard Keynes (1883-1946) argued that government involvement in the free market was necessary and without it, the private sector would settle on economic activity below its productive potential, under-employing the labour force and creating greater economic hardship (Victor, 2008). Through government intervention, such as infrastructure projects, a country could maintain a stable level of employment which, in turn, allows the citizens to spend money more freely, thus stimulating the market and encouraging further production and greater employment opportunities. Keynesian ideologies gained popularity in the 1940-50’s as the post-World War II economic stimulation after the Great Depression provided economists enough evidence to adopt into policy objectives. In 1953, GDP became a global standard for measuring and comparing economic activities. The metric gained prominence in the 1950-60’s during the Cold War, when the US and Soviet Union used GDP as a proxy for ideological superiority by demonstrating how well the respective nations were performing.

However, GDP was never intended to be used in the way that it is currently being interpreted. In his report to the US Senate, Kuznets warns, “The welfare of a nation can, therefore, scarcely be inferred from a measurement of national income as defined above” (Commerce, 1934, p. 7). Notable limitations of the GDP include domestic labour, volunteer work, leisure activities, illegal activities, wealth disparity, or depletion of natural resources. In its conception, it was always intended to be an approximation for evaluating the needs of consumption and studying changes in economic activity over time (Kuznets, 1937). In general, consumption levels do not correlate with wellbeing, however because consumption is linked with growth, like employment, it is encouraged as a patriotic activity (Thorpe, 2012; Whiteley, 1985).

The challenge of a growth-based economy is that growth is constrained by biological limits (Victor, 2008). The planet can largely be considered a closed-loop system, with little passing through the atmosphere (the primary exception being solar energy), and so the more that is consumed the less there is left to consume. As more resources are utilised and over-harvested, they become more cost-prohibitive to extract. An example of this is oil production: early in its usage, it was abundant and easy to extract but as the demand rose, extraction require deeper wells and unconventional sources, like oil sands or shale. Because the system is closed loop, if the demand doesn’t significantly reduce, it will eventually be used up, deposited into “sinks”. These sinks are physical spaces that hold the material and energy until they are released back into the biosphere. Considering, once again, Csikszentmihalyi’s definition of consumption as entropy, objects can be considered the sinks in which the energy and materials are trapped within. As objects are discarded, the stored materials and energy must wait for degradation to be released if they are not disposed of in a way that can recapture this energy. In other words, unless objects can be returned to the closed loop system, the resources used in manufacturing the object will be removed from the cycle in these sinks, reducing the total amount of resources available.

Beyond overall biologic limits to consumption, we also face temporal and spatial limits (Paech, 2012). Spatial constraints are the geographical limitations of production, whether it is access to resources or manufacturing abroad. Temporal constraints are more conceptual than physical and can largely be identified through debt, such as the ‘buy now, pay later’ premise. The consequences of exceeding the temporal limits will be ‘paid for’ sometime within the future. This debt may be financial or material, in which the debt manifests as waste. Where biological limits are finite, technology has found ways to mitigate temporal and spatial constraints. For example, spatial constraints are reduced through international trade networks and political trade agreements. No country is restricted by the resources on their land or availability of space. Expansion is limited by our technology and businesses are highly motivated to create new required technology to circumvent the limitations. Bypassing the temporal limits, however, are simply pushing our limits into the future. Both individuals and nations utilize debt to increase their short-term consumption capacity by increasing access to more resources.

Despite growing critiques of growth-focused economic policies, proponents of growth argue that the price mechanism will manage growing resource scarcity. When a resource becomes scarce, the price will increase as the demand is higher than the supply. The raising costs will encourage research and innovation to seek an alternative means of meeting the demand, either through substitutes, new technologies, or more efficient use of the resource (Victor, 2008). In response, Victor argues that this is only the case when the rights to the resources are clearly established and enforceable, otherwise there is a lack of incentive to research the new technology as there is no clear way to profit from it.

The Global North is continuously borrowing from the future: material debt to plunder finite resources and meet the collective energy demands; and personal debt to finance the acquisitions of the new technologies produced. Paech argues that debt, "either implies faith in a sufficient growth in income or assumes that the debt will be serviced later on through restricting consumption or the sale of assets" (Paech, 2012, p. 19). If society stops consuming, however, the current economic system will collapse. The common response to the growing consumption crisis is that sufficient technologies will be developed that would allow society to continue consuming in the manner it presently is without the consequences to the environment, either by achieving efficiency allowing maximum production for minimum resources or by relying on closed loop and renewable systems, like recycling efforts and renewable energy sources. However, this relies on the creation of new, unknown technologies to solve the problems of today, with the implication of sufficient faith. While advancements in production are increasing efficiency and reducing the environmental burden, to borrow phrasing from McDonough and Braungart, it is less bad but not good (McDonough & Braungart, 2002).

Technology comes with risks. The consequences of the new material or process are unknown and thus could be causing unknown harms, such as the greater use of electrical energy over fossil fuels, requiring extensive lithium mining. These new harms are simply shifting the burden, either by making it tomorrows problem to solve, while the benefits are reaped today, or by creating new damages to a different part of the ecosystem. In addition, new technology requires new infrastructure. Even when the technology itself is more eco-friendly, new facilities need to be built to manufacture the technology, and greater systems need to be built to support the use of it.

Additionally, if the economic burden is reduced relative to GDP, the impact will still continue to rise if GDP is also rising. Instead, an absolute decoupling of environmental damage and GDP will be required. This, however, is a paradox because impact reduction relies on the material flows to remain, at most, consistent while growth of GDP necessitates overall growth. Paech uses housing as an example to illustrate this paradox:

> "An absolute reduction in the ecological burden would mean that the total number of buildings could never increase. Existing buildings could only be maintained and if necessary renovated. But a renovation campaign would inevitably run out of buildings. So the only source of value added would be maintenance and the rather rare replacement of buildings that are no longer usable after fully exploiting all ecological optimisation measures." (Paech, 2012, p. 88)

Paech goes on to argue that sustainable objects are "unthinkable" and only lifestyles can be sustainable. In other words, there is no object that can be inherently sustainable if overconsumption continues.

Post-Growth Model

Post-growth, or degrowth, is an alternative economic model to capitalism, where society undergoes a de-industrializing process with the goal of economic, environmental, and social sustainability. It requires the elimination of structural and cultural growth drivers to reverse economic growth trends. Paech suggests that this is possible in four phases: (1) cutting supply chains to local and regional suppliers, (2) explore 'creative subsistence' to replace industrially manufactured products, (3) returning time to the citizens to perform creative subsistence activities, and (4) shift business activities away from production to growth neutral services (Paech, 2012).

The first phase is referred to as 'Economy of proximity' and calls for the disruption of global supply chains to encourage stronger regional supply chains. By reducing the proximity between the supplier and consumer, Paech argues that transparency and empathy will increase through the development of direct relationships, reducing the insecurity that justifies high risk investment (i.e. investment will not assume high risks) and strengthening collaboration. In a small enough market, the producers will have common interests in their community and will need to act in the best interest of their community to maintain their own best interests. In other words, they can't exploit others or act unfairly without seeing direct consequences of their decisions. They will also be incentivized to control their outputs to ensure long-term sustainability of their business practices, as regional-restricted distribution would limit the perspective market size. For example, if a manufacturer invested in high-cost autonomous equipment to maximize their economies of scale and drive prices down, the demand would increase for the short term, but a period would follow where no one needs the product until a replacement is required. Rather than a consistent flow of supply and demand, the product would then become a cycle of boom and bust. Finally, the currency would remain in the region and can be reinvested in other local incentives rather than accumulating local money in centralized regions.

The second phase is exploring 'creative subsistence' to replace industrial subsistence. That is, exploring ways to exchange goods and services without capital, profit, or the incentive to expand. Examples of creative subsistence include communal usage, such as borrowing a tool or being a part of a community garden, extending the use period of objects through emphasizing care, maintenance, and repair, and encouraging 'subsistence production' or the individual production of goods we require, such as furniture and clothing. Through these three avenues, the requirement for producing new objects industrially could be reduced in half, at minimum, if the objects are being used twice as often through communal usage or used for twice as long through maintenance efforts. Therefore, the demand for efficiency in manufacturing is reduced as the required output is reduced.

For the third phase, the opportunity to perform this additional labour of creative subsistence production and maintenance and the overall reduction in industrial labour requires individuals to have reduced work hours. This frees up more time to learn and practice new craft skills, contribute to their community and help their neighbours, and perform basic domestic labour themselves, rather than outsourcing tasks to other people. It also allows more leisure time for individuals to build relationships with others within their community, which encourages communal usage and support. Combined, these activities allow individuals to support themselves with lower expenses, which in turn necessitates fewer working hours and balancing with the lower number of industrial labour hours required.

Finally, the businesses will need to adapt to the new economic system by creating products that more easily repaired and have longer lifespans or through shifting their business towards zero-sum activities such as maintenance, repair, renovation, conversion, service providing, intermediary, and design. These zero-sum activities are oriented towards making material objects last as long as possible and closing the cycle when they become irreparable.

Paech argues that the adoption of a post-growth economic system will free society from the burden of indebtedness to energy, management of and overstimulation from too many useless objects, while encouraging stronger social bonds through community engagement, which is really what makes people happy. This system will require individuals to give up their perceived freedom of choice of consumption and instead explore their individuality through creative expression.

Research Methodology

My research utilizes the research-creation methodology of Research through Design in which new knowledge is created through the action-reflection approach (Racine & Frankel, 2010). Specifically, I will be utilizing speculative design to define the process and act as the framework for creation and reflection. Speculative design (SD) is a method of prototyping that removes the constraints of the commercial sector and prioritizes narrative to inspire dreams of what could be. It challenges conventional values present in commercial design and emphasizes skepticism and critique of our current consumer culture (Johannessen et al., 2019). SD is not a way to predict the future but rather to use "them as tools to better understand the present and to discuss the kind of future people want." (Dunne & Raby, 2013, p. 2).

SD is largely a continuation of ideas developed in critical design (CD), coined by Dunne. Where CD aims to "challenge conventional values", SD aims to foster social dreaming, encourage questions, and raise debates on what the future looks like. The ideas found in both CD and SD come from a long line of critical art and design practices, such as the Arts and Crafts movement, the Bauhaus school, and postmodern anti-design and radical design movements of the 1960-1970's. Each of these movements are the result of designers responding to changing, consumerist values and attempting to redesign objects that better aligned to thoughtful consumption.

There is no consistent method associated with SD, but rather the "designer draws from the 'designer's toolkit' and adapts whatever method is suitable in a particular situation, to spur debate" (Johannessen et al., 2019, p. 1627). It takes a creation-as-research approach in which the creative process is subject to "analysis, critique, and a profound engagement with theory and questions of method."(Sawchuk & Chapman, 2012, p. 19) Johannessen et al. outlines the three primary steps in the SD methodology: (1) Define a context for the debate; (2) Ideate, find problems, and create a scenario; (3) Materialize the scenario to provoke an audience.

I have created a series of furniture pieces to explore my research questions, including a progression of tables, four lamps, and a lounge chair. Through the design process, I am reconsidering the role of the industrial designer by first examining my present design process to identify opportunities in which post-growth ideologies might replace traditional growth-based commercial design ideologies.

Post-growth Exploration

The post-growth exploration applies the speculative research-creation methodology to use design to imagine what a post-growth future will look like in a society that eliminates any mass-manufacturing processes, either because the planet hit the biological limits of production or through extreme global policy to ensure the limit is not reached. The speculation takes the form of a series of domestic furniture to explore the aesthetic and functional implications of reducing the availability of commercial goods in a domestic setting. Inspired largely by IKEA hacking and other hacking movements, the furniture is used to develop a manifesto for the future industrial designer which will include design responsibilities to follow. This project utilizes the following rules to scope the limitations of what materials and processes can be used in the exploration:

Availability of Resources: In this future, the only means of manufacturing is artisanal or digital. There are no limited resources like oil and gas for fuel, rare earth metals for sensors and electrical systems, or virgin metals like steel and aluminum to support large-scale global shipping operations. The materials that are available are limited to: materials that are locally or regionally available; have been previously produced and reclaimed; renewable materials; recycled materials; or small-scale regenerative materials that are sustainable on a localized scale. All industrial extraction and mining have stopped.

Availability of Process and Technology: Only the technology that currently exists will exist within this future. Technologies that have yet to be invented come with unprecedented consequences that cannot be accurately accounted for and thus the sustainability of our materials, processes and technologies is limited to the knowledge that currently exists today (Paech, 2012).

Availability of Energy: All energy used will be assumed to be from a renewable energy source, such as, but not limited to, hydro, wind, or solar. Due to the scope of this project, energy usage is not accounted for.

Availability of 'Components': Standardized components, such as screws, bolts, and electrical fittings, can be harvested from existing and broken objects and are acceptable to use in this exploration.

The goal of the furniture collection is to create mock commercial products intended to explore what a future might look like if consumers had the required skills and access to tools and materials to renew their own goods, based on designed objects. The commercial products represent objects that designers would create and sell to future consumers, while considering their overall lifespan and lifecycle. The furniture pieces are intended to be desirable to a consumer of the future, but also to be a framework for industrial designers to reimagine existing objects and to use their discipline-specific skills to shift away from consumer-culture.

I use a combination of artisanal making methods and digital making methods to reduce the physical labour of the maker while maintaining the creative ingenuity of human intervention. Computer-based fabrication methods eliminate the need to use tools intended to create a standardized object (i.e. industrialized way of making) and instead use a standardized process to create unique objects (i.e. digital way of making) (Carpo, 2017). The creation process is documented through photography and active reflection during the designing and fabrication process.

Process First: Side Table

The first object began with a focus on the design process and how consumers can use the design process in regaining agency over their own objects. I began with my typical process: (1) a basic use-case for function; (2) rapid sketching for form and detail; (3) form finding through 3D modelling in Rhino to finalize proportions with standard material sizes; and (4) rendering the object for colour, material, finish (CMF) selection. At this point, I then move to the (5) CAD drawings to bring the object into the shop for (6) fabrication. For this object, I investigated the third (3) phase as I spend the most time in it and make the most decisions for the final object throughout it.

Figure 3. *Sketches of the side table series.* ***Note.*** This photo demonstrates phase 2 in the design process of rapid sketches of forms and details.

During the form finding process, I often start with a skeleton of the object using the parametric modelling software Grasshopper which allows me to rapidly iterate different combinations of dimensions to get a feel for the overall form before I turn to modelling the finer details. Sometimes the skeleton remains a skeleton and the model is then baked into Rhino, where I complete my modelling using standard operations. In this instance, I built the model so that all material components were modelled in Grasshopper and only hardware and decorative detailing like fillets were added in Rhino.

An early investigation of IKEA products, chosen for the consumer involvement in the building process, revealed that of the 105 objects that return from a ‘side table’ search query in November 2024, only 2 are structurally asymmetrical and 21 used non-right-angle joints. All 21 tables limited the non-right angles to the legs only; 11 were designed such that the joints were still right angles even if the legs angled outward, 2 did not use joints at all (pre-molded metal or plastic), and 8 incorporated the non-right angle into its joint. The non-right-angle joints used 3 methods: pre-drilled dowel holes, a tapered plate that the leg screws directly into, and a wedge mechanism.

I speculate that the reason behind the aversion for non-right angles is the manufacturing challenges associated them. Especially when the final assembly is placed in the hands of a consumer with unknown experience and dexterity, the most successful designs will eliminate any challenges with joint alignment. The consumers are not being sent home with a jig intended to aid in the assembly of the product and thus they are often left trying to prop each individual piece into position by balancing it against their leg while both hands are occupied trying to hold the Philips screwhead onto the screwdriver. Or, if it is all right angles, the object can just be balanced on its side.

But right angle-only tables can only be made in so many configurations, despite the efforts of every budget furniture manufacturer. In addition, tapered legs provide ample support and rigidity to create a firm base. In my table design, I wanted to explore how we can return angles to a consumer-assembled product through the development of digital aids. For this product, I speculate that the future designer is not just responsible for creating the product itself, but equally responsible for creating everything a consumer may need for its lifecycle in the future. Like an electronics manual, this digital package could contain 3D printable files of drill guides and jigs for calibrating the angle of the table saw. Perhaps it contains a 1:1 PDF that can be printed off and cut out to mark hole locations and radii. The package could go so far as to include files of 3D printable joints that can be used with stock material and screws in place of using wood or metal working tools. This would be supported by the parametric design process as new material dimensions could be input into the algorithm to return a printable file for the stock material the consumer has on hand. This digital package exists to provide varying levels of aid to the varying skill levels of the consumers. A skilled carpenter may not require any plans to recreate a leg that has been damaged, but a novice may need some support to home in the accuracy and achieve the best possible replication.

Figure 4. *Designed table (1/3).* ***Note.*** Constructed of birch and steel hardware. The first in the series of three tables representing the object as envisioned by the designer and the form of the object as the consumer first acquires it.

The resulting table consisted of three variations to create the series: the Designed table; the repaired table; and the designed table. The intention behind this piece was to create an object in which the consumer had agency over its lifecycle. The Designed table represents the object as a consumer will first acquire it. The capital D in Design is used to designate that it has been created by a design professional. While the act of designing is universal, the Designer will have had training and/or education in the product category. The resulting Designed table is professionally built and finished. The object is uniform and in good functional and aesthetic repair.

Figure 5. *Repaired table (2/3)*. ***Note.*** Constructed of birch, steel hardware, cardboard, and wheat paste. The second table in the series demonstrating the table in a state of repair.

The repaired table shows a transitional phase. Perhaps the table owner knocks over their bookshelf one day and it falls directly onto the table, shattering the glass and cracking one of the legs. In this instance, the owner can consult their 'owner's manual' for instructions on how to make an emergency repair. Unfortunately, they don't have the necessary woodworking skills to make a new leg like the original, but they use common household materials like cardboard and wheat paste made from flour and hot water to build a temporary leg and tabletop. With an hour of work and a day of drying, the table is ready to be reassembled and resume its function as a side table. In the meantime, the owner can take the plans to a friend who has the skills and access to a makerspace or to a professional to get a new wooden leg that blends in seamlessly into the original product. In this system, the object almost always continues to serve its function, and it eventually returns to its original state. It's never relegated to a corner of disuse only to be eventually discarded or replaced by a new item.

Figure 6. *designed table (3/3)*. ***Note.*** Constructed of construction-grade pine and steel hardware. The third table in the series representing a state of total replacement, where each essential element has been replaced with new components.

The designed table exists in one of two scenarios. The first scenario is a case of assemblage in which the repaired table never makes it to the stage that it is formally repaired by a skilled craftsperson. Instead, over time and piece by piece, the table has each individual component replaced with something new and the original object is only present through its essence. The second scenario is that the original Designed table was never acquired in its original form. In this scenario, the owner acquires the parametric plans of the table and uses them to construct the table using materials they already have access to. In both instances, the designed table maintains the original assembly relationships but may not have the same formal design elements such as material, proportions or scale.

Like the philosophical assemblage replacement problem, the designed table begs the question of what constitutes an industrial design—is it the unique combination of formal elements to construct a single object or is the parametric relation between the various elements a design in itself? When considering the initial question of what the future role of the industrial designer might look like, I posit that we will be Designing these relationships so that future consumers may design their objects.

To Design relationships, we first need to break the objects down into their various elements. Taking a cue from mathematics and 3D modelling, which is fundamentally visual mathematics, every 3D element can be broken into a skeleton of vertices, edges, and surfaces, or points, lines, and planes. We can break down each object into its stick figure skeleton to determine the fundamental elements that construct its functional form. A table is 3+ lines and a plane. A chair is 3+ lines and 2 planes (one being a backrest, otherwise it's a stool). More lines and planes can be added, but none can be removed.

When objects are broken down into the fundamental elements, we can then explore the materials that are suitable to each element. A line could be constructed from a length of wood, a plastic pipe, a metal I-beam, etc. A surface can be any sheet good—wood, metal, stone, etc. Then, when moving into the construction process, the maker can collect their combination of goods that they have the materials and skills to work with to construct their version of the object. Elements can be further determined by aesthetic, suitability, and taste.

The process of abstracting the various elements into relational components offers a vital understanding of how each piece is working together to form the whole and through creating the parametric algorithm to create the form, the designer can explicate this process, which is done intuitively by craftspeople already. For example, I had intended for my table to use 1 ½" x 1 ½" birch, however the available wood came in 1 ½" or 2" rough-sawn lumber and would require planing which would remove roughly up to ¼" of material in the process. This meant that I could either use the 2" lumber and plane up to ½" off, creating excessive saw dust, noise pollution, and general effort, or I could change my dimensions by up to ¼" to use 1 ½" stock instead. In this instance, I had to determine which relational quality was more important: did I want to preserve the overall width of the table, which would add ½" in length to the cross-supports, or did I want to preserve the dimension of the cross supports, which would reduce the overall width of the table by ½". I chose to preserve the overall width. I wanted the tables to fit the dimensions of a stool to provide an extra seating option if the top was changed and maintaining the width was crucial in preserving a comfortable seat. Alternatively, if I had already made or purchased a top for my table, then the length of the cross-supports would have been non-negotiable. In either instance, there is a tangible consequence for changing a single dimension that impacts the rest of the design and, in some cases, the overall functionality. A visual parametric algorithm can demonstrate these changes prior to any fabrication is done to ensure the consequences are understood.

Beyond the documentation of the relational components mathematically, the relationships can be signified visually through the use of visible hardware, as opposed to adhesive joinery or hidden joinery. Visible hardware celebrates each individual component while identifying how they all come together. Standardized hardware provides implicit instructions on how to assemble and disassemble, while also providing an entry point for consumers to deviate from the original design. A bolt may be used to secure a new addition to the assembly, or it can be swapped out for another length if the new leg is a different material thickness, for example. When provided in tandem with the product manual, the consumer should have a comprehensive understanding of the assembly logic of their object.

Material First: Lamp Series

The second type of object I designed was a lamp. This object was selected to serve as a means of aesthetic and material exploration as it has a distinct functional requirement of shining light but beyond that provides a canvas for aesthetic expression. The series includes a lamp constructed of recycled and shredded HDPE heat molded and hand formed, a Japanese inspired paper and wood lamp, and a pair of hand-thrown ceramic lamps of various assembly methods. Each lamp uses different materials to explore how different skills can ultimately result in an object of similar function.

<u>Plastic Plastic Lamp</u>

Plastic Plastics is an exploration of consumer-led plastic recycling, intended to examine material properties and capabilities in a domestic setting. Through the development of this lamp, I was interested in how artisanal and craft methods can be applied to industrialized materials and how consumers can utilize these methods in a domestic setting.

The process began with a critical examination on the public discourse of the material culture surrounding plastics. I was inspired by the monobloc chair, as discussed through two sources: *Respect Cheap Furniture* by artist Martí Guixé (2009) and a documentary titled *Monobloc*, directed by Hauke Wendler (2022). Both pieces explore the relationship between the perceived value of the monobloc chair in opposition with its functional value. About his work, Guixé has said that “the value [of the chair] lies in its lack of value” (Guixé, n.d.). While he was largely speaking about the global democratic qualities of the chair through its availability, this quote is interesting to consider how plastic is treated in general, especially in the Global North.

Figure 7. *Plastic Plastic Lamp*. ***Note.*** Constructed of recycled and shredded HDPE, hand-formed with heat.

The monobloc chair speaks to the wider wicked problem of plastic: plastic is an affordable material that allows functional goods to be created and used by people experiencing socio-economic disparity. However, this material has no disposal plan in place to mediate the harmful waste it creates, accelerating the climate crisis through toxic fumes, microplastics, and growing landfills. We are using a material that's largest strength is its durability under chemical, environmental, and physical stressors for single use products. The value of the object created is being correlated with its cost to fabricate, rather than its value of use. Although the plastic product is economically affordable to replace, the environmental cost of the product is exponentially higher.

Over the course of industrialization, we have become separated from the material world, divorced from the production process (Walker, 2006). The objects we own have become so far removed from human touch through automated manufacturing and the excessive levels of consumption that renders objects ‘useless’ far before its functional utility ends. Lacking the physical touch and quality time spent together, we have lost our intimate connection with our things.

Exploring theories of emotional durability, Plastic Plastics was created as a sort of marriage counselling; an attempt to reconcile my personal relationship with plastic and explore the materials ontology. I used various craft techniques to attempt to mold and form melted HDPE, such as candy pulling, clay wedging, origami folding, and hand sculpting. The handcrafting is intended to prolong my time in contact with the lamp I created. Through an increase in touch and care, I am working to build a relationship with the lamp to increase its personal sentimental value.

The final product is made up of heat-molded HDPE hand formed into an organic lamp shape. Recycled HDPE was shredded into fine particles and layered between two sheets of parchment paper and two aluminum plates. These plates are heated up to 130°C and compressed using a heat press. The HDPE is then melted over the course of five minutes under an extraction vent. Once the plastic is uniformly melted, the parchment and the plastic is extracted from the heat press. Using silicone oven mitts, the plastic is then wrapped around an aluminum can to create a tube shape, rolled into a coil, or left flat to cool, depending on its usage. The molding process must be completed within 5-10 seconds to maximize on the plasticity before the heat dissipates. The form is then held for an additional 30-60 seconds to retain its shape and allow the material to cool to the touch. The parchment is left on while the material cools, except for when the plastic folds onto itself, in which case the parchment is removed to allow the material to fuse. Joining two components together can either be done right after one of the pieces comes off the press, where the heat from one component will melt the second to create a welded joint, or by heating two cooled components with a heat gun or soldiering iron until they are both sufficiently warm enough to create a weld. The former is a stronger joint than the latter.

Beyond strengthening my personal bond, I explored a process that would be accessible to the average consumer. I intended to explore craft methodologies that didn’t rely on specialized tools, protective equipment, or skill sets. This is crucial to empowering consumers to imagine another possible future for their plastic waste, beyond industrialized recycling processes that are unable to keep up with the amount of waste we create (Statistics Canada, 2022; Sullivan, 2022).

Kumo Lamp

Building on the theme of craft and emotional durability of the Plastic Plastic Lamp, the Kumo Lamp is inspired by Japanese paper lanterns and Isamu Noguchi's Akari Light Sculpture. The Kumo Lamp removes the spiral ribbing in favour of the pliable support of aluminum armature wire spindles, hand stitched to mulberry paper with cotton thread. It embraces the soft and organic qualities of the materials to cast a warm glow in a dark space. This lamp was created as a response to Okakura Kakuzō's Book of Tea (Okakura, 1999/1906). The Book of Tea speaks to industrialization as a negative influence on Japanese Meiji nationalism in opposition of traditional values: through perfect repetition and symmetry, mechanization voids the object of the character of process and human touch.

Figure 8. *Kumo Lamp*. ***Note.*** Constructed of aluminum wire, mulberry paper, cotton thread, plywood, and India ink.

Kakuzō emphasized the importance of process, which is directly at odds with industrialization as a method of making. Where craft is process-oriented, industrial fabrication is outcome-oriented. In the context of emotional durability, the prioritization of outcome, along with the sameness and perfection of mass-manufacturing, has removed our attachment to our objects in that they are no longer unique or special and no longer have a 'conception' story associated. We are removed from the process of production and thus the outcome of the production. They are no longer objects of praise, no more beautiful or meaningful than the object beside it on the shelf, but just a function of utility, ready to be used and discarded at a moment's notice.

The Kumo Lamp seeks to express the organic, handmade qualities through the mulberry lamp shade, while simultaneously exploring how digital manufacturing can be used to aid in the creation of functional objects. The lamp shade was created by hand whipstitching 18-gauge aluminum wire to two sheets of mulberry paper with black, contrasting cotton thread. The whipstitch was selected to transfer the tension stress from the paper onto the wire itself, while creating a graphic statement of the tight, repeating pattern. As the paper shade is assembled, it develops creases and folds, showing evidence of the crafted element and making each lamp entirely unique. The size of the lamp was dictated by the paper available, and the bubble shape of the lamp is due to using two pieces of mulberry paper to achieve a larger size. The interior point hides the gap between the two sheets without requiring additional stitching to seam the pieces together. The aluminum wire provides a structural yet flexible support for the paper form. It is easily formable and deformable, allowing corrections to the form once assembled.

The lamp base is made from left over plywood laser cut into three components, where each component is stained black using India ink. The laser cut files were prepared using Rhino and Grasshopper. The overall form, as a solid mass, was created in Grasshopper to create the form based on the final size of the lamp shade and the lightbulb I had selected. The desired contours were then extracted from the shape to create the two vertical components and the circular base. The contours, in the form of curves, were offset and manipulated on a flat plane to create the notches to interlock the forms together. The curves were then extruded to mimic the thickness of the plywood and digitally assembled to ensure the components fit together. The thinness of the wood allows the components to be flexible, so the base can be assembled using a friction fit. When the prototype was laser cut, the joints were a little looser than I would have wanted, however the design was forgiving enough to tighten using more cotton thread. The added security from the knotted thread ensures that the weight of the electrical parts will be supported by the lightweight frame. The electrical components are assembled around the frame and the lamp shade rests on top, although could also be secured using more thread or wire.

The resulting lamp bares evidence of the handmade, such as organic folds of the paper and uneven distribution of stitches but leverages digital fabrication to adapt to the craft and material constraints. The organic nature of craft resists the use of standardized components when the machine parts need to be made to fit the crafted goods. While the mulberry paper provided material constraints that would dictate the size of the lamp shade, ultimately the overall form of the shade was dictated by my hand and my taste. Given a different base structure, the same shade could be stretched more oblong, compressed to be more bulbous, or manipulated to be something entirely freeform and asymmetrical. By using digital manufacturing techniques, the materials of the shade can be crafted to find their form, aesthetically and proportionally, and the components can be designed to support them.

Modular Ceramic Lamp Series

Learning a new skill with a new material can invoke fear for many people: the fear of wasting expensive materials; the fear of doing something dangerous; or the fear of making something ugly. We often internalize our objects as a reflection of ourselves (Atakan et al., 2014). If we produce a bad object, then we feel bad. We feel it is not a suitable reflection of how we see ourselves and thus are cautious to approach the process again in the future if we are not immediately good at it. Particularly in this age of mass-manufacturing, we are constantly comparing our creations with those that have been manufactured by machines.

In the creation process of this lamp series, the fundamental skill-building was the most challenging part. I had never made pottery prior to this project but decided to embark on wheel-throwing pottery classes to provide an opportunity to empathize with people who want to build and design their own objects, but don't have the skills to approach it. The class format is listed as one of the more common ways beginners engage in a new craft (Krugh, 2014) and provides a learning structure, materials, and tools for a more accessible entry cost in a community studio setting.

Figure 9. *Ceramic Lamp 1*. ***Note.*** Constructed of stoneware, upcycled electrical components, and a found lampshade.

Figure 10. *Ceramic Lamp 2.* ***Note.*** Constructed of stoneware and upcycled electrical components.

Each bowl I created, especially in the beginning of my learning, has evidence that it is handmade: the rim is wobbly; the glaze is uneven; the tong marks always appear; and my nails leave little knicks in the clay while its drying. Compared to an industrially produced ceramic bowl, my work is amateur. Because I am an amateur. But what is not seen when viewing a single bowl is the vast improvement I have made in the 18 months of practice. The process of learning a new skill is less about the singular outcome of the product created and more about learning a new tangible skill and finding space to explore the medium while doing so.

It is easy to find joy in the creation process when it is rooted in play. There is no pre-designated required outcome from the process, beyond our expectations, and thus anything created is the 'right' thing to create as the sole goal is to create anything. For this project, I had the primary goal of creating a lamp base, however this goal did not come with a prescribed brief on how I needed to fulfill it. The largest challenge I have faced in my ceramics practice has been throwing taller vessels. Combining this challenge with the studio restrictions of being unable to fire or glaze objects taller than 6", to fulfill my goal, I would either need to create smaller lamps or to rethink how I was approaching my brief. As a work-around to both problems, I leveraged the assembly method of the electrical components and used the 1/8IPS threaded pipe to screw a series of smaller pots together, while using the pipe to support the lightbulb. Assembling the lamps became a puzzle of piecing together various options to construct the resulting forms. I was able to throw a variety of smaller vessels within my skill-limits, exploring new forms without the pressure of hitting an arbitrary metric of height, but still achieve my goal of creating a 'reasonably sized' (subjective) lamp base. While some combinations of vessels are better than others, none were inherently wrong.

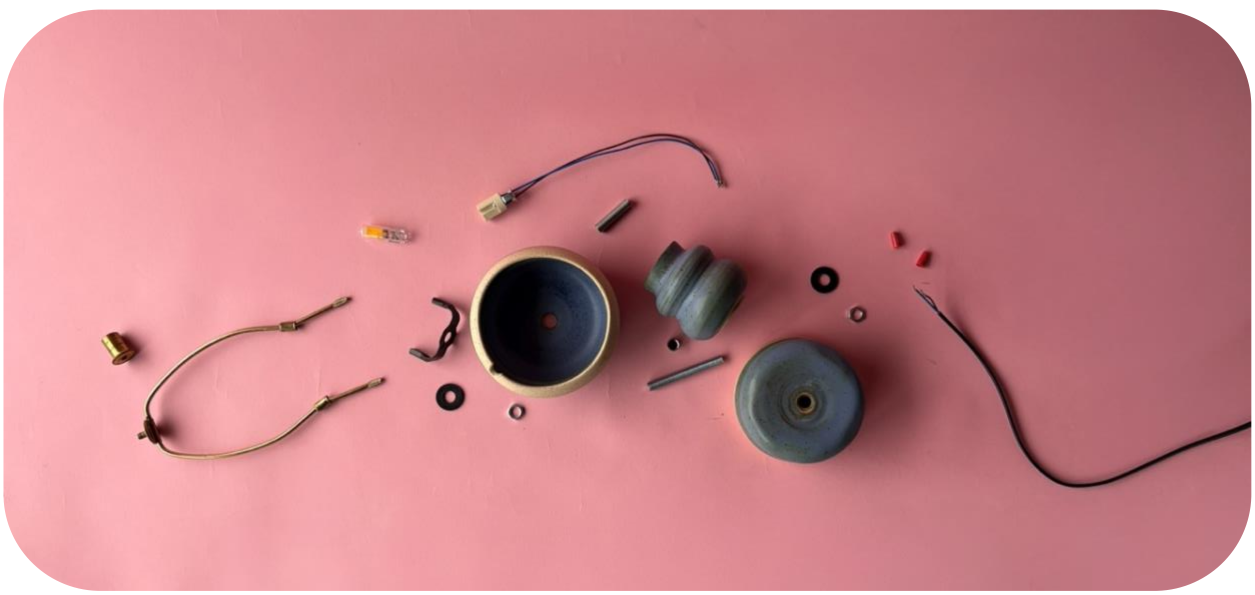

Figure 11: Disassembly of Ceramic Lamp 1. ***Note.*** A visual representation of the various elements and components required in assembling a lamp, demonstrating the use of standardized components to connect non-standardized body pieces.

Standardization and standardized parts are crucial to enable to agency of consumers. Standardized parts form rules of sorts, but with the rules comes the negotiation of what can be done with the components. How the components are used is as important as what components are used. If the rules of one component are not favourable, it can always be swapped for another one. The challenge of components is learning the rules and equally learning how to break the rules. The benefit of the standardization of components is that there is a community of people who may also be using them and eager to share in what they've come up with.

One example of this is the IKEA hacking movement, which is a digital-based DIY community devoted to sharing their 'misuses' of IKEA furniture. Hacking refers to the "repurposing, reassembling, upgrading, updating, personalizing, or creating [of] something new" (Yap, 2022). IKEA has locations in 63 countries across the world, forming a broad market of consumers who have access to the same finite number of products. Beyond that, IKEA often uses a lot of the same components and dimensions within their product lines to benefit from economies of scale, which allows products to be Frankenstein-ed together. This standardization has been critical in the ability to share the hacks and build the online community. IKEA products are plentiful and often regarded as low-value, releasing the hackers from the fear of destroying a new product (Rosner & Bean, 2009). Acting almost like a large-scale Lego set, IKEA hacking has provided an entry point into higher skill activity like woodworking. The participants can focus on the form and assembly without having to engage in heavier equipment and more intimidating tools.

As their interest and creativity grows, and they begin to run into limitations of the standardized pieces they have access to, they can then transition into more involved processes. This is not to say that IKEA hacking lacks skill, but at its basic level limits the variety of required skills to allow participants to focus on the smaller subsect of skills. Whether they are participating in the activity because of an interest in building furniture or they are taking a more artistic approach to their work, by engaging in IKEA hacking they will continually brush up against more advanced hand-manufacturing skills as they progress in the craft.

The ceramic lamps were designed around a similar process to IKEA hacking. When I reached my skill-limit of throwing the size of ceramic bases that I intended, I began seeking out pre-existing solutions to fit multiple pots together. Having recently rebuilt an antique lamp, I was familiar with the basics of a lamp kit. Lamps use a specific grade of threaded pipe to allow the cord to pass-through the lamp body. It is the uniformity of these lamp components that allow the exploration of unique forms, without concerning myself with the intricacies of utility.

The second major challenge I faced with each of the lamps was not creating the bases to house the electrical components, but to create a suitable lampshade with the desired light filtering qualities. Unlike the abstract, sculptural forms of the bases, a lampshade has a particular task of filtering enough light with a material that has the correct translucent undertone to create a light source that is pleasing yet functional, proportional to the base, and not a fire hazard when exposed to prolong heat. This is a portion of the object that does have a wrong answer. Where I would describe the bases as a process of play, I would describe the lampshades as a process of trial and error.

Both trial and error and play are fundamentally an iterative process; the key distinction is that trial and error designates what right and wrong whereas play follows a good, better, best evaluation. In contrast, I was approaching the lamp shades by evaluating various materials for flammability (or lack-thereof), translucency, rigidity, and aesthetic suitability for the already built lamp bases. Materials like paper and fabric are more translucent if they are less rigid and if they are less rigid, they require either a frame to support the material from the bottom or a harp to suspend the material above the light bulb. Plastic has rigidity and variable translucency; however, a lot of plastics cast a grey undertone when light is shone through it and many plastics are deformable under low temperatures and can be highly flammable, meaning higher precautions need to be taken with the electrical. While paper or fabric would be my preferable material, they lead to further design consideration of the frame. What material is this frame? Should the frame be secured below the socket or with a harp above the socket? Will the frame deform under prolonged load from the shade? How will the supports be visible when the light turns on? Choosing a lamp shade turns into a complex decision matrix that becomes too overwhelming with possibilities to make a single decision, and ultimately, I ended up selecting two of the most default options: a prefabricated lamp shade rescued from a broken lamp and a lightbulb that is dim enough to prevent a glaring hotspot. The multiple lamps created was a result of play and the lack of new lamp shades for either was a result of error.

What First?: Sofa Iterations

A common strategy in sustainable design is the concept of ‘slow design’. Slow design, like other sustainability methods discussed, is a response to industrialism (Beverland, 2011; Erlhoff et al., 2007). It encourages longer, more thoughtful design processes so that the outcome is fully thought through. This is in contrast to ‘fast design’, like fast fashion and fast food, in which modern efficiencies and technologies allow designers to continually push forward new products, whether they are fit for consumption or not. Fast design products are created for the sake of creating and sold for the sake of capitalism. Throughout the process of designing this final piece, I had been questioning the role of slow design in a post-growth industrial design.

This maquette represents a single module of a modular sofa design. Each module can be cut from a single sheet of plywood and is upholstered with upholstery fabric swatches stitched together to form a hammock seat. The sofa is functional with or without additional foam cushions for added comfort, although the maquette is without. The plywood panels slot together and are secured with visible wood screws. The flush fit of the panels and screws allow multiple independent modules to configured together or for additions to be added, such as an armrest. Alternatively, multiple seats can be built in a single unit by extending the horizontal supports. While the maquette uses solid sheets for the vertical supports, the design can be constructed with gaps to reduce material usage and weight.

Figure 12. *Sofa Module Maquette*. ***Note.*** Constructed of plywood, steel hardware, and upcycled upholstery fabric swatches. A single module of the sofa.

The goal for this design was to apply the post-growth principles I had explored in the case studies above into a single, complex object. The product category of sofa was selected because it is an intimidating furniture piece to build. The fabric obscures the inner construction of the structure while also revealing a new fundamental element: a manifold. Where the fundamental elements previously consisted of points, lines, and planes to form a skeleton, upholstery can be both the skeleton and the flesh. With tension, textiles can provide ample support. Without tension, it provides cushion, comfort, and aesthetics.

When designing any of these products, I am mentally constructing a matrix of materials to weigh the benefits and drawbacks of each individual decision. While the table was Designed with wood and designed with cardboard, it could have been feasibly constructed of any variety of other materials. As previously suggested, the lines could have been PVC pipes or steel I-beams, and the plane could be marble or pressed HDPE sheets. In the material matrix, the manifold introduces a new dimension of material offerings. Throughout the design process, after I had determined the plywood form, I had considered a plethora of options: recycled climbing ropes, corrugated felt, Danish paper cord, upcycled aircraft leather, woven discarded charging cables and recycled puffer jackets, before settling on fabric swatches. Each option comes with its own set of processes and design implications on the physical structure.

Slow design is contextually relevant in contemporary industrial making. It encourages quality over quantity, focuses on the long-term needs of the consumer, and reduces the need for continual consumption in the pursuit of replacing obsolete products (Beverland, 2011). However, in the context of a post-growth economy, there is no fast design to oppose. The industrially manufactured items would be significantly limited and thus reserved for objects of great need. Fast design serves wants but the only wants that could be fulfilled in post-growth would need to be fulfilled through creative pursuits. In this context, slow design would no longer refer to the oppositional production ethos, but to the extended temporal duration a design might take.

Designing the sofa module was a nine-month process before the object made it to prototyping. In contrast, the tables were designed over the course of three-weeks, and the lamps were designed as I was prototyping them. Production of the prototypes extended this design process while thinking-through-making, as design decisions are made through the prototyping process that impacts the final product. These changes are then reflected back into the 3D models and technical drawings in post-production. I attribute the extended design period of the sofa to my inexperience in soft good or textile-based furniture design, and the lack of constrained timeframe to complete the prototype within.

Regarding the former, inexperience with materials or product categories leads to similar paralysis as discussed with the trial and error with the added decision paralysis of the material matrix. There are too many options, too many unknowns, and too many ways for things to go wrong. When I contrast this to the process of designing the table series, although there are still plenty of material options, this is a product category I have been designing for 6+ years. While this particular design has had limited iterations, I have been iterating, considering, and prototyping with various materials, joinery methods, fabrication processes, and finishes long before this particular table has been conceived. Through previous trial and error and experimentation, I had gained some experience to better strategize my approach to my design. Only through more years of experience and living with the consequences of my design, for better or worse, will I continue to develop these skills.

In this context, consequences refer to the impacts of living with a product that you made. For a coffee table design, this could be that the height it was designed to was too short or tall for the sofa it was intended to pair with. Maybe the joinery method wasn't as strong as it needed to be and frequently became loose and wobbly. Alternatively, perhaps the lightweight construction made it easy to maneuver and rearrange. All of the consequences are parsed through consistent usage and can only be discovered when the product already exists. The benefit of crafting the furniture that will occupy one's own space is the ability to adjust the existing design if the consequences have too negative of an impact.

Rather than advocating for slow design in a post-growth future, I would instead advocate for a sprint-style methodology on an individual level. When a consumer has a need to fill, they should seek to fulfill the need in an ad hoc manner, using means that are readily available and easily accessible, rather than the 'best' option overall. They should then live with their solution. As with slow design principles, the design should be given the time and space to reveal what had been missed or forgotten in the original solution (Erlhoff et al., 2007). The process then repeats itself as needed: design fast to design slow.

The primary difference between a growth manufacturing context and a post-growth one is the ability to customize the objects that are made, not only to the materials that are locally available, but to the ergonomics, aesthetic taste, and lifestyle of the person who will be using it. As much as standardized hardware aids in the dissemination of design documentation and allows universal access to the product, the customization of craft and digital manufacturing ensure that the product is the best for the specified context. When the product works perfectly, there is no desire to replace it for a higher utility function. Aesthetic and symbolic function may change, but if the owner has the craft skills, they can make the desired modifications.

Responsibilities for the future industrial designer

Consumption is inevitable to human existence. Over our lifespan, our needs, as a consumer, will change. Rather than designing one object or set of objects to fulfill their needs throughout all of these changes, we can design objects that lend themselves to flexibility but prolonging their time with their consumer and to be flexible enough to move on to a new owner. To design these objects, I propose a set of responsibilities for Designers and designers to consider when creating objects for a post-growth future:

1. **The future designer should embrace craft.** The tactile experience of crafting provides hands-on engagement with objects, leading to a deeper relationship with it and therefore a higher level of care. Craft doesn't need to be machine perfect. It is the evidence of handcraft that creates value of authenticity and emotional connection.
2. **The future Designer should provide multiple entry points into engagement.** Consumers will each approach an object with unique and varied experiences, but despite this, they should have equal opportunity to engage in the design process. Whether they are novices or experienced, there should be some way to aid in the repair or maintenance process, be it crafting a temporary cardboard leg or crafting the permanent one from wood. Entry level engagement fosters long-term interest in the skill and aids in the learning process.
3. **The future designer should engage in play, not just trial and error.** While objects inherently contain 'rules' in their construction, like weight capacity, size constraints, etc., there are many ways to follow the rules. There should be fun and joy in pushing the boundaries while exploring suitable alternatives. There is no right or wrong if the object remains functional, only better or worse. Rather than pursuing perfection, designers should be seeking for better.
4. **The future Designer should create not just the product, but the plans to go with it.** Great care goes into designing a new object. When the object is passed on to the consumer, they take over the role of primary caregiver and thus they should be provided with the instructions to provide care until the end of the object's life. The plans may include technical drawings, 3D models, parametric algorithms, printable jigs, and methods to substitute materials.

Without industrialized material manufacturing, the continued care plan should account for a variety of alternatives and methods of joinery.

5. **The future designer should design fast to design slow.** The best object is a functional one. designers should prioritize achieving base function and then live with the object they create. Only through regular use and consideration, should the design be adapted to better fit their needs and requirements. Design is a skill developed through experience and observation. The best way to learn this skill is through experiencing the consequences of the decisions that go into the object. Working in sprints, the active design period should be in quick intervals followed by long pauses of passive consideration. To embrace the process is to recognize that no object is ever 'done'.
6. **The future Designer should explicate the implicit.** In order to successfully pass over the role of caregiver to a consumer, they first must understand how the object works. Beyond providing technical drawings and plans, Designers can call attention to the assembly through methods like visible hardware and joinery. Not only do mechanical fasteners allow for assembly/disassembly, but they also allow designers to modify the objects as they require. The plans can be used to further explicate the internal logic of the design through parametric algorithms that allow designers to understand how the geometry works in tandem and to visualize what an altered dimensions looks like.

Final Conclusions

Design plays one of the roles in the contemporary climate crisis, accompanied by producers, consumers, and political and economic systems. To suggest design alone is responsible for consumer culture is both overstating designs impact on consumers and understating consumers agency over their goods, despite producers' best efforts to remove it. Just as design alone did not cause the climate crisis, design alone cannot solve it. This is not to absolve designers of their responsibility, however. As an educated and informed participant of the system, it is the designer's responsibility to do better and design better, for the sake of the planet and the people within it.

Consumption is necessary for sustaining all life. We need to eat, be sheltered, and rest. It is merely a process of transferring energy. Overconsumption, on the other hand, is unnecessary. Overconsumption is the result of conflating our personal value with our objects symbolic value. It is used as a proxy for self-growth and self-actualization, to extend oneself into the objects we possess.

This shift in the perception of objects correlates with the rise of industrialism and consumer culture developed as a response to austerity of war-time restrictions intermittently between 1918 to 1945. There was a desire for self-expression, reinforced by positive political messaging surrounding the benefits of increased production.

Production changed drastically between the beginning of the first Industrial Revolution to the present. The traditional artisanal methods of making were disrupted by industrialized manufacturing, allowing for a greater variety of objects to be manufactured in less time, for less money. This led to newfound levels of wealth and a more democratic distribution of goods among socioeconomic groups; however, it also led to the systematic deskilling of labourers. This alienated workers from their labour and created a detachment between people and their objects. By separating people from the production of their goods, they lose the ability to empathize with them and remove the context for their material value. Objects became more plentiful, consumer culture developed, and overconsumption ensued.

Designers have responded to their role in the climate crisis in numerous ways: through calls for more ethical design and emotionally durable design to address the sociological impacts of design on consumer culture as well as rigorous environmental impact tracking (LCA), cradle to cradle, and various DfX methodologies to address the physical resources being consumed. Many designers accept that they play a critical role in this issue, as it is through the contribution of new objects that allow people to continually consume. However, it is the role of the designer to utilize their education in these techniques not only to mitigate the environmental impact of the field, but to aid in preventing it. No singular participant is solely responsible for the system we exist within. If designers stopped designing, then producers would continue to produce objects without them. As the designer plays the role of the intermediary between consumer and producer, our objects would suffer from the loss of translation. We would be left with worse products. If producers or consumers suddenly stopped participating in the system, our economic stability would collapse and ultimately cause the most harm to the most vulnerable people in our society.

Without change, however, we are on track to hit our planets biological limits. The system will need to change, whether it is by choice or by force. Instead, we need to reframe our society from a growth model to a post-growth one. A post-growth model prioritizes social and environmental wellbeing over GDP and emphasizes local economies, creative subsistence, and an increase in free time to prioritize personal and community labour over industrial labour.

Industrial design in a post-growth future will need to move away from product-orientation to process-orientation. While design today focuses on pushing a product out the door, the future designer will need to take responsibility for the entirety of the object's lifespan. Because they cannot feasibly be there to attend to each item, it means imbuing the consumer with the agency to attend to it themselves. This involves bringing the consumer into the implicit logic of the design and creating the tools to allow consumers of all backgrounds to approach the care process. In turn, the consumer should take responsibility for engaging in the skills required to provide care for this object and take ownership over the object, feeling comfortable to change, adapt, and alter it as desired or needed. In a post-growth future, the consumer is both the consumer and the producer, becoming a designer in their own right. It will be the Designers role to guide them: still mediating between production and consumption in the form of skill limitations and expectations.

Outcomes and Reflections

Through my speculative exploration of furniture design, I investigated various methods of making that would be feasible in this post-growth future. The speculative methodology is important to inspire possible outcomes, rather than to pose a prediction of what the future might look like. Through my designed objects, I aim to spark imaginations of craft-based futures as an alternative to the techno-futurism so prevalent in media today.

The primary outcome of this research is the responsibilities for the future Designers and designers. Based on the literature review, my speculative future asserts that we will all need to take on the role of the designer to manage in a future with limited production. The challenge of a post-growth future lies in this skill gap. It is not feasible to expect all consumers to understand all of the nuances of craft and digital manufacturing techniques in the way that trained designers do, especially when considering each person has their own vocations and interests. But just as we do not expect everyone to be a medical clinician, we do expect most people to understand the basics of first aid as a prerequisite of self-care. Industrial designers will still be trained to understand all that goes into a successful design, and consumers will be expected to understand how to administer first aid to a broken object.

This is not to say consumers will be left on their own in this process. Because industrial production will need to be drastically decreased for degrowth, there will be less objects to design. Instead, the designer will fill their time constructing the manual, like the one described in the side table series, complete with drawings, models, and algorithms, providing consumers multiple entry points into the process. Where the present-day designer is translating the wants and needs of consumers to the producers, the future designers will be translating the manufacturing knowledge of the producers to the consumers.

How consumers chose to engage with the design process will be left up to them and their individual interests. As demonstrated in the lamp series, there is ample room for craft of all types in the creation process of a designed object. Where the industrial designer is crafting the relationships of the object, the actual crafting will be determined by the object's maker through the use of standardized components, material matrices, fundamental elements, and a combination of digital and handcraft making techniques. The designed relationships provide a framework and structure for the consumers to engage in a process of play and exploration as a more positive experience than that of trial and error.

This framework is critical in providing both a starting point and on-going guidance for the consumers who decide to embark on learning new skills. The modular sofa highlights the challenges associated with approaching a new product category, like soft seating, where the construction method isn't readily apparent. The unfamiliarity makes decision making feel impossible. The proposed process of the design manual helps outsource this decision making to an expert. The act of engaging in this process, even as a beginner requiring ample guidance, empowers the consumer to regain their agency over their objects through skill development and confidence over time.

With agency, changes, customizations, and alteration all become a possibility and thus, all objects can become a perpetual work in progress. No object ever needs to be 'done', but we may feel it is 'done enough' to be content with the object for now and can revisit it with more time and skill in the future. Our objects are vessels for energy and materials. They are the sinks that Paech describes (2012). Through regaining our agency and engaging in the making process, we can learn how to release the energy back into the world.

Limitations and Further Research

This research is limited in scope to the Global North and is primarily examining contemporary, colonialist Western consumer culture as the primary perpetrators of overconsumption habits. While I have not examined alternative practices in this thesis, it is important to acknowledge the plethora of cultures across the globe and throughout history that embody sustainable relationships with objects, whether it is out of cultural and spiritual values, or necessity.

This research is also limited in scope due to the research methodology of speculative design. Speculative design prioritizes “fostering social dreaming” (Dunne & Raby, 2013) and uses design as a catalyst to spark discussion of what the public wants the future to look like, rather than acting as a tool for prediction. It exists within the realm of a “possible” future, in which the speculation is built on current understandings of society in order to propose a situation the designed objects exist within. The limitation of this methodology is that of plausibility. It is more concerned with generation of ideas and what the reactions they incite say about society rather than proposing a future and a pathway to achieve it.

In the context of my research, this limitation presents itself in the technicalities of my proposed relationship between the consumer and designer, ‘such as how will consumers learn the required skills to repair the vast array of objects that presently exist’, and ‘how will designers manage the health and safety education when consumers are working with various materials’? While my theoretical framework and research creation suggest designer-created object manuals, craft education, and creative subsistence, this does not provide sufficient consideration to the complexities of achieving this possible future. However, in the speculative design methodology, generating questions such as these may be helpful to shift our collective desired future by inspiring future research of consumer agency.

Additionally, while this research does not directly address the growing debates surrounding artificial intelligence, the discussions surrounding consumption and consumer agency will be of growing importance as we consider the roles humans will fulfill in the future and the skills we should possess. Future research directions along this topic could include explorations of the relationship between AI, digital manufacturing, and craft as well as an investigation into post-digital craft and manufacturing. The relationship between people and machines has always been contentious, but through the thoughtful application of tools we can augment our innate skills to attain a more sustainable future: socially, environmentally, and economically.

References

Atakan, S. S., Bagozzi, R. P., & Yoon, C. (2014). Consumer participation in the design and realization stages of production: How self-production shapes consumer evaluations and relationships to products. *International Journal of Research in Marketing*, *31*(4), 395–408. https://doi.org/10.1016/j.ijresmar.2014.05.003

Bandoni, A. (2016). The Digital Age Reaches the Fringes: A Public Fab Lab in Brazil and Its (Possible) Implications for Design. In M. van Helvert, E. Canlı, A. J. Clarke, É. Forgács, S. R. Henderson, E. van Hinte, E. C. Miller, L. Prado de Oliveira Martins, & P. J. S. V. de Oliveira, *The Responsible Object: A History of Design Ideology for the Future*. Valiz ; Ueberschwarz.

Bean, J. (2019). The Consumed Object. In A. Massey (Ed.), *A companion to contemporary design since 1945*. John Wiley & Sons.

Belk, R. W. (1988). Possessions and the Extended Self. *Journal of Consumer Research*, *15*(2), 139–168.

Bell, E., Dacin, M. T., & Toraldo, M. L. (2021). Craft Imaginaries – Past, Present and Future. *Organization Theory*, *2*(1). https://doi.org/10.1177/2631787721991141

Bellamy Foster, J. (1998). Introduction to the New Edition. In H. Braverman, *Labor and monopoly capital: The degradation of work in the 20th century*. Monthly review press.

Beverland, M. B. (2011). Slow Design. *Design Management Review*, *22*(1), 34–42. https://doi.org/10.1111/j.1948-7169.2011.00108.x

Braverman, H. (1998). *Labor and monopoly capital: The degradation of work in the 20th century*. Monthly review press.

Bürdek, B. E., Dale, M., Richter, S., & Hausmann, N. (2015). *Design: History, theory and practice of product design* (2nd rev. ed, Vol. 1–1 online resource). Birkhäuser. https://doi.org/10.1515/9783035603941

Carpo, M. (2017). *The second digital turn: Design beyond intelligence*. The MIT Press.

Carpo, M. (2023). *Beyond digital: Design and automation at the end of modernity*. The MIT Press.

Chapman, J. (2009). Design for (Emotional) Durability. *Design Issues*, *25*(4), 29–35. https://doi.org/10.1162/desi.2009.25.4.29

Clarke, A. J. (2016). The Humanitarian Object: Victor Papanek and the Struggle for Responsible Design. In M. van Helvert, A. Bandoni, E. Canlı, É. Forgács, S. R. Henderson, E. van Hinte, E. C. Miller, L. Prado de Oliveira Martins, & P. J. S. V. de Oliveira, *The Responsible Object: A History of Design Ideology for the Future*. Valiz ; Ueberschwarz.

Commerce, U. S. B. of F. and D. (1934). *National Income, 1929-1932*. https://fraser.stlouisfed.org/title/national-income-1929-1932-971?page=2

Cross, N. (Ed.). (2006). Design as a Discipline. In *Designerly Ways of Knowing* (pp. 95–103). Springer. https://doi.org/10.1007/1-84628-301-9_7

Csikszentmihalyi, M. (2000). The Costs and Benefits of Consuming. *Journal of Consumer Research*, *27*(2), 267–272. https://doi.org/10.1086/314324

Dormer, P. (1990). *The Meanings of Modern Design: Towards the Twenty-First Century*. Thames and Hudson.

Dunne, A., & Raby, F. (2013). *Speculative everything: Design, fiction, and social dreaming*. The MIT Press.

Environmental management: Life cycle assessment : principles and framework = Management environnemental : analyse du cycle de vie : principes et cadre ([2nd ed.]). (2006). Canadian Standards Association.

Erlhoff, M., Marshall, T., & Board of International Research in Design. (2007). *Design Dictionary: Perspectives on Design Terminology* (Vol. 1–1 online resource). Birkhäuser. https://www.degruyter.com/doi/book/10.1007/978-3-7643-8140-0

Forgács, É. (2016). A Political Education—The Histrocial Legacy of the German Bauhaus and the Moscow VKhUTEMAS. In M. van Helvert, A. Bandoni, E. Canlı, A. J. Clarke, S. R. Henderson, E. van Hinte, E. C. Miller, L. Prado de Oliveira Martins, & P. J. S. V. de Oliveira, *The Responsible Object: A History of Design Ideology for the Future*. Valiz ; Ueberschwarz.

Graeber, D. (2011). Consumption. *Current Anthropology*, *52*(4), 489–511. https://doi.org/10.1086/660166

Guixé, M. (n.d.). *Stop Discrimination of Cheap Furniture*. Martí Guixé. Retrieved April 14, 2024, from https://www.guixe.com/GUIXE/2023-09_Stop_discriminating_cheap_furniture_monobloc_Centraal_museum_Utrech_GUIXE.html

Guixé, M. (2009). *Exhibition | Chairs and Fireworks*. Martí Guixé. https://www.guixe.com/exhibitions/guixe_exhibition_chairs_and_fireworks.html

Haakonsen, S. M., Tomczak, A., Izumi, B., & Luczkowski, M. (2024). Automation of circular design: A timber building case study. *International Journal of Architectural Computing*, *22*(3), 475–491. https://doi.org/10.1177/14780771241234447

Hauschild, M. Z., Rosenbaum, R. K., & Olsen, S. I. (2018). *Life Cycle Assessment: Theory and Practice* (Vol. 1–1 online resource (xx, 1216 pages) : illustrations (some color)). Springer. https://doi.org/10.1007/978-3-319-56475-3

Helvert, M. van. (2016a). Design for Consumer Society: Planned Obsolescence, Styling, and Irresponsible Objects. In A. Bandoni, E. Canlı, A. J. Clarke, É. Forgács, S. R. Henderson, E. van Hinte, E. C. Miller, L. Prado de Oliveira Martins, & P. J. S. V. de Oliveira, *The Responsible Object: A History of Design Ideology for the Future*. Valiz ; Ueberschwarz.

Helvert, M. van. (2016b). Good Design for Everyone: Scarcity, Equality, and Utility in the Second World War. In A. Bandoni, E. Canlı, A. J. Clarke, É. Forgács, S. R. Henderson, E. van Hinte, E. C. Miller, L. Prado de Oliveira Martins, & P. J. S. V. de Oliveira, *The Responsible Object: A History of Design Ideology for the Future*. Valiz ; Ueberschwarz.

IKEA Circular Product Design Guide. (2024). Inter IKEA Systems.

Jackson, F. (1993). Design for the Real World: Human Ecology and Social Change. *Journal of Design History*, *6*(4), 307–310. https://doi.org/10.1093/jdh/6.4.307

Jakob, D. (2013). Crafting your way out of the recession? New craft entrepreneurs and the global economic downturn. *Cambridge Journal Of Regions, Economy And Society*, *6*(1), 127–140. https://doi.org/10.1093/cjres/rss022

Johannessen, L. K., Keitsch, M. M., & Pettersen, I. N. (2019). Speculative and Critical Design—Features, Methods, and Practices. *Proceedings of the Design Society: International Conference on Engineering Design*, *1*(1), 1623–1632. https://doi.org/10.1017/dsi.2019.168

Kilbourne, W. E. (1987). Self-Actualization and the Consumption Process: Can you get there from here? In A. F. Firat, N. Dholakia, & R. P. Bagozzi, *Philosophical and Radical Thought in Marketing* (pp. 217–234). Lexington Books.

Krugh, M. (2014). Joy in Labour: The Politicization of Craft from the Arts and Crafts Movement to Etsy. *Canadian Review of American Studies*, *44*(2), 281–301. https://doi.org/10.3138/CRAS.2014.S06

Kuznets, S. (1937). Definitions and Scope. In *National Income and Capital Formation, 1919-1935* (pp. 3–7). NBER.

Li, M., Holstein, J., & Wedekind, V. (2023). The Historical Shifts of In/Formality of Learning within Craft Skills Ecosystems in the United Kingdom. *International Journal of Training and Development*, *27*(3–4), 405–421.

Maslow, A. H. (1943). A Theory of Human Motivation. *Psychological Review*, *50*(4), 370–396. https://doi.org/10.1037/h0054346

McDonough, W., & Braungart, M. (2002). *Cradle to cradle: Remaking the way we make things* (First edition). North Point Press.

Monobloc. (2022). [Video recording]. PIER 53 Filmproduktion. https://docuseek2.com/if-monob

Okakura, K. (1999). *The Book of Tea* (45. impr). Tuttle.

Paech, N. (2012). *Liberation from excess: The road to a post-growth economy* (B. Liebelt, Trans.). Oekom-Verl.

Papanek, V. (2023). *Design for the real world* (Third edition). Thames & Hudson.

Racine, M., & Frankel, L. (2010). *The Complex Field of Research: For Design, through Design, and about Design*. Design and Complexity - DRS International Conference 2010, Montreal, Canada. https://dl.designresearchsociety.org/drs-conference-papers/drs2010/researchpapers/43

Rosner, D., & Bean, J. (2009). *Learning from IKEA Hacking:*

Sawchuk, K., & Chapman, O. B. (2012). Research-Creation: Intervention, Analysis and ``Family Resemblances''. *CANADIAN JOURNAL OF COMMUNICATION*, *37*(1), 5–26. British Library Serials.

Sennett, R. (2008). *The craftsman*. Yale University Press.

Statistics Canada. (2022). Pilot physical flow account for plastic material, 2012 to 2018. *The Daily*, *11*. https://www150.statcan.gc.ca/n1/daily-quotidien/220323/dq220323f-eng.htm

Sullivan, L. (2022, October 24). Recycling plastic is practically impossible—And the problem is getting worse. *NPR*. https://www.npr.org/2022/10/24/1131131088/recycling-plastic-is-practically-impossible-and-the-problem-is-getting-worse

Thorpe, A. (2012). *Architecture and design versus consumerism: How design activism confronts growth*. Earthscan.

van Raaij, W. F. (1993). Postmodern consumption. *Journal of Economic Psychology*, *14*(3), 541–563. https://doi.org/10.1016/0167-4870(93)90032-G

Victor, P. A. (2008). *Managing without growth: Slower by design, not disaster*. Edward Elgar.

Walker, S. (2006). *Sustainable by design: Explorations in theory and practice*. Earthscan.

Walker, S. (2023). *Design for resilience: Making the future we leave behind* (Vol. 1–1 online resource : illustrations). The MIT Press. http://mitpress.mit.edu/9780262048095

Warde, A. (2005). Consumption and Theories of Practice. *Journal of Consumer Culture*, *5*(2), 131–153. https://doi.org/10.1177/1469540505053090

Whiteley, N. (1985). Pop, Consumerism, and the Design Shift. *Design Issues*, *2*(2), 31. https://doi.org/10.2307/1511416

Wolff, J. and. (2021). Karl Marx. In E. N. Zalta (Ed.), *The Stanford Encyclopedia of Philosophy* (Spring 2021). Metaphysics Research Lab, Stanford University. https://plato.stanford.edu/archives/spr2021/entries/marx/

Yap, J. (2022, September 6). We're about making your IKEA furniture even better—IKEA Hackers. *IKEA Hackers*. https://ikeahackers.net/about