

**RESPONSIBLE DESIGN:**  
**DESIGN METHODS FOR ANTHROPOCENTRIC SUSTAINABLE FUTURES**

by  
Andrea Quirós Balma

Dual BFA in Furniture and Fibers Design,  
Savannah College of Art & Design, 2014

Submitted to the Integrated Design and Management Program in partial  
fulfillment of the requirements for the degree of  
**MASTER OF SCIENCE IN ENGINEERING AND MANAGEMENT**  
at the  
**MASSACHUSETTS INSTITUTE OF TECHNOLOGY**

June 2023

©2023 Andrea Quirós Balma. All rights reserved.

The author hereby grants to MIT a nonexclusive, worldwide, irrevocable, royalty-free license to exercise any and all rights under copyright, including to reproduce, preserve, distribute and publicly display copies of the thesis, or release the thesis under an open access license.

Authored by : Andrea Quirós Balma

Integrated Design and Management.

May 13, 2023

Certified by : Timothy Gustowski

Professor of Mechanical Engineering.

Thesis Supervisor

Certified by : Desiree Plata

Professor of Civil and Environmental Engineering.

Thesis Supervisor

Accepted by : Antonio Hu

Director. Integrated Design and Management Program

**RESPONSIBLE DESIGN:  
DESIGN METHODS FOR ANTHROPOCENTRIC SUSTAINABLE FUTURES**

by

Andrea Quirós Balma

Submitted to the Integrated Design & Management Program on May 13, 2023 in Partial Fulfillment of the Requirements for the Degree of Master of Science in Engineering and Management.

ABSTRACT

Finding a state of sustainability in which present and future human generations may have equal opportunity in perpetuity is an anthropocentric pursuit. It requires intergenerational equity in everything we do, including how we design the products, systems, and companies we build and use. Responsible Design is a new methodology that helps provide the structure designers need to develop sustainable solutions. It is an evolved version of Human Centered Design, a methodology that although well intentioned can deliver solutions with dangerous effects on the environment. Responsible Design uses frameworks that consider the current climate change crisis across scales, the ethical concerns it poses across generations, and the viability of solutions across environmental, social, and economical dimensions.

For the love of learning & humanity

## **Acknowledgments**

This thesis and method would not have been possible without the support of wonderful people I have found along the way. People who have influenced how I see the world and supported me to always delve deeper into my curiosities. It is because of them that I have had the courage to continue challenging myself.

Thank you to my advisors who have been patient with me as I changed the subject multiple times to find the right way to articulate what I had learnt through my research. You've inspired and empowered me to speak freely and taught me more in a year than I could have ever imagined.

Thank you to the IDM program for giving me the opportunity to become part of a wonderful community of independent thinkers, all my IDM classmates for being the most supportive group of people I have ever encountered, and my lifelong friends for always listening to my complaints and making me smile.

Thank you to the DesignX team for believing in me and helping me prepare for the next stages in my life, for opening the doors to a world I have been waiting for.

Thank you to my mentor Rama for reminding me to be humble, your teachings have brought me peace and kept me centered on what truly matters. To Adam, for showing me the ropes and demanding that I believe in myself.

And finally, thank you to my family. My parents who have taught me to dream, be critical when it matters and most importantly to never settle. My sister for reminding me to relax and enjoy the ride, and all the other unique individuals that make up our family for showering me with love every time we are together.

**Table of Contents**

Acknowledgments ..... 4

Table of Contents ..... 5

List of Figures..... 7

List of Tables..... 8

Introduction ..... 9

CHAPTER 1: Drug Dealing and Design..... 12

CHAPTER 2: Turning drug dealers into doctors..... 19

    2.2 Considerations for new iteration of HCD..... 20

        2.2.1 Ethics and Designer Responsibility ..... 21

        2.2.2 Present Bias ..... 24

        2.2.3 Marginal Impact Monitoring ..... 26

        2.2.4 Need theory..... 31

CHAPTER 3: Responsible Design..... 35

    3.1 Ecosystem Examination ..... 39

    3.2 Adaptation Roadmap..... 43

    3.3 Integrated Viability Comparison ..... 50

    3.4 Monitoring Plan ..... 55

CHAPTER 4: Case Study - Furniture Industry ..... 57

    4.1 Ecosystem Examination: ..... 57

        4.1.1 Context on the problem selection ..... 57

        4.1.2 Country Level - USA..... 59

        4.1.3 Industry Level..... 61

        4.1.4 Company Level ..... 64

        4.1.5 End Users Level ..... 65

        4.1.6 Leverage Points for solutions ..... 69

4.2 Adaptation Roadmap.....	70
4.2.1 Constructive Stakeholder Profiles.....	70
4.2.2 Solution strategies developed. ....	72
4.3 Integrated Viability Analysis .....	76
4.4 Monitoring Plan .....	79
CHAPTER 5 - Conclusions & Next Steps.....	80
BIBLIOGRAPHY .....	83

**List of Figures**

Figure 1: HCD Success Venn Diagram (IDEO, 2023) ..... 27

Figure 2: Success Venn Diagram LCD (Torry, 2022) ..... 27

Figure 3: Life Centered Design Compass (Lutz, 2022)..... 28

Figure 4: Countries Mapped by Environmental Power based on 2022 values..... 30

Figure 5: Share of cumulative emissions from 1990 to 2015 and use of global carbon budget for 1.5C linked to consumption by different global income groups (Gore, 2020) ..... 33

Figure 6: The ‘Dinosaur graph’ of unequal carbon emissions growth 1990-2015 (Gore, 2020) ..... 33

Figure 7: Process of Creation - Relationship between design, engineering, and management..... 35

Figure 8: Innovation Sweet Spot for Responsible Design ..... 36

Figure 9: The Responsible Design Method Summarized..... 38

Figure 10: Ecosystem Examination Summary Framework Template..... 39

Figure 11: HCD Journey Map Template Example (Beausoleil p177, 2022)..... 42

Figure 12: HCD Persona Template Example (Beausoleil p171, 2022) ..... 42

Figure 13: Adaptation Roadmap Summary Framework Template..... 43

Figure 14: Yerkes Dodson Law of Arousal and Performance (Nickerson, 2023)..... 44

Figure 15: Constructive Persona Framework Template ..... 46

Figure 16: Possibility Cone (Dunne & Raby, 2013)..... 47

Figure 17: Integrated Viability Summary Framework Template ..... 50

Figure 18: HCD Three Traits Solution Comparison Framework, DFV (Beausoleil p185, 2022) ..... 53

Figure 19: Performance Monitoring Framework..... 55

Figure 20: Ecosystem Examination - Sustainability of Furniture Industry in USA..... 58

Figure 21: Affinity Diagram Interview Data Round 1 ..... 60

Figure 22: Partial Technology Pallet - Worldbuilding Example..... 60

Figure 23: Furniture Industry Stakeholder Map..... 62

Figure 24: Furniture Industry Value Chain..... 63

Figure 25: Furniture Industry Business Model Mapping ..... 64

Figure 26: Consumer Journey Map – Example..... 65

Figure 28: Insights from End Consumer Interview Data .....	67
Figure 29: Current Customer Furniture Shopping/Ownership Journey .....	68
Figure 30: Preliminary Consumer Archetypes.....	68
Figure 31: Constructive User Profile Example.....	71
Figure 32: Solution A - Adaptation Roadmap .....	74
Figure 33: Solution B - Adaptation Roadmap .....	75
Figure 34: Integrated Viability Analysis Example .....	76

## **List of Tables**

Table 1: Countries Ranked by their Environmental Power Score by Quadrant for 2022 .....	30
Table 2: List of Sustainable Development Goals .....	50
Table 3: Monitoring Plan – Example .....	79



## **Introduction**

Designers are creators and innovators that follow a process of envisioning, independent of the type of problem that is being solved, or the type of medium used for the solution. Design is a process of exploration and analysis with the goal of developing a vision for a product, system, or business. This vision is drawn up and justified to give a strategy and purpose for its implementation. The process of designing something is interdisciplinary and may include different types of primary and secondary research as well as decisions related to aesthetics, user experience and engineering, without being limited to one realm alone.

Engineering and Design are interdependent practices that should be understood as two separate stages of creation even if they are conducted by the same person or team. Engineering and Design both involve finding solutions to problems, but engineering will do so within a predetermined set of a rules which define the goal or optimal function desired, whereas design usually starts with a blank canvas. The focus of engineering is more granular, as the goal or optimal function of the overall solution (be it a system or a product) is determined through design. Designers are involved in concept and vision development, which will give a north star for a solution to a problem but will still need further refinement for production or deployment. Design can be applied at different scales, including enterprise, product, feature, or policy level. Regardless, it is concerned with the development and communication of a vision and its purpose, not its implementation.

Design is a methodology and a result. The methodology that is used will determine the type of solution reached and the impact that it may have. The solutions found must be communicated to others to become a reality, which is why a tangible result that explains the visions developed is necessary. What designers provide are blueprints, plans, strategies, and visions. What is done with those visions and who or what type of professional should build upon them is determined by the nature of the solution developed. It is therefore essential for designers to be generalists, able to understand multiple disciplines and problems so they may recognize opportunities for innovation.

The title of 'Designer' is usually, and mistakenly, reserved for very specific types of creatives. These are normally subdivided by the type of products they create, such as architecture, industrial goods, graphics, services, UX/UI, interiors, and fashion items. Although designers can certainly specialize in a certain area, in many cases what is being referred to as design, is in fact styling. Styling is concerned only with aesthetics, and although designers might consider how aesthetics affect the solutions they envision for a particular problem, they are also usually altering the basic functions or systems that make products possible and innovative.

Design can be applied in all sectors of society. When we consider design at an enterprise or business level, entrepreneurs and CEOs are in many cases acting as designers as well but are not typically recognized as such. The goals that company founders and eventual CEOs will outline for their companies are ultimately designed; they are visions that carry intention and require a desired effect to take place to be successful in their implementation.

Designers have a unique opportunity to contribute towards sustainable development, by creating and sharing visions that organize and inspire people. However, despite any good intentions, the world we have so far collectively designed is not sustainable. As a species we are faced with multiple challenges related to sustainability that include climate change, population growth, wasteful consumption and production patterns, biodiversity loss, poverty and inequality, the over exploitation of natural resources and other issues.

The visions designers develop are ultimately the stories we tell each other about what the future might hold. These stories influence how we envision the future, and how we each lead our lives. The stories may exist in movies, shows, marketing campaigns, books or in board room presentations. They gain network effects as they are shared across communities, countries, and generations to become part of our cultures. Science fiction stories for example have historically influenced the technologies we build and the policies we enact, turning into self-fulfilling prophecies. (Gendron et al, 2017) Stories can reinforce biases and values, but they can also critique and challenge people to change through the imagination of their authors.

The stories we tell each other, and the designs or visions we share, and build will be essential in our adaptation towards a state of sustainability. Given that we are now living in a new geological age in which the human species may determine the future of the planet, it would be wise to focus on optimistic and progressive ideas and narratives. Managing our growth inevitably requires sacrifice and an unprecedented change in social norms across scales; people need motivation to act. Dystopian visions of the future, as is often the case in Hollywood movies, only enhance negative emotions and overwhelm people, inhibiting productive change. (Dasilva, 2019)

Design is the practice of dreaming, dreaming consciously and enacting that dream into physical form. Imagining how to redefine our values and systems to ensure a fair future for all is and has been our greatest design challenge as a species. Dr. Martin Luther King once taught us the power of a dream, as he fought for a better future with optimism and courage. Through his speeches he was able to clearly outline a vision for a better future that people could relate to and one day follow.

Current design methods reflect the world in which we live; they are outdated and incapable of delivering the type of ultra-radical solutions we need. Despite good intentions, designers, whose decisions have direct consequences on the actions of others, are at a disadvantage when they are looking to be responsible agents of change. They lack adequate design frameworks for managing the complexity that sustainable development entails. Although every professional and citizen carries a responsibility to be sustainable, designers are especially concerning, as they will inevitably guide the direction of any creation that affects our shared human experience and environment moving forward. The impact of their ideas is exponential. As such, climate change and the humanitarian crises that accompany it call on designers around the world and in all different types of industries and disciplines, to help gradually change the status quo. That is precisely what Responsible Design, the new method proposed in this thesis, aims to help designers achieve.

## **CHAPTER 1: Drug Dealing and Design**

If we compare designers with doctors, in many cases we will be faced with the sad reality that design practices are more closely related to drug dealing than treating patients. Creatives, across multiple industries and professions, are often allowed and encouraged, to perpetually create without consideration of their product's long-term effects or unintended consequences on society and the environment.

The industrial design practice today is a simple example of how harmful design can be and how much we need to change the design methodologies we use and the application of design across industries. Industrial designers are not the only ones who have dangerously impacted our ecosystem, but they serve as an example to the problem at hand. Together with their business mind partners and engineering counterparts they have subordinated themselves to profit generating mechanisms and structures, that inhibit sustainable development. This dynamic has been going on for quite some time now, in fact Victor Papanek emphasized this on his book 'Designer for the real world' back in 1971.

*"There are professions more harmful than industrial design, but only a few of them. Never before in history have grown men sat down and seriously designed electric hairbrushes, rhinestone-covered file boxes, and mink carpeting for bathrooms, and then drawn up elaborate plans to make and sell these gadgets to millions of people. Today industrial design has put murder on a mass production basis. By designing criminally unsafe automobiles that kill and or maim nearly one million people around the world each year, by creating whole new species of permanent garbage to clutter up the landscape, and by choosing materials and processes that pollute the air we breathe, designers have become a dangerous breed.*  
(Papanek, 1971)

Industrial designers are usually following a Human Centered Design (HCD) methodology; the most widely used design methodology today. HCD is famous for its use in design consultancies, and sometimes also referred to as user centered design

or as design thinking. Its origins can be traced back to engineering education at MIT in the 1950s, where a professor called John E. Arnold started and taught a class called Creative Engineering (McCarthy, 2021).

HCD is based on the notion that designers must consider the perspective of the user and cater to the user's needs with their solutions. It considers that designers might be biased when developing a solution for another person or being, and that using ethnographic techniques can help generate empathy for the user's condition and bridge the designer's knowledge gap. Human Centered Designers will do interviews, surveys, and observational research, to find commonalities in expressed and latent needs between end user subjects. The needs that are identified drive the solution developed, as they become the problem to be solved.

This method's popularity stems from its relatively seamless translation into business development and profit generating schemes. Listening to users has the benefit of making customers happy, which in turn generates revenue and profits, so it seems like a win-win situation for all. Any company that is customer centric is ultimately following a HCD philosophy. Executives at such companies are making business decisions based on customer centric metrics under the premise that this will maximize profits for themselves and their shareholders.

Amazon is an example of a company that is built upon user/customer centric values and has become incredibly successful because of it. It's dedicated to giving users the products they want as fast and as simply as possible. They have built an interface where impulse buying is easier than ever, with a subscription model and one click purchasing system that allows people to get stuff almost immediately. Their platform is incredibly popular, and to some parts of society has almost become a necessity. Business models like Amazon's can not only gain market share but also increase consumption rates per person. This increased consumption will generate more revenue and give an incentive for the company to continue functioning in the same way. It's a never-ending reinforcing loop.

By building a closed-looped flywheel around customers' durable needs in our retail space, and by staying close to our customers and continuing to think about how their needs evolve, Amazon drives continuous innovation that delights customers and helps fuel our retail growth. (Slater, 2023)

The 'Swiffer' product is another famous example of how HCD excels at financial value creation and financial value capture. Its business model also relies on reinforcing loops of consumption. This clever award-winning product was launched in 1999, claiming to make life easier for urban apartment dwellers by giving them a disposable wiper to clean their floor with. Instead of washing towels or mops all the time, customers could now buy boxes of single use paper towels and keep replenishing them on demand. This design and business model maximizes returns by using economies of scale and introducing customers into a never-ending cycle of consumption. The Swiffer was designed using a human centered methodology by a design consultancy called Continuum for Procter and Gamble. The product is still in the market 23 years later.

The Swiffer came into existence after Continuum researchers videotaped people cleaning their homes and realized just how much people hated touching dirty mops. They also realized that most dirt in the home is primarily dust that could be picked up electrostatically... "Development really depends on empathy for what's going on," Zaccai said (founder of Continuum). "It's definitely work understanding what people say, what they do, and what they care about." (Woolhouse, 2023)

HCD can have terrible unintended consequences in our society and the environment. Although sustainability was not top of mind when the method began at MIT, the benefit that design should have for society was. The motivation for the methodology was to give humans better products and ultimately better lives, but somewhere along the way the process has gotten distorted, as Arnold's methodology has evolved.

*Creative Engineering: Promoting Innovation by Thinking Differently...* reveals Arnold's definition of the creative process, which consisted of four criteria:

- The creative result must be a superior combination, and not merely differentiation for its own sake
- The result must be tangible and have material properties, and not simply be a concept
- **It should be future-oriented and useful to society**, functional rather than recreational.
- And it should have a value in which the sum is greater than the total of the parts, or synergy through a multiplicative effect. (McCarthy, 2021)

HCD is now pervasively biased towards profit generation, making it seem more applicable to refer to it as user or customer centered rather than as human centered. HCD as it is today, reduces any friction that might inhibit the adoption of a new product by striving to reflect a thorough understanding of user's current behaviors, wants and needs in their solutions and adapting the product completely to the user's current lifestyle.

In the case of the Swiffer product line, the problem of cleaning the floor with a dirty mop was clearly an issue for consumers, that they were willing to pay to resolve. Continuum's designers did an excellent job at identifying customer pain points and developing a product that they would be willing to buy. However, the amount of waste that the Swiffer creates, begs the question of whether it was the right solution or not and if the environmental impact of solving this problem could have been reduced.

Swiffer's website states that their product is not only easy to use but also "uses less water than the typical mop and bucket. Households went from using gallons of water to ounces of solution to clean their floors. Every household that uses Swiffer Wet could save over 70 gallons of water per year vs. mop and bucket cleaners." (Swiffer, 2023) It is unclear if this calculation was part of Continuum's original design process, but the resulting water savings, if true, are positive. However, there are many other dimensions of this product and its business model that are not being mentioned or accounted for

as it relates to their environmental footprint. One of those being material waste as previously mentioned.

The phenomenon of greenwashing has now become extremely common across different industries. Leaving consumers confused and overwhelmed about what products are sustainable and which ones are not.

Generally speaking, *greenwashing* involves a discrepancy between organizations' green claims and their actual environmental performance. Greenwashing suggests that organizations try to reap the benefits of a green positioning without behaving accordingly. The rise of greenwashing fosters CSR (Corporate Social Responsibility) skepticism. (De Jong, 2020)

Greenwashing does not have to be intentional to have a negative impact. Its prevalence is counterproductive to sustainable development, by making real and significantly positive environmental contributions become invisible, as consumers are inundated with information and unable to distinguish between significant and insignificant contributions. However, there is nothing in the HCD methodology that would dissuade a designer from marketing environmental impact strategies to consumers, apart from their own moral compass. Although companies may not be telling the whole story, the parts that they are sharing are true (hopefully), and if it's the type of information the user wants to hear then they are doing it in the service of the consumer.

Products like the 'Swiffer' go on to be sold in marketplaces like Amazon, creating reinforcing and unsustainable feedback loops in multiple dimensions. The Swiffer concept produces much more waste than the alternative it was replacing, and Amazon is increasing its consumption, making it extremely easy for users to buy it without questioning their responsibility in doing so. Furthermore, Amazon's subscription business model locks customers into using this platform only. This type of systems exemplify why HCD refers to the people it services as users; just like drug addicts these systems get customers addicted to unsustainable behaviors that satisfy all their cravings in favor of economic growth. If we want to design a more sustainable world, we must reconsider the frameworks we use to guide our thinking when developing



solutions. If in fact we were designing for all humans and therefore for humanity, our solutions would be entirely different. HCD or UCD is not in service of humans, but instead in service of corporations.

*Human Centered Design was created to serve the economic system we currently live in. However, our current system is on the threshold of change, in which a complete mindset and culture shift will be necessary to continue as a species on this planet. In our current economic model, the incentives of production do not reward tackling larger systemic problems – ironically, in a time where all of our problems grow increasingly systemic. There is money in creating a better banking experience. But there is no money in solving systemic poverty in rural East Africa. Human Centered Design alone can no longer tackle the complexity of today's wicked problems, and something new must come into play. (Owens, 2019)*

HCD is solidifying consumeristic and materialist lifestyles that inflict unnecessary pressure on the natural environment and risk the wellbeing of future populations. HCD frequently delivers solutions that make people believe they will achieve happiness if only they have one more thing or work hard for one more superficial recognition. It has strengthened capitalism and gamified our human existence. Although it may in some cases provide solutions and products that help people and make them happy in the short term, it is unfortunately also able to lower people's wellbeing, which is exactly what it was meant to prevent. Designers need to be extremely careful about the products and solutions they recommend, if they are at all interested in sustainable development.

Studies document that strong materialistic values are associated with pervasive undermining of people's wellbeing, from low life satisfaction and happiness, to depression and anxiety, to physical problems such as headaches, and to personality disorders, narcissism, and antisocial behavior. (Kasser p22, 2002)

There are multiple studies that have shown happiness does not increase with higher income levels (Kasser p45, 2002), and that instead it plateaus after a certain point were

our human basic needs are met. But although studies show no correlation between happiness and income level, it is shown to have a relation to values and aspirations. The failure to reach our aspirations is what generates distress and frustration, leading to depression. Unfortunately, in many cases the systems that have been built are designed for people to feel like there is always something else they need to achieve or possess. This is the premise for materialism, and as explained by Kasser in his book 'The high price of materialism', it can have detrimental systemic effects of our society.

The job of designers today is to determine what a sustainable and post materialistic world might look like. A new type of training is required. One that prepares designers to act more like doctors instead of drug dealers who work to satisfy the needs of human greed. We need designers who take responsibility for the recommendations they make and how they may affect the people they serve. Designers who are focused on the wellbeing of humankind.

## **CHAPTER 2: Turning drug dealers into doctors.**

To develop a new iteration of HCD that can properly address sustainability concerns and fulfill the original goal of being in service of society, we must first examine the meaning of sustainability and the guiding principles of this movement. Sustainability as defined by the Brundtland Commission in 1987 implicitly relies on 3 main principles as it refers to “meeting the needs of the present without compromising the ability of future generations to meet their own needs.”

1. Sustainability requires intergenerational equity.
2. Sustainability can only be achieved through the partnership of behavior change and technological innovation.
3. Sustainability requires measurement and monitoring.

Sustainability is an anthropocentric concept, that implicitly places humans at the center of any future we devise (Goralnik, 2012). Finding a state of sustainability means that our species carries a new responsibility to not only satisfy its needs and those of its future generations but also to determine the rights of other species. Climate justice and ethics are therefore inevitably intertwined with sustainability, as future human generations and other species may come to hold rights of their own. Ecuador is a leader in this space being one of the first countries to have official granted rights to animals (Pallotta, 2023). However, granting rights to other beings does not necessarily mean equality. The rights that future human generations should be granted are different to those that will likely be granted to flora and fauna entities.

The nine planetary boundaries framework (Rockstrom Et al, 2009) includes biodiversity as one of the key processes that regulate the stability and resilience of our planet, and alert us that crossing any of the boundaries may result in irreversible harm. Animal rights will be developed to manage human impact, as our effects on other species are a potential threat to the environmental stability that allows human flourishing.

Our grand challenge is to stop our current trajectory and to prevent the Anthropocene from becoming a new, self-reinforcing hot state. The only way to success in this human quest is to avoid crossing tipping points in the earth system that regulate the state of the climate and the living

biosphere. This in turn requires that we govern and manage the global commons - all biophysical systems that are critical in regulating the state of the planet - within planetary boundaries that provide a scientifically defined safe operating space on Earth. (Thunberg p33, 2023)

To avoid crossing tipping points, human rights to earth's resources should be determined in relation to those of other beings that help maintain the environmental equilibrium that provides livable circumstances for our species in perpetuity. Although some have compared our current lack of vision and our transition out of speciesism to what has historically happened with racism (Burkey p125, 2017), these two pursuits are different, in that abolishing racism entails equal rights, whereas granting rights to flora and fauna does not. Although it would be benevolent to provide equal rights to all flora and fauna and run our society based on these, it is perhaps unrealistic to expect such levels of altruism from humanity.

The ultimate goal of sustainability is to ensure survival and wellbeing of the human species in perpetuity, is it not to ensure the survival and wellbeing of all flora and fauna species as well. Our collective moral values prevent us from inflicting unnecessary suffering on other species, so the important factor is to define what is necessary and what is not if the goal is to find balance. Once we find a balance, we may choose to continue to reduce our population and resource consumption consciously to give other species a bigger chance to grow and flourish. We might therefore eventually progress from an anthropocentric reality towards a zoocentric or biocentric reality, but sustainability as it is defined today, and as it will be most beneficial to all living beings in the centuries to come, is decidedly anthropocentric. Finding an environmental balance where humanity is aware of its own boundaries will be beneficial to other species given that humans are the species with the most detrimental effect on the ecosystem. (Kopnina et al, 2018)

## **2.2 Considerations for new iteration of HCD**

Considering the 3 main sustainability principles listed previously, 4 underlying issues with HCD will need to be addressed. These include, in no particular order:

1. Ethics and Responsibility
2. Present Bias
3. Marginal Impact Monitoring
4. Need Theory

### 2.2.1 Ethics and Designer Responsibility

The solutions designers or groups of designers choose for a particular problem may have serious consequences in the physical and metaphysical world, whether they were able to predict it or not. However, the responsibility of designers as the visionaries of such solutions is nuanced and uncertain in today's world. The creation of 'Facebook' is a famous example of this. Even though the company claims the platform was intended for social networking and community building, it has become a space where cyber-bullying thrives, and its technology has been used to disseminate fake information. Although it is difficult to claim intentionality, the effect is real. HCD does not provide any guidance for designers in this respect though, because they are only providing a service to the companies that employ them and the end users of such companies. HCD ignores designer's responsibility and instead passes it on to other stakeholders.

This raises the question of whether designers should be judged based on consequentialist ethics or deontological ethics. In other words, if they should be judged by the results of their actions or the intention behind them. The answer is nuanced and as such requires designers' responsibility to be judged by both. Consequentialist ethics or utilitarianism say the result is what matters, as moral actions are those that result in the greatest good for the greatest number of people. However, deontological ethics claim that moral actions are those that adhere to the rules and the socially determined duties of all members of a society. So, if our actions are in accordance with the law and socially accepted norms, then they are moral. But what if the rules need revision?

The speed of technological innovation today has made it difficult for bureaucratic political systems to keep up and limit the growth of technologies or systems that could be potentially harmful to society. Political parties and governments are in many cases corrupt and lobbyists will skew politicians to ignore important social matters for their own benefit.

Designers cannot predict the future, and will always have a risk for unintended consequences, but there is a need for more meticulous solution assessments to try to mitigate these as much as possible. Morality for designers will remain relative, to the information, knowledge and experience they had at the time of concept development and the methodology they used to monitor its implementation and impact. If they are abiding by the law and are doing everything in their power to manage unintended consequences, then their actions must be considered ethical. Otherwise, the responsibility of designers should be more clearly recognized.

Doctors don't ask their patients how they should be treated. They may ask them about their symptoms and matters of their daily life to get a sense of what might be causing their condition, and based on what they hear and their developed expertise, they will provide recommendations. Patients are ultimately the ones that decide if they take the medicine that was prescribed, but the doctor is responsible for recommending the best solution for the patient's wellbeing long term. Their responsibility is so salient, that many function under the threat of lawsuits for malpractice, having to be always extremely careful about the type of information and treatments they deliver.

Just as the Hippocratic oath does not hold doctors responsible for consequences outside of their purview when it says - 'to fulfill, to the best of my ability and judgment' (Lasagna, 2023), we cannot hold designers accountable for the potential repercussions their interventions have that they were not able to predict or would be able to predict with normal training. However, if designers are trained to take comfort in ignorance and, only desire to satisfy or echo the cravings of their audience, then the practice is completely counterproductive to sustainable development.

Designers cannot provide advice, or develop solutions that truly help people, all people, without considering how their environment functions or what a state of sustainability entails. Consider again, the Hippocratic oath as it says, "I will remember that I do not treat a fever chart, a cancerous growth, but a sick human being, whose illness may affect the person's family and economic stability. My responsibility includes these related problems if I am to care adequately for the sick (Lasagna, 2023)." Designing products and enterprises without consideration for environmental and social impact

not only can have unintended effects on the population the solution is intended for, but also on other third parties.

Although HCD can increase empathy with potential users and stakeholders by using ethnographic techniques, its blind spots are the voiceless future generations and species that surround them. Stakeholders should be consulted on their experience whenever possible, but solutions cannot solely depend on their perspectives. Thus, designers should strive to have a wider lens when trying to uncover the right problem to solve. The focus on ethnographic research and testing prior to market introduction, like what is done in the scientific method, is commendable, as it makes the design process more democratic. However, regardless of how collaborative or participative the ideation process is conducted with system stakeholders, the designer is and should always be understood to be the one to make the final decision of what is recommended. This decision-making power is a responsibility that should be acknowledged, and doing so is the basis for switching from a drug dealer to a doctor position.

Co-Design and participatory design are two very similar methods that are commonly used in conjunction with HCD. Applying this type of process helps users feel more empowered and allows designers to learn from observing the interaction of different stakeholders. "Participatory design is a democratic process for design (social and technological) of systems involving human work, based on the argument that users should be involved in designs they will be using, and that all stakeholders, including and especially users, have equal input... In some projects, participatory design limits user power to creating only inputs for the professional designers to consider, an approach called consultative design. Other approaches give the users full power to share in the responsibility for the outcome, in what Mumford calls consensus design" (Hartson & Pyla, 2018)

Other methods such as the STEP (Socio - techno - economic - political) framework (Daher et al, 2018) recommend engineers to guide the negotiation between stakeholders. However, like participatory design, it encourages communication with system stakeholders and the integration of their views in the design process, but it does not include a way to adequately and fairly decide which stakeholder should bear the potential burden or compromise in the negotiation. Thus, we must conclude that in this

case the implicit understanding is that consultative design would be the adequate practice, where the designer still holds the power of decision on the final solution selection and is responsible for that recommendation.

The Hippocratic oath created a sense of accountability in the healthcare industry for centuries. Although its relevance in today's world has been questioned (Shaikh, 2016) as the oath may need to be revised to reflect new policy developments, the requirement for professionals to take an oath is an interesting idea for designers. Although the power that designers hold has not been historically recognized, just like doctors, there is a need for designers to feel a sense of responsibility about the impact of their work.

### 2.2.2 Present Bias

Present bias refers to the human's tendency for hyperbolic discounting (Oxenham, 2023); a natural inclination to focus more on the present situation than the future when making decisions. This can lead us to prioritize immediate rewards instead of future payoffs, regardless of the potential for a bigger reward in the future. Present bias applies to losses as well. People will usually avoid short term discomfort, even when they know it will lead to a larger loss or frustration in the future.

Present bias is normal and natural, we all experience it in our daily lives. A simple example is the choice of going to the gym or choosing to eat an apple instead of a piece of chocolate. (Oxenham, 2023) People that are not accustomed to doing exercise will encounter high levels of friction to change their behavior when they try to start a new routine of going to the gym regularly. Present bias makes us internally negotiate with our future selves. We understand that our future selves will be happier if we go to the gym and start a new routine, but on the day of making the decision it may seem more appealing to stay home and watch TV or go out for a meal with friends, so we choose to postpone it to tomorrow. It's one of the many biases humans have, which are meant to make decisions easier. There are over 180 biases that have been identified by behavioral scientists, present bias is just one, but one which poses a big issue. (Yagoda, 2023)

Present bias is deeply linked with the types of products that people buy, and as such with the types of products that we design and produce as a society. It is also inherently



linked with sustainability because sustainability is a long-term goal. The changes that we make as a society today will not provide tangible rewards in the short term, but science tells us that they will in the future. Furthermore, if we choose to make decisions based on what is more sustainable, decision makers will not personally reap any of the environmental rewards in the future, although members of their family or community might. It is therefore a case of present bias where a collectivist instead of an individualistic ideology is required to solve it, which adds to its complexity.

HCD does not help designers manage present bias, and instead in some ways reinforces it. Designers encounter present bias from the perspective of the user and how they express their needs, as well as from their own perspective as designers and consumers. Designers may for example choose to make a product that provides a benefit in terms of revenue in the short term rather than a product that might provide a bigger return but require a longer-term commitment, or they might simply discount the effect that a product might have on the environment because the effect is not immediate or personal.

Currently the only HCD frameworks that could be applied to help designers manage present bias and behavior change are stakeholder maps and journey maps. However, although these two frameworks can be helpful, the focus on customer centric solutions tends to cancel their possible effect on present bias, as it blocks the systems approach that a stakeholder map can start to provide. Stakeholder Maps provide a holistic view of the players in the game, to ensure no major parties that could change the context in which the solution would take place are unintentionally ignored. Journey maps are a visualization of the process that a person goes through to accomplish a goal. "In its most basic form, journey mapping starts by compiling a series of user actions into a timeline. Next, the timeline is fleshed out with user thoughts and emotions to create a narrative. This narrative is condensed and polished, ultimately leading to a visualization." (Gibbons, 2023)

The focus of HCD on current behavior and customer adoption also anchors solutions in the present and jeopardizes the opportunity for potentially better or more sustainable behavior. HCD methods are not optimized for the possibility of behavior change across

scales, there is no clear structure to assess when behavior change may be necessary or how to handle it if in fact it is.

Understanding when and where behavior change is necessary is essential to delivering sustainable solutions that foster the wellbeing of current and future generations (Klaniecki et al, 2018). Additional efficiencies in the form of technological innovation will certainly help us (humans) lower our footprint, but they will not solve the problem in its entirety and in perpetuity. “For example, the telephone was to reduce car trips, email would reduce paper use, more efficient light bulbs would reduce energy use and improved American football helmets would reduce head trauma” (Gutowski, 2018) but none of these solutions have delivered on their promise. The possibility of rebound effects and unintended consequences has been extensively studied and shows that with additional growth we could end up right where we started. What designers often predict will happen gets disrupted due to consumer behavior. The goal is therefore not to only increase efficiency, but to reduce our absolute footprint long term. The potential for rebound effects could be managed if we paid more attention to how and why we develop technology in the first place; if we took a different kind of design approach before we choose to build them, one that clearly identifies the purpose for its existence and its limits.

### 2.2.3 Marginal Impact Monitoring

There are multiple frameworks published by scientists and drafted by policy makers to help measure and enact sustainability long term, none of which are officially applied in HCD frameworks. Life Centered Design (LCD), the newest iteration of HCD, has started to integrate environmental and social impact in its methodology, but it is still insufficient considering the challenges faced. The philosophy behind how success is measured in LCD is slightly different to HCD. The success Venn diagram used in HCD (Figure 1) is altered to include one more circle of consideration (Figure 2). The innovation sweet spot is now considered to be at the intersection of integrity, feasibility, desirability, and viability. This starts to positively reframe the problem being solved from a user centered perspective only, towards a systems perspective, but unfortunately leaves integrity and

impact as somehow a siloed concept and in reality it is not, given that sustainability is integral to how we understand desire, viability and feasibility.

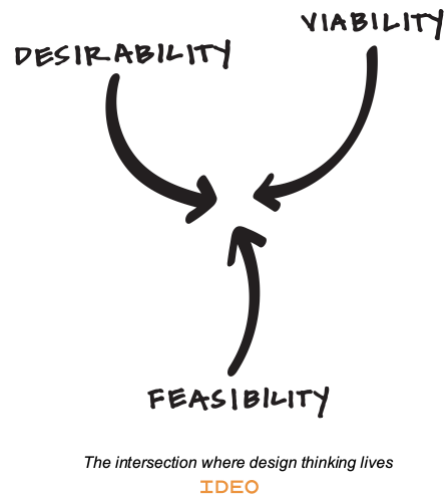


Figure 1: HCD Success Venn Diagram (IDEO, 2023)

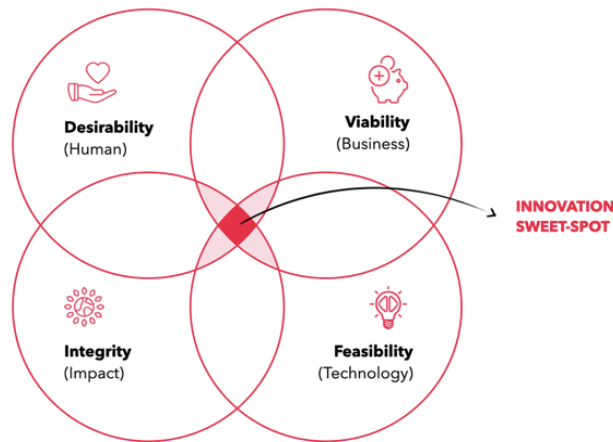


Figure 2: Success Venn Diagram LCD (Torry, 2022)

There are no globally agreed upon frameworks for sustainability in existence, but the SDGs might be the closest thing to it today. The Sustainable Development Goals (SDGs), were modeled as a revision of the millennium goals<sup>1</sup>, and developed by the United Nations. The SDGs outline 17 goals spanning 169 social, governance and environmental indicators that have been deemed essential to achieve a sustainable

<sup>1</sup> Millennium goals were a set of 8 international development goals established by the United Nations in 2000. They included a range of issues related to poverty, health, education, gender equality and environmental sustainability, with a deadline of 2015.

future. The Paris Agreement and the development of the SDGs<sup>2</sup> was a historical moment that inspired hope for cooperation and peace. These goals are used in LCD to start to analyze the impact of different solutions.

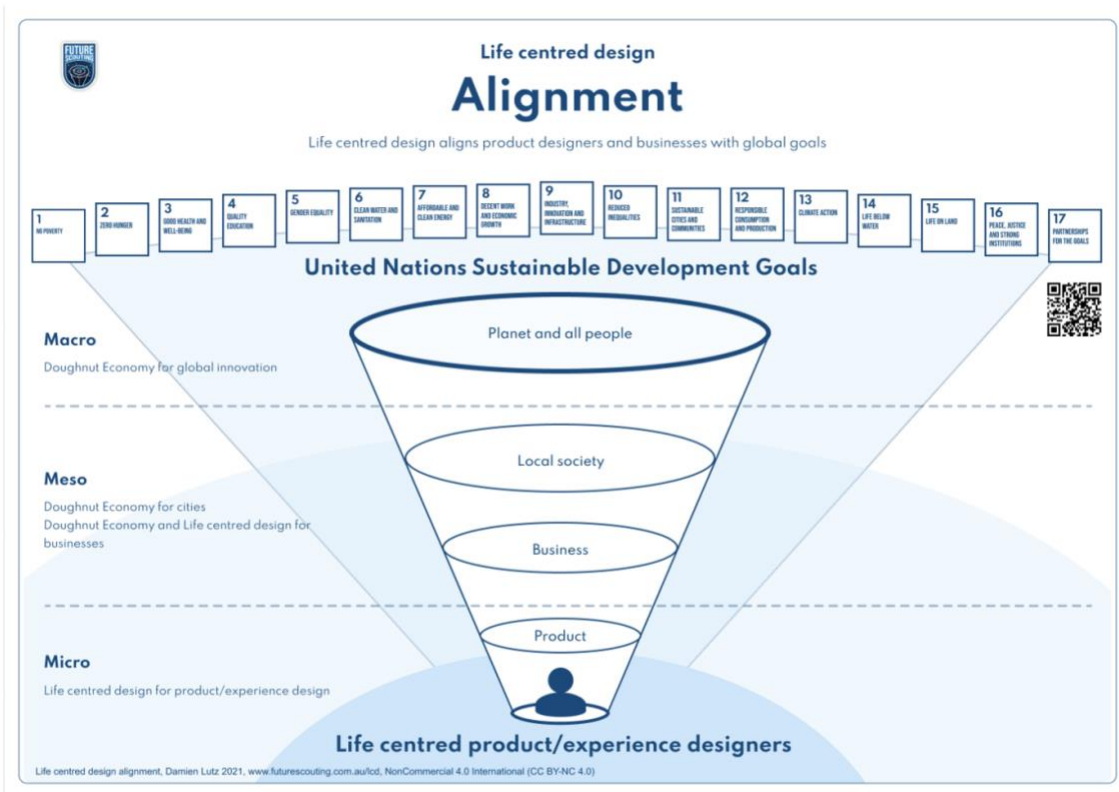


Figure 3: Life Centered Design Compass (Lutz, 2022)

Life Centered Design recommends that designers use the SDGs to ensure solutions are sustainable. As seen in Figure 3, which summarizes the LCD process. The list of SDG indicators and goals is helpful, but there is no way to enforce or prioritize the indicators, which leads to a lack of accountability and increased potential for greenwashing. Governments and companies have a lot of flexibility to apply them as they see fit, without any understanding or alignment of global strategy. A recent commentary on

<sup>2</sup> Paris agreement is an international treaty established under the United Nations Framework Convention on Climate Change (UNFCCC). It was adopted in Dec 2015, and entered into force on Nov, 2016. The agreement aims to limit global warming to well below 2 degrees Celsius above pre-industrial levels, and to pursue efforts to limit the temperature increase to 1.5 degrees Celsius. The SDGs are related to the Paris Agreement but at not part of the agreement itself. SDGs take a broader approach to development, encompassing social, economic, and environmental goals.

the SDGs by Rutger Hoestra on his book *Beyond GDP by 2030*, reinforces the point that unfortunately, the only agreed upon strategy and framework we have, is not comprehensive enough to carry us towards the future we want.

“...The SDGs do not define what the ultimate goal of sustainable development is. There is no model that relates the 169 indicators to an end goal. This also means that it is unclear how the goals are linked to each other. There is no underlying framework that links education to health to environment to gender issues to employment”. (Hoekstra p111, 2019)

Based on the most recent IPCC report (IPCC), global agreements like the Paris agreement are failing, and will continue to do so unless we can fairly prioritize goals and monitor our progress across scales. The SDGs benefit the large economies that ironically are most responsible for climate change, because they have a built-in skew toward social metrics. This becomes obvious when you map out countries based on their environmental power; defined as the opportunity an entity or country must enact change in the immediate short term that can benefit overall environmental conditions long term.

EP can be calculated by multiplying a country's human development level, environmental impact (as defined by the EPI index<sup>3</sup>) and the size of the economy of a country (GDP). Ranking countries by EP and comparing the results to those of the SDG country rankings shows that there is a bias towards large economies. Small developing countries on the front lines of climate change are unfairly affected by climate change and are being punished with low ranking on the SDGs. While large economies, who in many cases hold the most environmental and political power, are deceptively awarded high SDG rankings, and allowed to continue to do minimal effort on environmental impact management.

---

<sup>3</sup> (“Environmental Performance Index”)

Climate Impact (EPI Sub-Index) vs Human Development Index

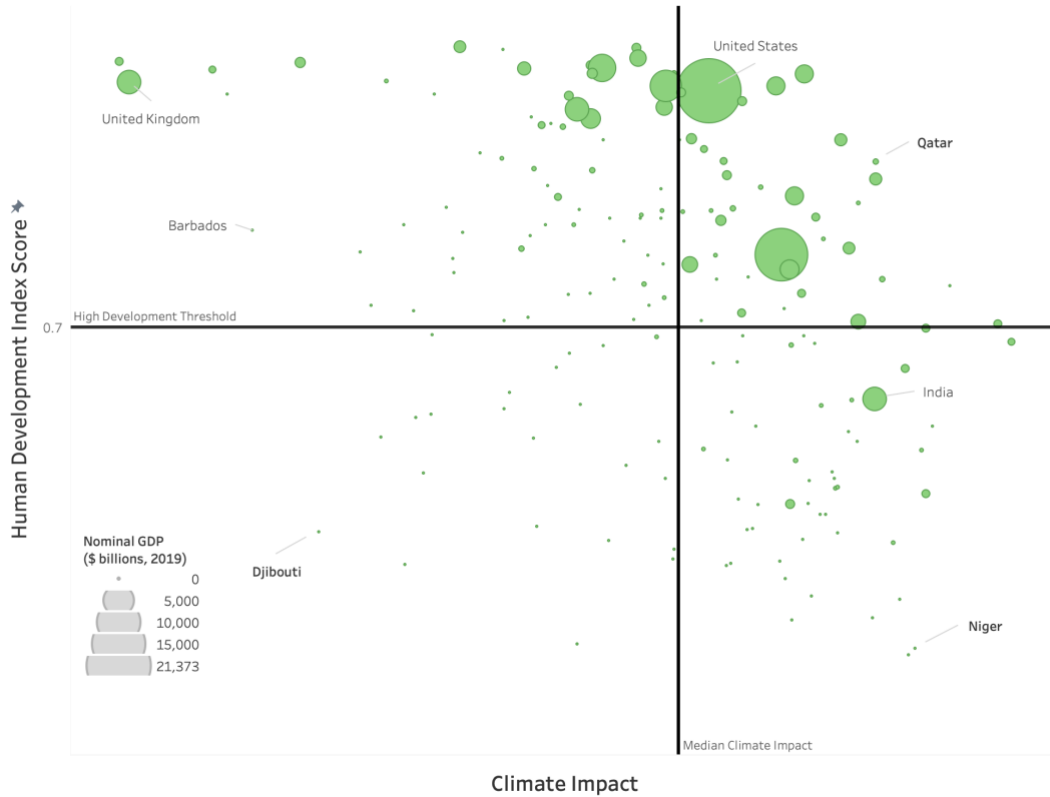


Figure 4: Countries Mapped by Environmental Power based on 2022 values

Table 1: Countries Ranked by their Environmental Power Score by Quadrant for 2022

Leaders	Irresponsibles	Dual Crises	Independents (Only HDI considered)
1. Japan	1. USA	1. India	1. Afghanistan
2. United Kingdom	2. China	2. Nigeria	2. Djibouti
3. Germany	3. Canada	3. Pakistan	3. Lesotho
4. France	4. Korea (Republic of)	4. Bangladesh	4. Solomon Islands
5. Italy	5. Brazil	5. Phillipines	5. Equatorial Guinea
6. Australia	6. Russian Federation	6. Iraq	6. Eswatini (Kingdom of)
7. Spain	7. Indonesia	7. Ethiopia	7. Namibia
8. Netherlands	8. Mexico	8. Kenya	8. Sao Tome and Principe
9. Switzerland	9. Saudi Arabia	9. Morocco	9. Kiribati
10. Sweden	10. Turkiye	10. Myanmar	10. Marshall Islands

It is therefore important to differentiate between environmental and social metrics when developing sustainable solutions, and give these two perspectives equal weight, given that currently living beings should have the same human rights as those that will be alive in the future. The SDGs can still be used to provide a general vision of where we would like to be headed, but more granularity is necessary in the design process to make progress towards them.

We need frameworks for carbon footprint tracking and management across scales. This includes individual citizens, families, groups, companies, industries and ultimately governments and countries. To determine the viability of a solution, we must analyze its potential environmental footprint as well as its potential for profit. The best way to do so is carbon accounting which can be done with a Life Cycle Assessment (LCA<sup>4</sup>), but neither HCD nor LCD include any carbon accounting in their process. This tool, or at least a certain level of carbon intuition, should become part of a designer's toolkit. If designers can speculate and compare the environmental impact of different solutions, then it is much more likely that they will hold themselves accountable to find the best solution possible. In the same way businesses perform financial projections for new market introductions, they should be performing impact projections. This would mean that in addition to looking at a profit margin they are also calculating an impact margin and trying to monitor and optimize it.

#### 2.2.4 Need theory

The global carbon budget for the next 100 years of human life is estimated to be 485B Tons or less (Pearce, 2023). This amount divided by the 9.8B people that are estimated to live on earth by 2050, leaves about 49 tons per person (½ a ton per year). The average personal carbon footprint is approximately 4 tons per year globally, and 14.7 Tons per year in the United States (World Bank Data, 2020). This means that an average

---

<sup>4</sup> LCA is a technique used to assess the environmental impact of a product, process, or service over its entire life cycle, from raw material extraction and processing, through manufacturing, use and disposal. It is a comprehensive and quantitative method that considers all stages of a product's life cycle, including inputs of energy and raw materials, as well as emissions and waste generated at each stage. The environmental impact of each stage is then quantified and aggregated to provide a comprehensive assessment of the product's overall environmental performance.

American citizen will go over their budget within the next 5 years, while others may be looking at roughly a decade. In any case, a drastic behavioral change and level of technological innovation is necessary.

The Earth is one, but the world is not. We all depend on one biosphere for sustaining our lives. Yet each community, each country, strives for survival and prosperity with little regard for its impact on others. Some consume the Earth's resources at a rate that would leave little for future generations. Others, many more in number, consume far too little and live with the prospect of hunger, squalor, disease, and early death. (Brundtland Commission p28, 1987)

HCD does not have a way to clearly differentiate the urgency of the needs or wants that are expressed by users. Need theory urges us to define what the basic needs of humans are, and by doing so identify the luxuries that we might be able to give up. (Gough, 2017) One way to do so is to calculate the elasticity of demand of different products, based on how people's incomes change. Those products with a high elasticity of demand are luxuries, given that when people's income is reduced, they choose to purchase other products instead or give up the category completely.

Due to climate change, it's likely that certain parts of the world will need to reduce lifestyle requirements significantly while others may not have to as much, depending on the number of luxuries that a particular population consumes. Designers looking for sustainable solutions are therefore challenged to define what might be reasonable for each person to consume, and if a limit has been reached imagine how the behavior could be managed and improved. Consumers will always have the freedom to choose different products, but they should not be tricked or manipulated into consuming more if it is not good for the environment or for future human generations. Differentiating between needs and luxuries can help designers manage climate justice concerns, present bias, and the overall footprint of their solutions.



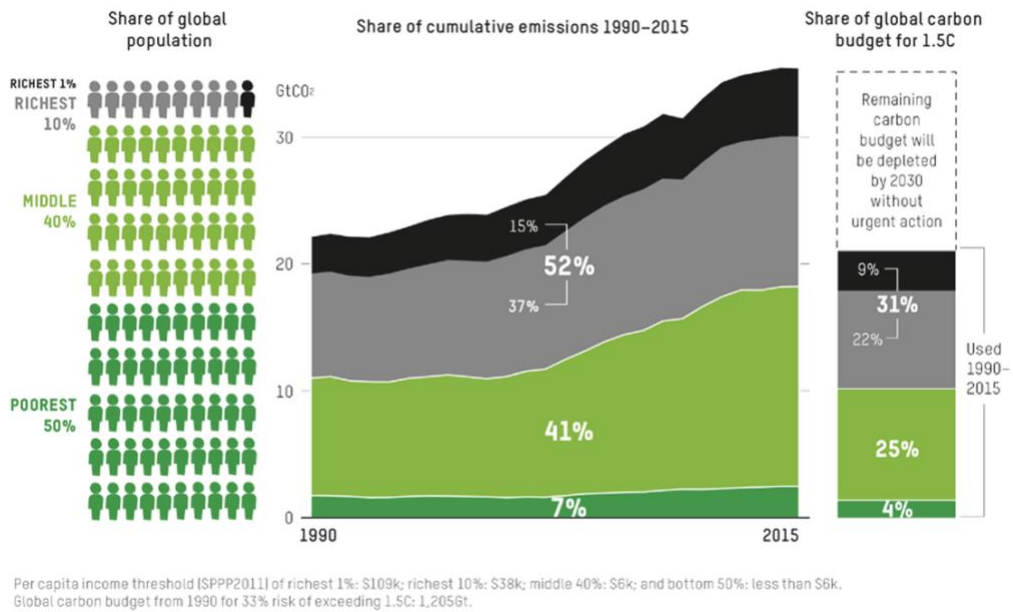


Figure 5: Share of cumulative emissions from 1990 to 2015 and use of global carbon budget for 1.5C linked to consumption by different global income groups (Gore, 2020)

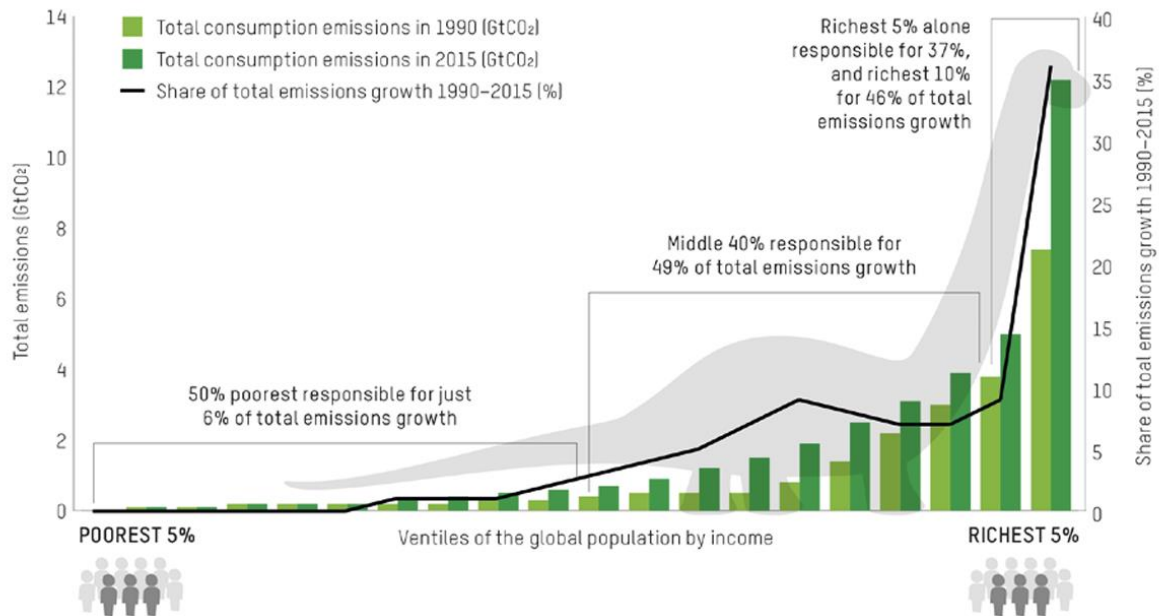


Figure 6: The 'Dinosaur graph' of unequal carbon emissions growth 1990-2015 (Gore, 2020)

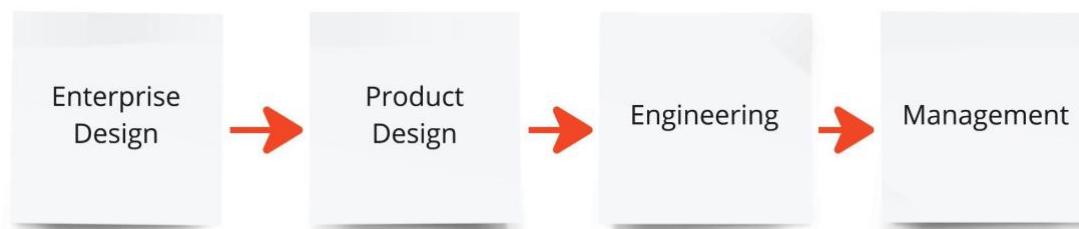
It's estimated that roughly 58-72% of all global GHG emissions are due to household consumption (Ivanova and Wood, 2020). Consumption is not equal across income levels; however, higher income levels show much higher levels of consumption. It's

estimated that roughly 50% of the global emissions are coming from the consumption of the top 10% of the global population (Gore, 2020). Managing the overconsumption of resources of those in the higher income levels, requires changes in behavior and values, and poses political implications as it could put personal liberties into question depending on how it is handled.

The top 10% are also responsible for roughly 50% of the global emissions growth from 1990-2015, which means that the income disparity and emissions disparity has so far grown continuously. Poverty may have been reduced, but the top 10% has had a significantly greater benefit from any economic growth that happened in this period. Progress will require a decoupling of emissions from personal income and economic growth, but the top sectors of society will need to limit personal resource consumption to reach a state of sustainability. Alternatively, we could strive to provide a portion of humanity with a similar lifestyle to what those that are most privileged have today but could end up severely hurting or sacrificing the remaining portion of society, while also strictly limiting our reproduction long term. However, somewhere in the middle of these two extremes, lies the balance that we are trying to achieve. We cannot pretend that all humans will be perfectly altruistic, but we can assume that those who are today the largest emitters are able to find happiness with lower levels of consumption (Kasser, 2002).

## **CHAPTER 3: Responsible Design**

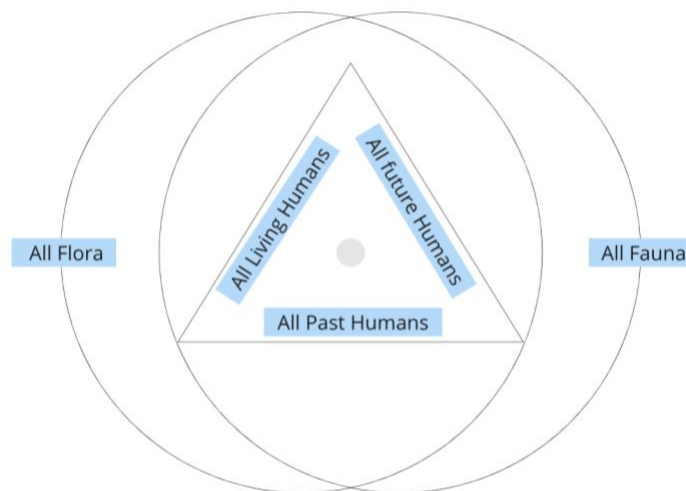
Responsible design (RD) is a methodology for concept development in the sustainability space. As such it is intended to take place before engineering and management, as a method to define the problem, scope and purpose of a project or venture (Figure 7). The name is an acknowledgement and reminder of a designer's responsibility to create sustainable solutions to the best of their ability and judgment. The method includes new design frameworks that provide a structure to help designers consider intergenerational equity throughout the design process. These frameworks are not meant to exclude already existing HCD or LCD frameworks, instead they are meant to complement them and build upon them to create a more comprehensive approach. RD is therefore an iteration of HCD, meant to unify and adapt previous design methods, based on the four sustainability themes explained in chapter 2.



*Figure 7: Process of Creation - Relationship between design, engineering, and management*

The design process should include prototyping and testing whenever possible, but it is primarily focused on the development of a vision and strategy, which in some cases will precede testing. It may be that the implementation of the solution requires skills that the designer themselves do not possess. This should not bias the solution toward a certain direction. Instead, designers should embrace the collaboration that sustainable solutions require, and learn about other subjects through primary and secondary research or invite other members to the team that can speak to a particular part of the problem. Ideal solutions will inevitably be interdisciplinary given the interconnected nature of sustainability problems, so a generalist perspective is necessary.

RD will inevitably require more research than other methodologies and a lot more effort from the designer's perspective as it integrates traditional design, business and engineering concepts and practices to ultimately serve society better long term. As our world becomes more complex, then our methods need to adapt to serve it as well.



*Figure 8: Innovation Sweet Spot for Responsible Design*

The innovation sweet spot for RD is significantly different to that of HCD and LCD. As shown in figure 4, instead of looking at viability, feasibility, and desirability as the three main factors to define success, RD considers success to be in the intersection of the interests of different stakeholder groups. These stakeholders are based on climate justice principles, derived from interspecies and intergenerational rights. All these different stakeholder groups have their own desires that must be accounted for. They will in many cases be in contradiction with each other, which is where designers can provide help in finding solutions that can manage the negotiation. We (humans) can certainly choose to live in a world where only presently living humans' matter and present bias guides our actions, but if sustainable development and a state of sustainability continue to be the global goal, then a framework for success that incorporates all the actors in the ecosystem is necessary. Training for designers should now empower them to be the voice for those that cannot speak for themselves but are still part of the conversation.

The success Venn Diagram shown in figure 4, splits humans into three categories. These being living humans, past humans, and future humans. Past humans are included in recognition of the effect that our ancestors have had on our environment and how our societies work today. Solutions developed with responsible design methods might apply retributive, rehabilitating or distributive justice frameworks to solve for the challenges that past humans may have imposed on select currently living and future populations. Future humans, although voiceless, are of imminent concern. Given our current carbon budget and the challenges we face in lowering our emissions per year at a global scale, it is possible that future generations will not have the same opportunities that currently living generations have. For that reason, it is important for designers to understand the limits that sustainability poses on each person and each company's footprint, and how these should be reflected in the solutions developed.

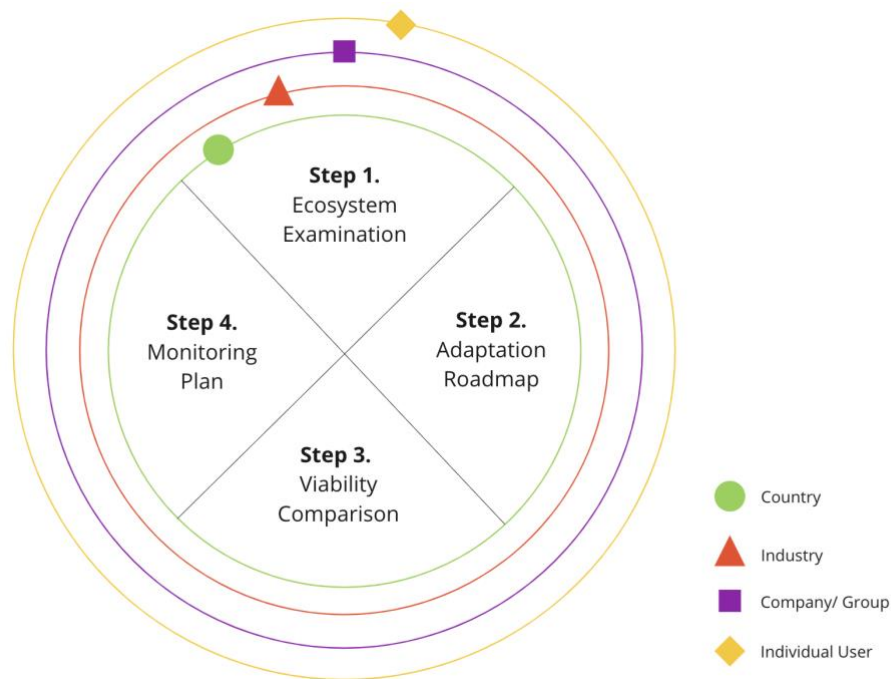
This method abides by the idea that sustainability is inherently anthropocentric because humans will not consciously sacrifice the species completely in favor of planetary sustainability. We may reduce our footprint, size, and impact, but the goal is not to disappear in favor of other species that have been more benevolent so their wellbeing may be ensured long term. The goal of the sustainability movement is to find a balance in which humanity is collectively able to live well in perpetuity even if we arguably don't completely deserve it. This means the goal is for the natural ecosystem to be in balance with our existence in perpetuity. Therefore, the Venn diagram for RD success includes flora and fauna as important stakeholders but does not give them the same importance as humans, as their intergenerational equity is not considered.

The new overarching stages and frameworks of the responsible design method are listed below. Within each stage, other supporting frameworks are listed. Some of these are existing frameworks of the traditional HCD method, while others are iterations. The overarching stages and new frameworks will be described in more detail in the following sections.

- Ecosystem Examination
  - Stakeholder Maps
  - Value Chains
  - Affinity Diagrams

- Data Coding
- Adaptation roadmap
  - Archetypes
  - Constructive Personas (Iteration on HCD Personas)
  - Speculative Journey Maps (Iteration on HCD Journey Maps)
- Viability Comparison
  - Holistic Viability Study (Iteration on DVF)
- KPI Monitoring Plan

The RD method consists of four consecutive steps. These steps are shown in Figure 5, and the progression through them is visually summarized. Each step is meant to be considered through a multi-scale and multi-dimensional lens. There are four scales that should be always considered, represented by the four concentric circles around the four stages.

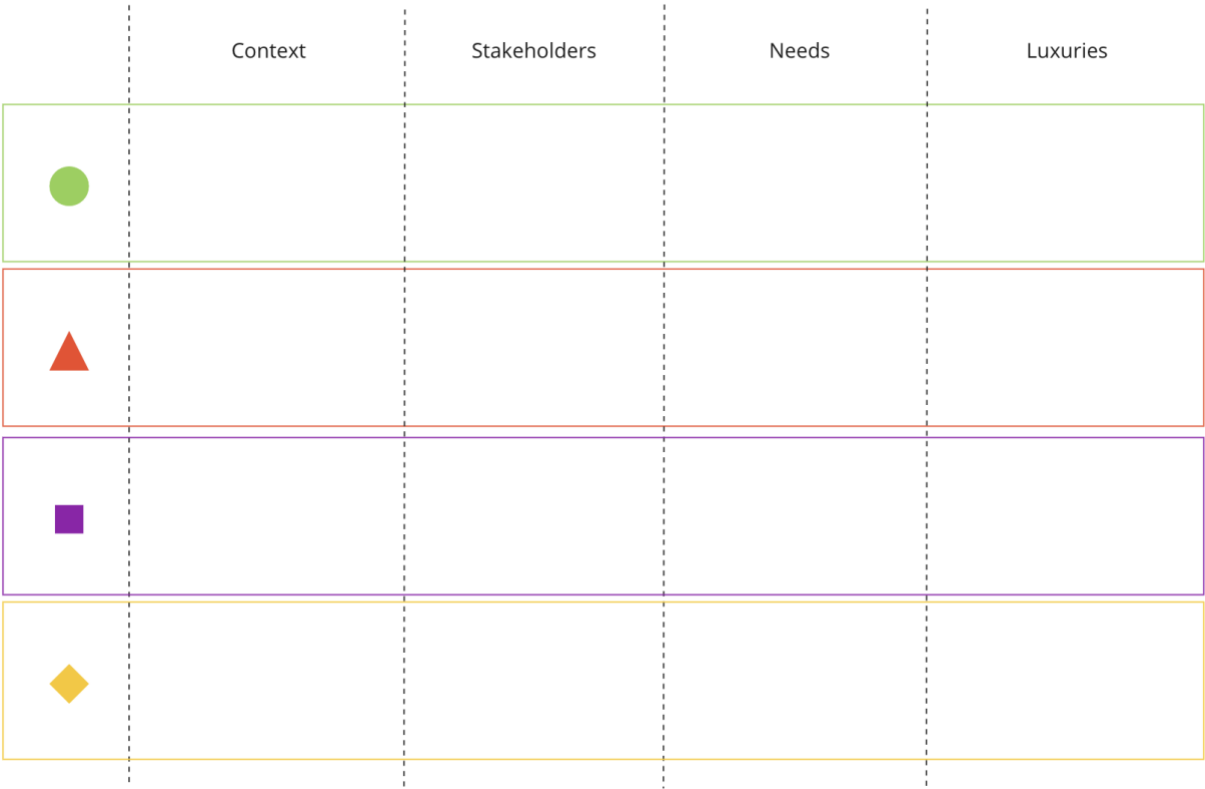


*Figure 9: The Responsible Design Method Summarized*

These four scales are global or country level, industry, company and individual or customer level. They help ensure the creation of solutions that are resilient and built for interconnectivity of systems, regardless of the final size of the product or intervention.

Furthermore, each scale is multidimensional, meaning it represents a collection of stakeholders and corresponding views, which will need to be considered. The goal is to design products and services that can function within systems that are congruent with sustainable futures, and to start building conditions for those systems to fully arise. Solutions are therefore flexible to have customer/user centric dimensions, if these are considered within the larger scope of the system. User centric solutions should be seen as incentives to reach an overarching goal. These will in many cases need to be dynamic to allow for behavior change, as will be explained in the following sections.

**3.1 Ecosystem Examination**



*Figure 10: Ecosystem Examination Summary Framework Template*

Given that sustainability is a problem that stems from the interconnectivity of systems and stakeholders, it can only be solved with equally interconnected solutions. The ecosystem examination recommended therefore considers a progression of scales and dimensions within them, ideally starting with a global perspective and progressively

moving towards individual people or consumers. In HCD, designers will normally start with the needs of an individual/user and look for commonalities in their expressed and latent needs, but this, as discussed previously, will frequently end up providing solutions based on present bias. Starting with a global perspective instead, reframes the problem into a collective, interconnected, multidimensional and long-term problem that requires looking into the needs of more stakeholder groups to be solved, given that sustainability is a global goal.

More information on what is meant to be included in each tab of the table can be found below.

- *Stakeholders*: List all the relevant stakeholders in the system that fall into each level. These are the decision makers across the value chain. They may not always be involved in every process being studied, but they are relevant to the ecosystem at hand. At this stage they do not need to be representative of the solution that will be proposed, even if a hypothesis has already been roughly identified. Instead, all stakeholders should be listed, because the process of design is iterative, and there is a high chance that it will be valuable to revisit the stakeholder list to help refine solutions as they evolve. Stakeholders that designers think may not be involved in the solution could end up being integral partners in making it happen.
- *Context*: List the most important insights about this stakeholder group that should be considered when developing a solution. This may include incentives, processes, opinions, or system failures that were identified during primary and secondary research.
- *Intrinsic Needs and Luxuries*: Making a distinction between needs and luxuries will force designers to gather data on how stakeholders understand the difference between the two and draw conclusions based on this as well, to understand the overall flexibility for behavior change within different stakeholder types. The distinction between intrinsic needs and luxuries is nuanced and will require significant research to be uncovered. Furthermore, solutions may be developed to solve for needs or for luxuries, depending on the stakeholder type. This is independent to the overall sustainability of the solution. The ecosystem



examination framework is a way of mapping the different leverage points in the system that could be used to achieve a particular goal in the adaptation roadmap. It may be that providing a solution for a luxury for one stakeholder type can incentivize the solution for a need in another stakeholder type, and if this is the case it's possible that the overall impact on the environment could be positive relative to the status quo. However, the distinction does give priority to intrinsic needs, if in fact that is a possibility, in the short term or long term. For more information on the difference between intrinsic needs and luxuries please refer to the Need Theory section in chapter 2.

This stage is similar to what HCD calls the empathy generation/ ethnographic research part, or what the scientific method deems as the observation stage. Although some practices/frameworks from these and other methods are still applicable in RD, they should always be applied through the multi-scale perspective. This framework is meant to serve as a summary of the key insights gathered and guide the work by highlighting the type of information that was comprehensively analyzed before moving onto other steps. The goal is to list the current behaviors, sub-systems, operations, and conditions that may lead to a particular problem(s). Existing frameworks that could be helpful at this stage include stakeholder maps, value chains, journey maps, process flows, business model landscape maps, and even environmental power mapping.

Example templates for journey mapping and persona development are shown in Figure 7 and Figure 8 respectively. These two HCD frameworks still apply to the process of ecosystem examination, but their application will be revised in the adaptation road mapping stage. Designers are encouraged to use these two frameworks in the ecosystem examination to facilitate the comparison between the status quo and the solution proposals. They will also help organize data gathered from primary research and uncover insights to include in the ecosystem examination summary framework.

**JOURNEY PHASES**

(pre-interaction, during interaction, post-interaction)

PERSONA PROFILE: \_\_\_\_\_


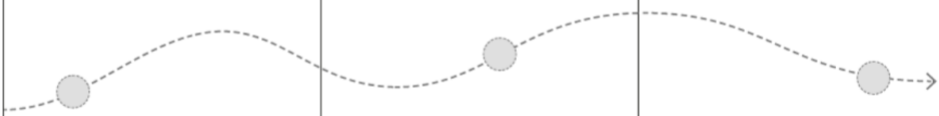
INTERACTION	PRE	DURING	POST
<b>KEY EVENTS AND TOUCHPOINTS</b>			
<b>ASSOCIATED SENTIMENT WITH NEW SOLUTION</b> 			
<b>KEY ISSUES OR OPPORTUNITIES</b>			

Figure 11: HCD Journey Map Template Example (Beausoleil p177, 2022)


<b>PROFILE IMAGE/SKETCH</b> 	<b>PROFILE NAME</b> _____ <b>PROFILE TYPE</b> _____
	<b>DEMOGRAPHICS</b> Occupation _____ Age _____ Location _____
<b>PERSONAL GOALS AND MOTIVATIONS</b> What are their goals, drivers or motivations?  	
<b>BEHAVIOURAL PROFILE</b> (traits and habits, lifestyle choices)  	
<b>NEEDS AND WANTS</b> (pains and gains relative to project)  	

Figure 12: HCD Persona Template Example (Beausoleil p171, 2022)

## 3.2 Adaptation Roadmap

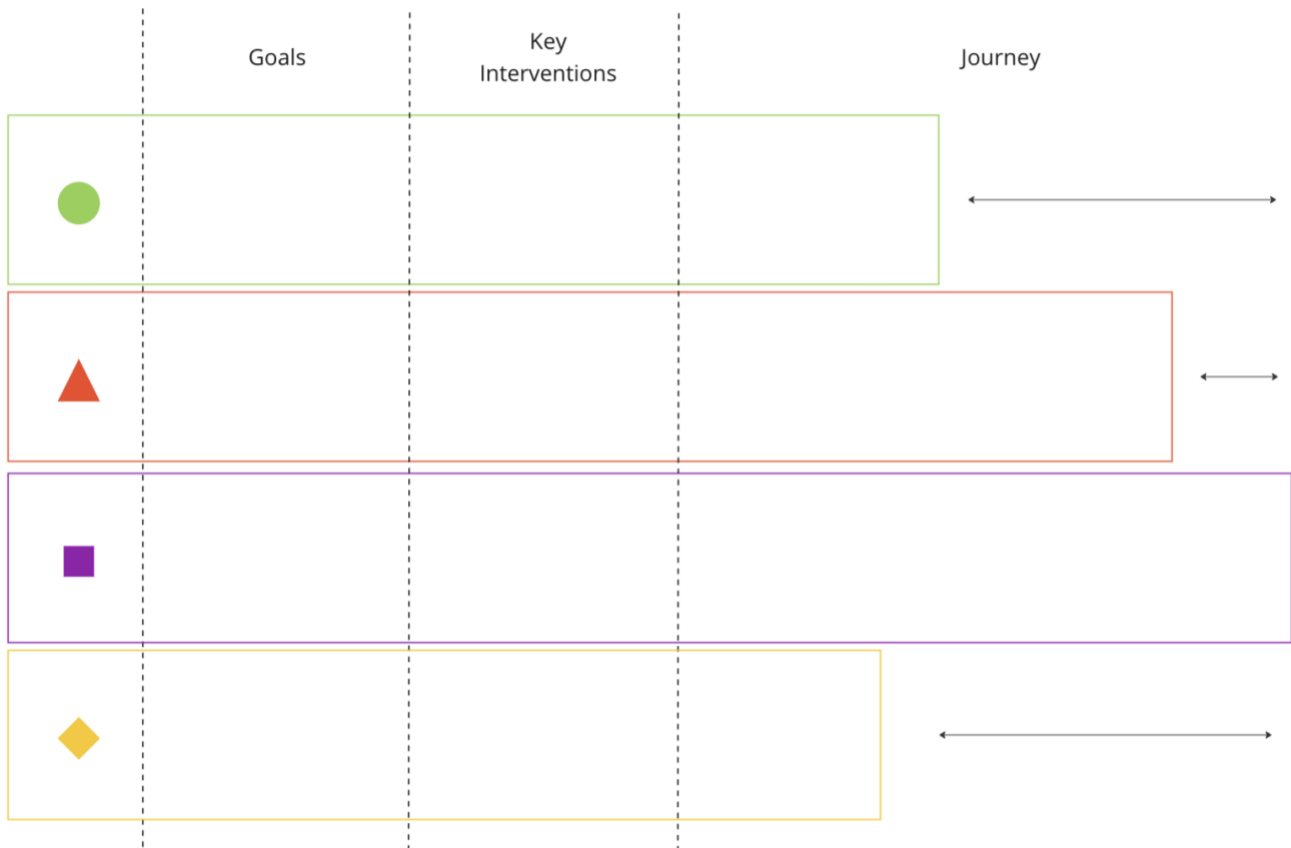


Figure 13: Adaptation Roadmap Summary Framework Template

The adaptation hypothesis is equivalent to when a doctor comes up with a treatment plan. The diagnosis has already been made; it might need to be revised later, but at this point the designer or design team has already taken the time to consider all the different potential causes to the symptoms at hand. This is the moment to come up with hypotheses of what the best way to treat the symptoms might be, and if possible, test the ideas with the different stakeholders to get their opinions on it.

It's possible one or more stakeholders will not be happy with the treatment plan, but that doesn't mean the strategy should change if it's the best course of action for the whole system. Designers should instead look for ways to make the treatment more agreeable and help their 'patients' adapt, for as long as the 'treatment' lasts. Furthermore, multiple adaptation roadmaps should be developed, in an iterative

fashion. This will help design teams keep a record of their progress and help with the refinement and comparison of solutions in later stages.

This stage is the most creative part of the design process, where solutions will emerge and be explored. Solutions should be explored with financial, environmental, and social sustainability in mind. The goal here is to define the desired behavior of each stakeholder for the system to behave optimally and map out the potential path and interventions necessary for each one, considering the starting point and potential end point.

Special emphasis on 'all stakeholders', as if we focus only on user stakeholders changing their behavior while supporting business models and infrastructure remain the same, then the solution will likely seem unfair to users and lack the adoption rates necessary. It might also reduce the potential positive impact of the solution. Solutions should guide stakeholders towards a desired outcome, at a pace that is realistic and maintains a certain level of challenge/arousal to keep them interested.

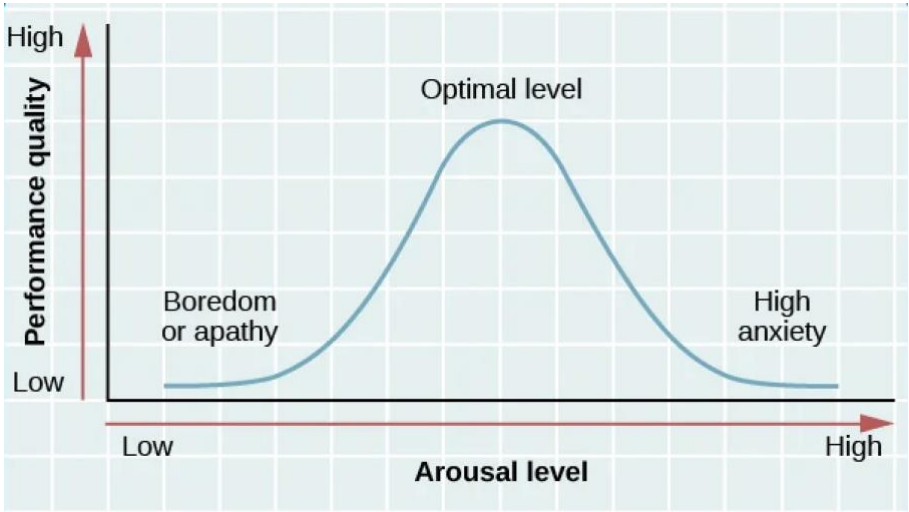


Figure 14: Yerkes Dodson Law of Arousal and Performance (Nickerson, 2023)

The Yerkes-Dodson law states that there is an empirical relationship between stress and performance and that there is an optimal level of stress corresponding to an optimal level of performance. Generally, practitioners present this relationship as an

inverted U-shaped curve (Nickerson, 2023) as you can see in Figure 10. Designers should keep this in mind as they develop journeys for different stakeholders, always with consideration of the health of the person or group in question. Stakeholders do not have to be in a constant optimal level of arousal to performance. Instead, designers should strategically intervene when necessary for the fulfillment of the overall goals set for the stakeholder type.

Behavior management goals will include strategies that improve, increase, decrease, or maintain a behavior. Stakeholder goals should not be confused with purpose, a term commonly and increasingly used in business model development, because the purpose of a multi-scale solution may not be the same as the goals for each scale level. For example, if the purpose of the solution is to make a particular company or organization carbon neutral, the goal for the company level would be reaching carbon neutrality by X year, but for other scope levels it might be different. Country level might be related to a policy being enacted, industry level could be related to collaboration across the industry in which the company exists or in related systems that will be essential for the company to reach its carbon neutrality goal. Finally, the individual user level, would likely be much more granular and specific to a particular type of behavior that different stakeholders in the company would need to display for the overall solution to function.

To understand what these goals are and how they will be managed, the first step is to develop constructive stakeholder profiles; an adaptation of the persona framework used in HCD. The focus of these profiles is on the current and desired behavior for each stakeholder, and the interventions that could be applied to help them reach such a state. The framework asks designers to identify the start point that a single stakeholder or stakeholder group has and the end point that the designer/design team hopes that the stakeholder will reach. The starting point should ideally be based on the personas or archetypes that were developed in the previous ecosystem examination process.

## User/Stakeholder Persona

<b>Name/Archetype</b> <b>Occupation, Location, Age</b>		
<u>Current relation to system:</u>	<b>Interventions:</b>	<u>Desired relation to system:</u>
<u>Current preferences &amp; behaviors:</u>		<u>Ideal future preferences &amp; behaviors:</u>
<u>Current Pain Points:</u>		<u>Catered Solutions:</u>

Figure 15: Constructive Persona Framework Template

Constructive stakeholder profiles help designers begin to create alternative futures. HCD normally tries to minimize behavior change, to make things easy for end users, but as has been discussed previously, this might not be in the benefit of the end users or other stakeholders in the system after all, which is why building constructive stakeholder profiles is a necessary exercise. It may be that in some cases the behavior can remain the same but given the amount of changes our society needs to reach carbon neutrality the likelihood of that being the case for all stakeholders is low and might reflect a need for the designer/design team to delve deeper into the roots of the problem.

Imagining alternative futures and the behaviors that might be needed to make them function is a practice integral to speculative design and science fiction. Speculative design, although not specific to sustainable futures, involves using design methods and techniques to provoke thought and discussion about the social, cultural, and

technological implications of emerging trends and technologies. This method is often used for social commentary, or to challenge assumptions and question established norms and values. By imagining provocative and engaging scenarios, designers can start to think about the implications of emerging technologies and trends and build solutions that lead us to preferable futures instead of other dystopian futures.

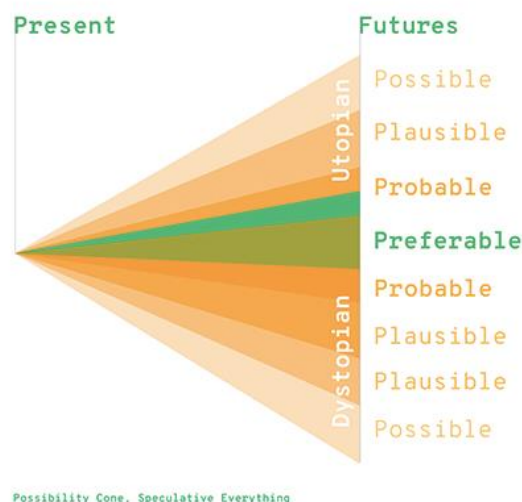


Figure 16: Possibility Cone (Dunne & Raby, 2013)

Developing sustainable futures requires designers to think through the possible, plausible, probable, and preferable futures that are potentially in front of us. This process is similar to worldbuilding, and commonly used technique by science fiction writers and sci-fi prototypers. Worldbuilding is “the creation of imaginary worlds with coherent geographic, social, cultural, and other features” (Zaidi, 2019).

Structuring a story background of near future—twenty, thirty, or forty years from now—is in some way more difficult than creating an entire alien planet in some impossibly distant age, for the near-future background cannot be wholly a product of the imagination. The writer must conduct extensive research to discover what engineers and scientists project for every aspect of future life. From that data, the author then extrapolates a possible world of tomorrow, one which might

logically rise out of the base of the future which we are building today.  
(Johnson p27, 2011)

The goal of the adaptation roadmap is ultimately to have designers go through the foresight exercises necessary to determine the preferable journey maps for all the different stakeholders in the system. In addition, the interventions listed in the constructive stakeholder profiles should reflect the selected interventions explored further through speculative journey mapping. The roadmap should summarize the hypothesized preferable future for each stakeholder group. However, this should not stop designers from speculating about different possible futures. This speculation, whether captured through journey maps or not, will help designers be more creative and build resilient and flexible systems. This can be more time consuming than the status quo of performing only preferable journey maps to understand our intended solution adoption but rebound effects must be considered early in the design process to develop countermeasures and minimize the likelihood of negative unintended consequences on the environment and our society.

“Designers should not define futures for everyone else but working with experts, including ethicists, political scientists, economists and so on, generate futures that act as catalysts for public debate and discussion about the kind of futures people really want.” (Dunne and Raby p6, 2013)

Designers are not alone in this process and should not work in silo. Ethnographic primary research and secondary research should still inform the decisions that design teams take, with the acknowledgement of those stakeholders that do not have a voice and that design teams must advocate for, including future generations, flora, and fauna entities. Designers are responsible for guiding the negotiation, proposing solutions, and ultimately recommending the best course of action, but their decisions should always be informed by others. Depending on the complexity of the problem, design teams might also choose to appoint certain people in the team or invite others to become the advocates for groups, to reduce bias.



Devils' advocates used to function in a similar fashion for the catholic church. The devil's advocate was appointed by the Pope to challenge the evidence in support of the nominee for canonization, and to present counterarguments, with the goal of ensuring that only those individuals who were truly deserving of sainthood were canonized (Brinkhof, 2022). Today, this type of position may be conducted by consultants or advisors in business, law, politics, and academia. They may be individuals who have earned a reputation as independent thinkers and are sought out for their expertise and perspective about a particular subject.

Devising solutions through a multi-scale approach can increase the time spent in the analysis and solution development design phases, however this process should increase the financial viability of businesses and products long term, which will inevitably become a pressure for design teams. Studies have shown that business with a clearly articulated purpose can increase customer loyalty and financial growth. (EY, 2020). The adaptation roadmap process will help designers not only clearly articulate the purpose of a company or product, but also deliver on it and gain trust from their employees and end customers.

The roadmap will also help determine the type of partnerships and non-market strategies<sup>5</sup> that companies should implement. It may be that some of the interventions listed on the adaptation roadmap must be done by another entity. If so, designers can label these differently. These insights will allow other teams to organize around the goal that designers have outlined and give them a purpose to do so. However, before making any official recommendations, designers/design teams must study the integrated viability of each solution and compare it against the status quo state as well as any alternative solutions that may be relevant.

---

<sup>5</sup> Non-Market Strategies are approaches that businesses and organizations use to influence outcomes in areas outside of their direct economic transactions. These may involve actions taken to shape policies, regulations, and public opinion. Through non-market strategies, business can influence the broader social, political, and environmental context in which they operate and improve their competitive position in the marketplace.

### 3.3 Integrated Viability Comparison

	Status Quo Option				Alternative Option				Solution X				Solution Y			
Marginal Carbon Emissions (5 points)																
Marginal Profit (1 Point)																
Enterprise Level SDG Performance  (+1/2 point per SDG) ● Positive Impact ★ Negative Impact	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
	5	6	7	8	5	6	7	8	5	6	7	8	5	6	7	8
	9	10	11	12	9	10	11	12	9	10	11	12	9	10	11	12
	13	14	15	16	13	14	15	16	13	14	15	16	13	14	15	16
Total Points																
Rank & Notes																

Figure 17: Integrated Viability Summary Framework Template

Table 2: List of Sustainable Development Goals

SDGs	
1	No Poverty
2	Zero Hunger
3	Good Health & Wellbeing
4	Quality Education
5	Gender Equality
6	Clean Water & Sanitation
7	Affordable & Clean Energy
8	Decent work & Economic Growth
9	Industry Innovation & Infrastructure
10	Reduced Inequalities
11	Sustainable Cities & Communities
12	Responsible Consumption & Production
13	Climate Action
14	Life Below Water
15	Life on Land
16	Peace Justice & Strong Institutions

Interventions and product launches could fail or could have unintended consequences. Even if their intention is to solve an existing problem, it's very possible that a new one

could be created. To try to minimize the risk of unintended consequences and come up with a plan for how to address them, solutions should be further analyzed and scrutinized considering ecological, social, and financial metrics.

The viability of a solution is thus no longer defined by its performance on the desirability, feasibility, and viability framework (Figure 1), as it is usually done in HCD. Instead, RD approaches it in an integrated fashion, acknowledging that environmental and social impact are part of an intervention's viability, now and in the future. The framework in Figure 17 helps designers compare different potential solutions in a qualitative and quantitative fashion by measuring marginal carbon emissions, marginal profit, and in general terms the performance of a product or company on the SDGs.

Solutions should be compared using these three metrics against the status quo solution and against each other, to start a discussion on what the best-case scenario in planetary terms would be. Designers will need to find an equivalent scenario between solutions and make some assumptions for each one to calculate carbon emissions. They might also need to work with rough estimations for each of these metrics, which should be sufficient if more detailed analysis is performed later to prove or disprove the assumptions. The true effect on the factors included in the SDGs list will be hard to measure, without the solution being implemented and monitored. Therefore, this framework is not intended to provide a granular and perfect measurement of the carbon footprint or social impact of a solution, but in broad strokes it should orient designers toward the most viable option. The true impact of a solution will only be known after implementation, which is why a monitoring plan, stage 4 of the RD method, is necessary, in case countermeasures need to be applied.

Social and environmental factors will frequently end up competing against each other, and designers may decide to move forward with a solution because it has a positive social impact in the present that seems urgent, even if its carbon emissions are not favorable. The carbon emissions will seem reasonable and fair, even in consideration of future generations. An example would be providing shelter for refugees. This is why need theory is so important, and why the difference between needs and luxuries should always be discussed during the design process. Providing basic needs to people today, even if it means increased carbon emissions is ethically reasonable, because otherwise

we would be giving an unfair advantage to future and past generations but sacrificing current human wellbeing. Although designers should still try to provide the lowest carbon solution, the urgency is on lowering emissions from luxuries not basic needs.

Marginal carbon emissions will depend on carbon accounting. Designers should be trained in the basics of carbon accounting or rely on trusted partners to help determine the additional carbon emissions created by each solution. To do this, a single unit of measurement, be it a product or transaction must be selected, and a life cycle assessment (LCA) must be done to calculate the number of emissions it would produce based on the current or hypothetical practices of the business.

The marginal carbon emissions in the viability comparison framework are heavily weighted to give priority to intergenerational equity and remind designers that even if stakeholders have a problem today that needs to be solved, that does not allow designers to provide a solution that could hurt the environment. However, as mentioned, this depends on the type of problem faced, and how critical it is to solve in the present. The weight on carbon emissions is an invitation to return to the drawing board and find ways to still solve the current problem with a lower impact on the environment, if in fact the problem is valid.

Lowering carbon emissions is the only way we can ensure equity across generations, as it allows other generations the opportunity to live in a healthy environment, regardless of the technology or social norms of the time. It is the only factor we can control today that may have an effect long term. Designers may use the DFV framework to help determine financial viability and marginal profit if helpful, but it will not provide the holistic assessment necessary for a sustainable solution. Keeping this in mind is important, although it could still help designers assess user centric solutions within a more complex system that considers sustainability. User centric design is a powerful tool that can provide just as much value in sustainable development as it does for economic growth. Designers just need to know when and where to apply it.

PROTOTYPE TITLE		CONCEPT 1		CONCEPT 2		CONCEPT 3	
<b>DESIRABILITY</b> Is it needed or wanted?	CUSTOMER =	Yes	No	Yes	No	Yes	No
	COMPANY =	Yes	No	Yes	No	Yes	No
<b>FEASIBILITY</b> Can the company develop and deliver it?	CAPABILITIES =	Yes	No	Yes	No	Yes	No
	INFRASTRUCTURE =	Yes	No	Yes	No	Yes	No
	WILLINGNESS =	Yes	No	Yes	No	Yes	No
<b>VISIBILITY</b> Will it create value and generate revenues and/or impact?	COST/INVESTMENT =	Yes	No	Yes	No	Yes	No
	PROFIT/IMPACT =	Yes	No	Yes	No	Yes	No
	STRATEGIC FIT =	Yes	No	Yes	No	Yes	No
<b>RANK</b> How does it rank?		# _____		# _____		# _____	

Figure 18: HCD Three Traits Solution Comparison Framework, DFV (Beausoleil p185, 2022)

Marginal profit is a quantitative metric representative of the amount of additional income earned by a business or individual by producing or selling one more unit of a product or service. It is the difference between the revenue generated by an additional unit and the incremental cost of producing or selling that unit. Although this is not related to the environmental or social impact of a company, it is still important. A venture or product that is financially sustainable will be able to maximize its impact. In the case of Non-profits or NGO's, designers could consider the potential funding they would be able to raise based on solutions as a way of assessing the financial viability of each one.

Other KPIs related to environmental and social impact will be addressed by assessing the performance of a solution in relation to the SDGs developed by the UN. There are currently 17 SDGs that have been globally agreed upon. These are split between social and environmental impact measures, and in some cases include metrics that would fall into both categories. The framework gives designers a space to annotate potential positive or negative impact on any of the 16 goals (partnership around the goals is excluded). It does not provide a quantitative measure for each one, but designers could study these further if the difference between solutions depends on it.

Doing a detailed carbon emissions study for each solution might not be what every company wants. Not all corporations will be comfortable with such a process. This will be determined by their values and goals for the future. Responsible designers will likely not work in corporations that do not value environmental or social impact. If so, they will probably be trying to internally change how these corporations' function and what they value. However, it must be recognized that when designers are providing a service to other companies there may be push back on the amount of time and resources needed for analysis performed with RD methods. Thus, the best corporations to aim to partner with will be B-Corporations, NGOs or Governmental entities, who already value impact as part of their bottom line and will benefit from the additional structure and vision.

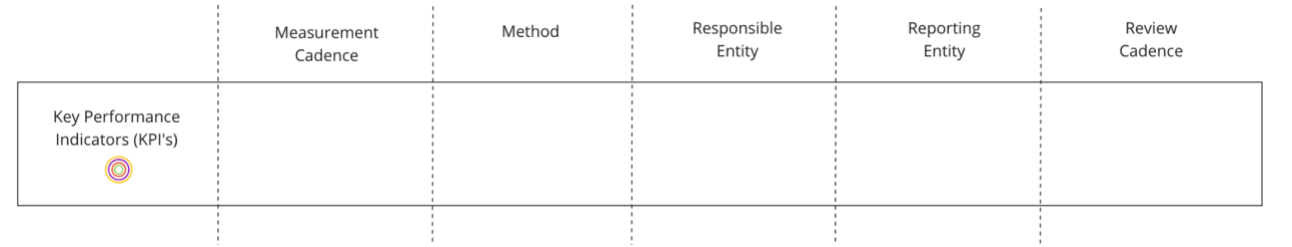
B-Corps are business that have committed to meeting rigorous social and environmental standards set by the nonprofit organization B Lab. As part of their commitment to sustainability, B Corps often track a range of environmental impact KPIs.

B Corp Certification is a designation that a business is meeting high standards of verified performance, accountability, and transparency on factors from employee benefits and charitable giving to supply chain practices and input materials. To achieve certification, a company must:

- Demonstrate high social and environmental performance by achieving a B Impact Assessment score of 80 or above and passing our risk review. Multinational corporations must also meet baseline requirement standards.
- Make a legal commitment by changing their corporate governance structure to be accountable to all stakeholders, not just shareholders, and achieve benefit corporation status if available in their jurisdiction.
- Exhibit transparency by allowing information about their performance measured against B Lab's standards to be publicly available on their B Corp profile on B Lab's website. (B Corp, 2023)

C-Corporations may still be interested in this process, but clear explanation of the process is advisable before a partnership of any kind. Otherwise, even if they are not good candidates as clients for design or innovation studios focused on using RD or similar methods, they are not outside of the scope of the transformational impact responsible designers can have. They may be stakeholders in the systems that designers develop and might need incentives to transition into new ways of thinking and behaving. This highlights the fact that shareholders are a particular type of stakeholder that designers should always be mindful of. In the case of B-corps and NGOs, shareholders will likely be aligned with the need for positive environmental and social impact, but in the case of C-Corps they might not. This will be a challenge for designers, like any other type of behavior change. It should be addressed from a systemic perspective and strategically managed to help companies and their shareholders transition towards more sustainable futures.

**3.4 Monitoring Plan**



*Figure 19: Performance Monitoring Framework*

Designers don't have to oversee the implementation and monitoring of their proposed solutions. The solutions will likely be shared with clients or with other stakeholders in their organization for further study and implementation. In some cases, designers will be part of other teams in engineering or management and will be able to continue working on the solutions proposed, but this is not always the case and is not required. The presentation and transition of the solutions from idea to implementation should be treated carefully, and ideally with all the information necessary to maintain the desired impact identified by the design team.

Designers should in some way remain informed about the performance of their solutions as they are implemented in case there is a need for a re-design and alteration to the strategy. The best way to do this is to determine the main KPIs to keep track of before there is a handoff for implementation. This may include a pilot for customer testing or a full launch of the product or company.

The main KPIs should reflect the metrics used in the integrated viability assessment and any other further studies done on the potential solutions. Designers should have a plan for how often these will be measured, how they will be measured, who will be keeping track of the information and who the information should be reported to for a periodical review. This will force designers to think about the organization structure that will be needed to keep each solution on a path to success and allow for the minimization of unintended consequences.

Some examples of KPIs include:

*Social impact KPIs:* jobs created, people served, women or underrepresented groups in leadership positions, employee satisfaction, volunteer hours,

*Environmental Impact KPIs:* carbon emissions per transaction, carbon emissions per product, water usage, waste production, % renewal energy, total energy consumption.

*Financial KPIs:* revenue, profit margin, return on investment, cash flow.

*Customer KPIs:* customer retention rate, customer lifetime value

*Operational KPIs:* production cycle time, inventory turnover, employee productivity

*Sales and Marketing KPIs:* conversion rate, customer acquisition cost, website traffic

*Employee KPIs:* turnover rate, absenteeism rate, training hours per employee.



## **CHAPTER 4: Case Study - Furniture Industry**

To test the frameworks and provide an example of the responsible design process, the following sections will show how the method could be applied to design a new venture. The goal of this new venture being to help make the furniture industry more sustainable in the USA and globally. The RD process will therefore focus on finding the most impactful solution to transition the furniture industry towards carbon neutrality and overall sustainability.

### **4.1 Ecosystem Examination:**

#### 4.1.1 Context on the problem selection

The United States is the biggest furniture market in the world, with Americans spending 253B dollars on furniture per year<sup>6</sup>. This includes residential and commercial consumption. The market is expected to continue growing, and yet at the same time, the industry struggles with a waste problem. In the United States alone, there is over 10M metric tons of furniture waste sent to landfill every year, and the provenance of the waste is unknown.<sup>7</sup> In comparison, the automotive industry, produces 5M tons of waste that is landfill bound<sup>8</sup> These two industries function very differently, and have been subject to different levels of public scrutiny as well. The furniture industry does not get a lot of media attention, although its footprint may in fact be quite significant at a global level. The USA does not have any enforceable Extended Producer Responsibility Policies (EPRs) that apply to this industry either, giving businesses a lot of flexibility to continue business as usual. (Beyondly, 023)

---

<sup>6</sup> (Statista, 2023)

<sup>7</sup> (RTS, 2020)

<sup>8</sup> (US EPA, 2022)






	Context	Stakeholders	Needs	Luxuries
 <b>USA</b>	Largest Economy - Great Irresponsible Category - Need to reduce emissions across all industries ASAP	Federal Government Policy Makers Media channels	Maintain HDI Levels Maintain GDP Levels <b>Reduce GHG Emissions</b>	Grow Economy Privacy Laws Improve National Waste Management
 <b>Furniture Industry</b>	Globalized production, & cost competition leading to cheap construction and consumerism ( <b>fast furniture</b> ) <b>No communication channels across product lifecycle</b> <b>Increasing greenwashing</b> <b>12M tons of waste going to landfill/year in USA</b> <b>No measurement of overall industry emissions</b> <b>No EPR requirements</b>	Production: Furniture Brands Furniture Manufacturers Material Marketplaces Material Processors Distribution: Cargo Shipping Co. Warehousing Co. Last Mile Co. Use: Residential Customers Contract Customers Interior Designers Developers Procurement End of life: Resellers Liquidators Waste Collectors Waste Sorters Waste Processors Landfills Material Marketplaces	<b>Maintain Revenue Levels</b> <b>Maintain Jobs</b>	Increase local production <b>Measure overall emissions</b> <b>Reduce material consumption</b> <b>Reduce energy use</b> <b>Increase material recovery</b> <b>Increase access to recycled material</b>
 <b>Furniture Brands</b>	Product Launches 2/year Holding inventory Omnichannel Sales Brick and Mortar Marketplaces Online direct High markups or volume based Royalties for outsourced designers Style based competition Increasing resellers/ liquidators EPRs only for public companies (Majority of companies are privately owned) De-centralized Production	Management Finance & Accounting Marketing R&D Logistics & Operations Retailers & Partners Warehousing Factory workers & Managers Procurement Contractors: Design Studios	<b>Lower Costs</b> <b>Product Differentiation</b> <b>Brand Differentiation</b> <b>Increase Sales &amp; Revenue</b>	Increase material recovery Increase recycled material use Lower emissions <b>Measure Impact</b>
 <b>Furniture Customers</b>	Residential : Frequent moving/nomadic Moving items is a hassle Renters prefer low price due to uncertainty/instability Home owners < price sensitive. Contract: Remodel every 5-10 yrs Buy in bulk/ large orders Use Interior Designers	Furniture Users Residential Shoppers Interior Designers Office Space Renters Office Space Owners Hospitality renters/owners	<b>Functional:</b> <b>Easy to carry</b> <b>Easy to find</b> <b>Reasonable price</b> <b>Safe/Comfortable</b> 	Functional: Easy to get rid off/resell Durable construction Flexible ownership <b>Emotional:</b> <b>Memorable story</b> <b>Reflects Identity</b> <b>Sustainable</b> <b>Durable style/hierloom</b>

Figure 20: Ecosystem Examination - Sustainability of Furniture Industry in USA

#### 4.1.2 Country Level - USA

##### Environmental power of USA

The USA is the country with the most environmental power in the world today (see Figure 4), which requires all industries to lower their emissions in the coming years, if not immediately. This confirms the urgency to reduce emissions and waste in the furniture industry. Although the solution should be focused on furniture, an opportunity to expand into other retail industries would be ideal as well.

##### Technological developments & Worldbuilding

A round of stakeholder interviews was conducted with the goal of understanding what the word sustainability, outside of its relation to the furniture industry, means to different types of stakeholders, and how they project the concept into the future. 15 people from a variety of backgrounds, including philosophy, entrepreneurship, science fiction, sustainability in academia, waste management, mechanical engineering, economics, & materials engineering were interviewed on the subject.

The data from the interviews was analyzed through affinity diagramming. The common themes found were translated into a set of adjectives to describe the future that people envision (Figure 21). The way people described their ideal future was also used to map out different technologies that could become widespread (Figure 22). The overall sentiment from the people interviewed entailed a strong desire to have a better and more sustainable future, combined with a sense of doom that it will likely not happen. The set of adjectives used to describe the ideal future included: smart, interconnected, customer centric, transparent, progress driven, equitable, efficient, enjoyable, and mindful. Technological developments mentioned in the interview data and collected through secondary research included: robotic material sorting, biodegradable materials for packaging, renewable energy solutions, artificial intelligence, machine learning, virtual reality and 3D printing.



Figure 21: Affinity Diagram Interview Data Round 1



Figure 22: Partial Technology Pallet - Worldbuilding Example

### 4.1.3 Industry Level

#### Considerations in carbon neutrality transition

Secondary and Primary Research show that in most cases, furniture is not accepted for recycling in the USA, which is mainly due to the type of materials that are used and how difficult the items can be to disassemble. Companies are required to pay tipping fees per item or KG for waste to be accepted by recycling facilities. These fees dissuade companies from taking responsibility for the objects their customers discard.

Although furniture can be designed and built to last long periods of time, fast furniture business models and products have increasingly become popular in the last decades. Fast furniture practices encourage overconsumption and exacerbate waste management challenges. Second-hand marketplaces offer an opportunity to reduce waste by maintaining products in use, but although the sector is growing it still only represents ~4% of the total American furniture market. (Verified Market Research, 2021) Additionally, consumers desire sustainable futures but lack awareness of the impact products have on the environment, making them easily susceptible to greenwashing, a practice that is also increasingly common in the industry.

Most of the embedded carbon emissions of a furniture product happen during material extraction, production, and shipping, not during the use phase, as might be the case with electronics, due to electricity consumption. Although this makes the carbon accounting relatively simpler than for other product typologies, the furniture industry today is a globally decentralized and fragmented system, with very little communication amongst its stakeholders. Production and logistics include multiples stakeholders and without adequate data sharing and transparency between them there is no way to measure the total emissions of the industry.

Businesses could take on the responsibility to change the way they produce and distribute products, but this requires investment and poses a risk of losing market share due to consumer price sensitivity, making it a hard decision for most companies/brands.

## Stakeholders

The main stakeholders of the industry can be categorized based on three product lifecycle phases - production, use, and end of life or disposal (see Figure 23). The data to develop the stakeholder map was taken from primary and secondary research conducted, including stakeholder interviews of furniture users, furniture brands, interior designers, logistics and distribution companies, residential and commercial customers, resellers, and material marketplaces. The relationships between stakeholders were then analyzed using a value chain framework to visualize the type of transactions stakeholders perform with each other and understand the variety of relationships they may have with others in the system (Figure 24).

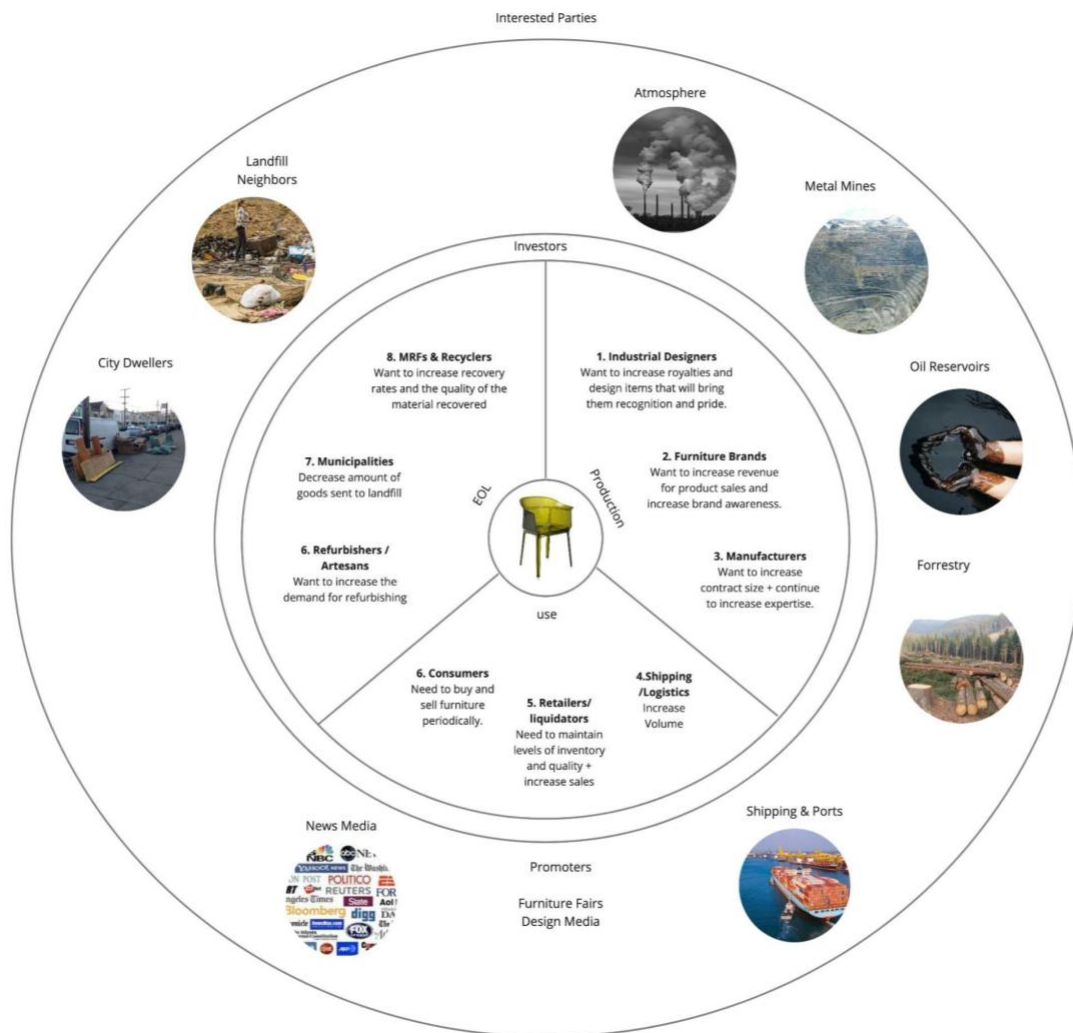


Figure 23: Furniture Industry Stakeholder Map

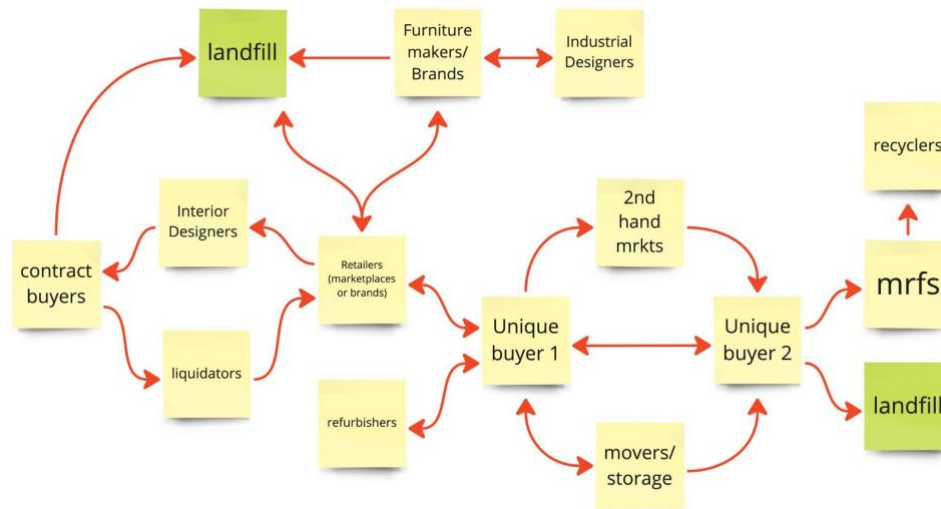


Figure 24: Furniture Industry Value Chain

#### Stakeholder relationships:

- Industrial designers will develop product designs for brands as either in house designers, contractors, or partners with a licensing agreement.
- Furniture brands will in some cases be retailers themselves, but others may use retailing partners such as furniture marketplaces to sell their items. These furniture brands in some cases are vertically integrated and do the manufacturing themselves, although in most cases the production is decentralized and outsourced. Waste from production is normally sent to landfill.
- Interior designers will usually work in either the high end residential or contract sector and will be the decision makers of what items are purchased. They will be in direct contact with retailers and generally receive a commission on the sales they refer as well as discounts with select brands.
- Apart from interior designers, there are two types of buyers, contract, and residential individual buyers. Both are split amongst different income levels as well. Buyers will eventually need to resell or discard their items. If they discard them - the items go to landfill. If they decide to resell or donate, then these items are given to liquidators or secondhand marketplaces. Otherwise, people will

directly sell or share items with people they know and might potentially use movers to pick up and deliver the items.

- Secondhand marketplaces can function on a peer-to-peer basis or they can include delivery.
- When items are no longer desirable, owners will usually discard them on the curb. These items will be picked up by the city and taken to landfill. In some rare cases these will be taken to recyclers.

#### 4.1.4 Company Level

There are 4 main types of furniture sellers, these include furniture brands, furniture marketplaces, second-hand furniture marketplaces and furniture owners. There is a variety of companies in each category, excluding furniture owners. Furniture owners include collectors and commercial owners, who could do a direct sale in cash, but in most cases depend on other companies to facilitate and host the asset transaction. The other three categories include companies with a variety of business model types, servicing different parts of the furniture lifecycle. A business model map was developed to compare company types and identify service gaps or system leverage points (Figure 25). Select companies were then further analyzed based on their customer journeys and services. (Figure 26)

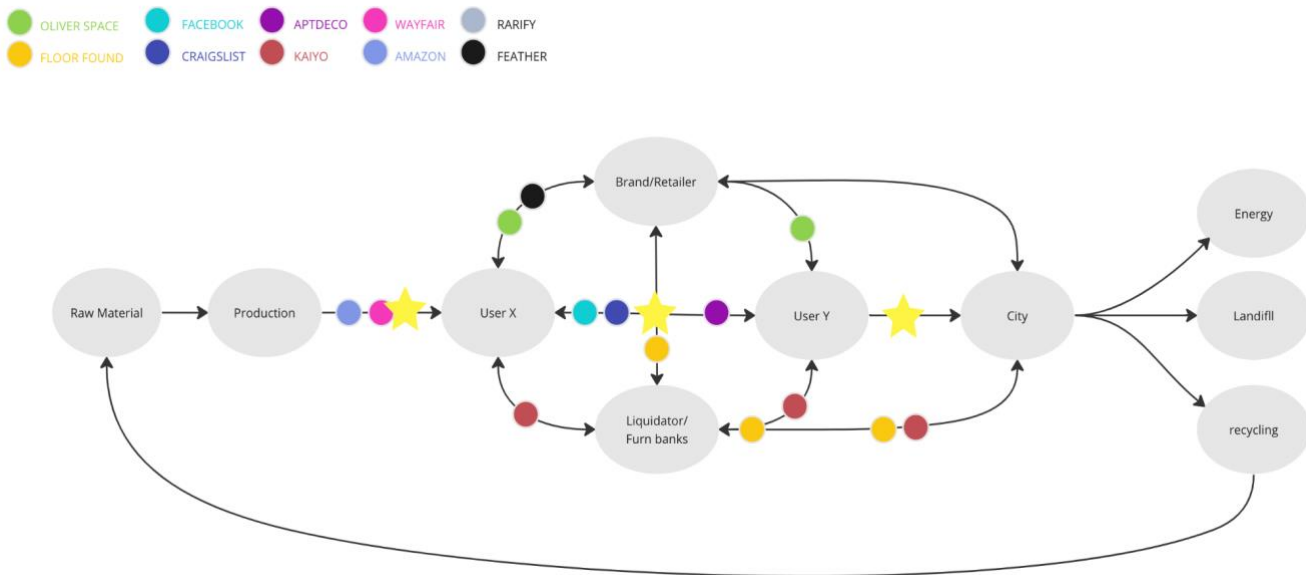


Figure 25: Furniture Industry Business Model Mapping



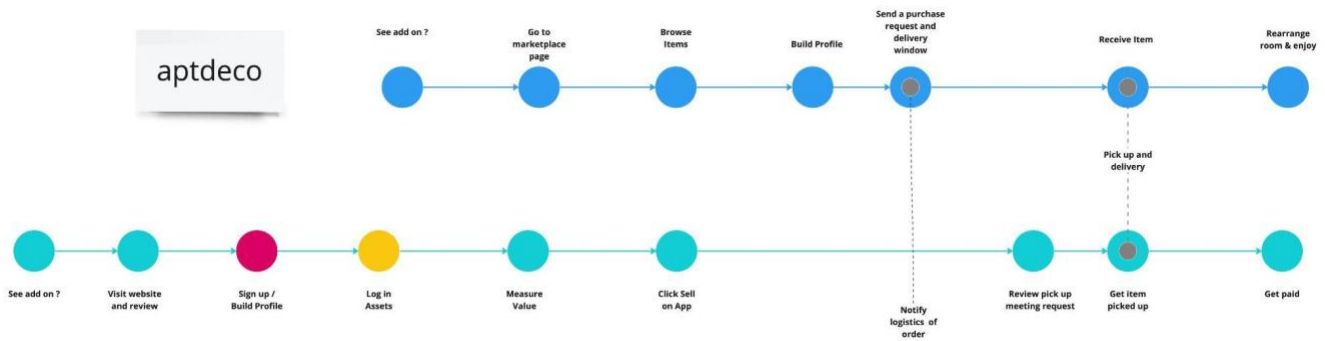


Figure 26: Consumer Journey Map – Example

#### 4.1.5 End Users Level

Multiple studies have shown that consumers around the world want sustainable product options. These include a study done by McKinsey in 2020, that stated 66% of American consumers and 75% of millennial consumers make purchasing decisions based on sustainability claims (McKinsey, 2023), and a 2021 study from Kantar showing that 62% of consumers in the European Union are swayed by sustainability claims, and that 22% of them could be considered eco-active (Kantar, 2021). A term used to describe a consumer that is actively searching for the most sustainable product when shopping within a category. Since then, a possible decline in eco-actives has also been identified by Kantar, as eco-actives moved from 22% to 18% in the last year. (Kantar, 2022)

#### Customer Needs

A second round of interviews was conducted with furniture consumers, focusing on their shopping journeys and preferences. The data was once again organized through iterative affinity diagrams, categorizing quotes or sentiments shared during the interviews by type. The insights gathered were then also grouped by type to develop a set of solution needs from the customer point of view. (Figure 28). These included easy moving or selling of items, access to inspiration for interior decor, product durability, reasonable price to footprint ratio and waste management.

These needs were then assessed on their relative urgency and intrinsic value to customers, to determine which may be luxuries or wants instead of needs from the customers perspective. The ecosystem examination summary organizes these into buckets and highlights that sustainability in this case is ultimately still regarded as a luxury. Therefore, one of the main challenges for the solution is to switch sustainability into the real intrinsic needs bucket, given that at a global scale it is regarded as such. Although consumers consider sustainability in other industries, when it comes to furniture it is not top of mind.

### Current Journey Mapping

Primary and Secondary data throughout the ecosystem examination process was used to develop a complete user journey map for the shopping experience (Figure 29). It includes the option consumers have in terms of point of sale and company type, and how their experience would be different with each one. Emotions and insights were not included as the main purpose was to understand the actions themselves and not the customer reaction for this analysis. This journey map, together with previous diagrams, sets the stage for the development of potential solutions.

### Archetypes

Different customer types and customer preferences were identified based on the two rounds of interviews conducted. These are reflected in the consumer archetypes developed and shown in Figure 30 below. The archetypes are based on 3 main decision points that explain customer preferences. People will fall within a spectrum between different archetypes and will be a combination of their result on each of these spectrums.

The spectrums are roughly defined on a person's answer to the following questions:

1. How attached does the person feel to their belongings?
2. How willing is the person to invest time into decorating and shopping?
3. How important is sustainability to them and who do they think is responsible?



Figure 27: Insights from End Consumer Interview Data

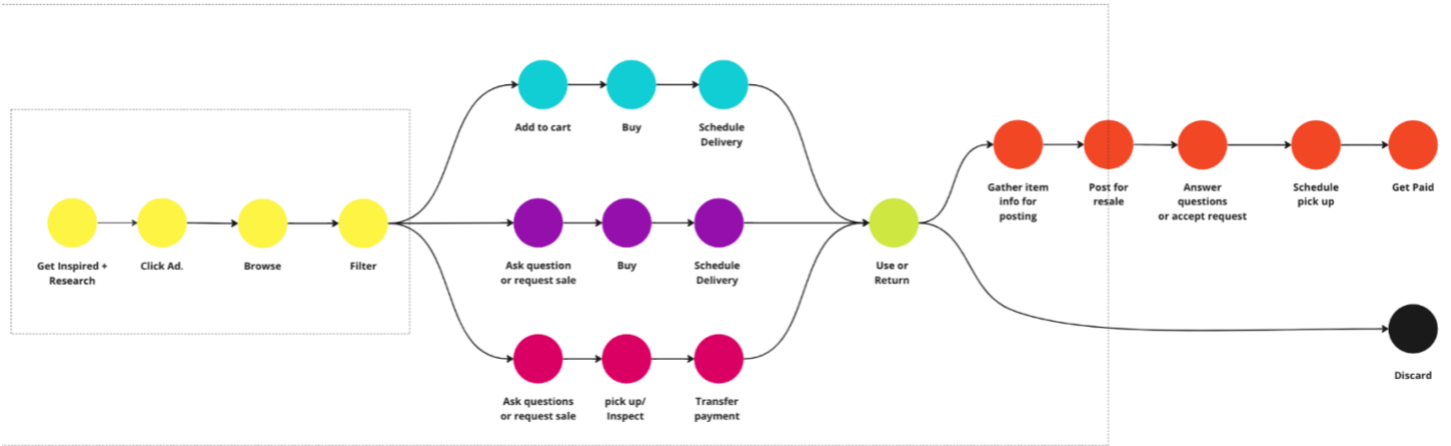


Figure 28: Current Customer Furniture Shopping/Ownership Journey

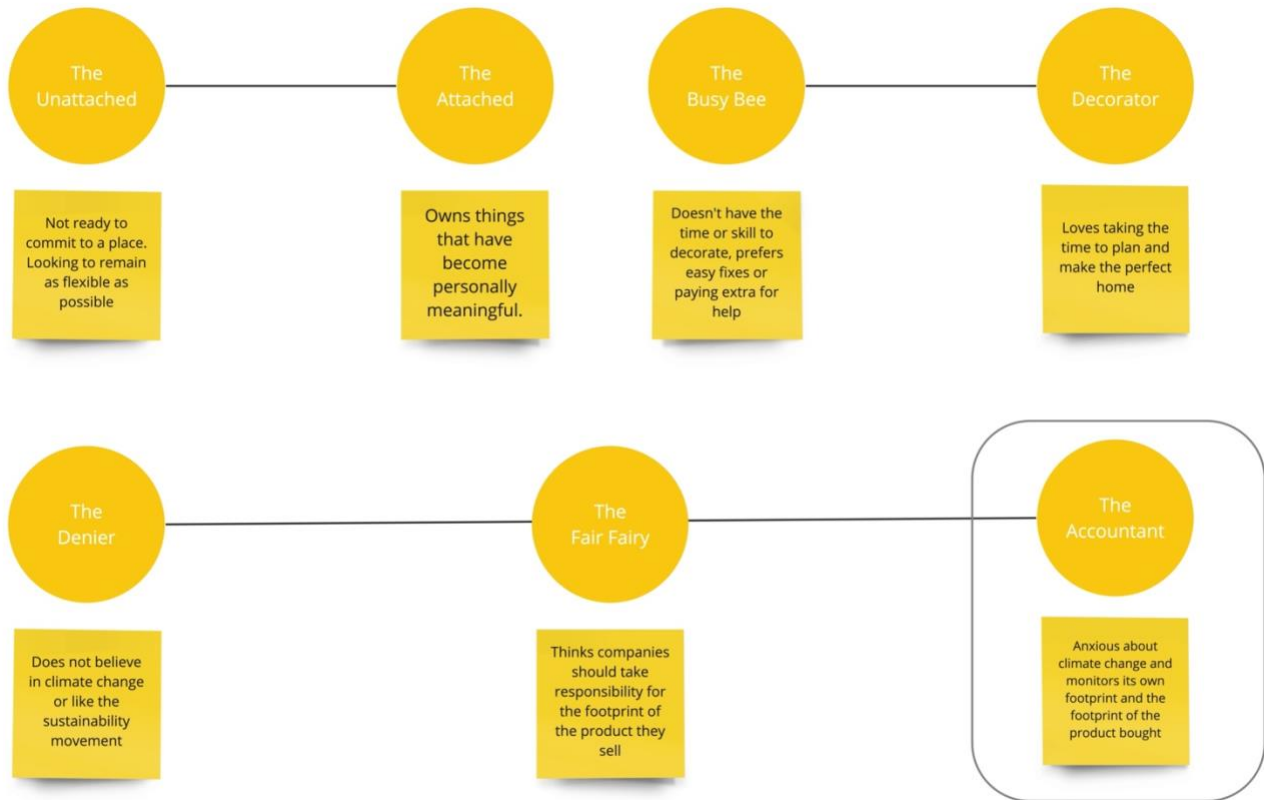


Figure 29: Preliminary Consumer Archetypes

#### 4.1.6 Leverage Points for solutions

Businesses lack the incentives to de-carbonize. Unless consumer awareness is raised, or policy is enacted, the system will remain as it is or move far too slowly towards carbon neutrality goals. Policy interventions would be ideal, and solutions in this space should be investigated. However, for the scope of this design project, policy development is ultimately out of scope. The solutions developed should still be compatible with a world in which EPR policies exist and with a world in which they do not, because regardless of the outcome, the solution should help the industry transition towards carbon neutrality. Policies would likely make the development and scaling of the solution easier but are not guaranteed.

Lowering production or lowering consumption across the industry would immediately reduce emissions, but there is no clear reason for people to do that in the current system. Alternatively, projects in renewable energy for production would help lower the emissions per product, but these types of solutions already exist and are growing, what is needed is for companies to invest more in them. However even if there was 100% renewable energy available everywhere, raw material consumption would also still need to be managed, as consumption could rebound when renewable energy is widespread. Therefore, lower emissions will require the extension of product lifecycles as well as additional energy and material efficiency in production and logistics. Maintaining emissions levels in a low and reasonable state will require a management of consumption levels per person and entity.

In the current system, and in a future world where EPRs do not happen, consumers are the only ones with power to gradually incentivize brands and their affiliated stakeholders to change course and invest in de-carbonization. If the only incentive for companies to change is revenue, then the solution must in some way align sustainability with revenue without falling into greenwashing. Additionally, if in fact EPRs were put in place for the furniture industry and retail sector in the USA, consumption per person still needs to be addressed, to prevent overconsumption. Furniture Brands and their affiliated partners need incentives to help consumers buy less, as it ultimately goes against their business models currently.

Extending product lifecycles is especially difficult for urban dwellers that tend to move frequently. Moving can be cumbersome and frustrating and reselling items as well. This allows fast furniture to thrive as it reduces the initial investment for consumers. The solution could involve improving the customer experience of secondhand marketplaces to make it easier for people to share or sell their products to others when they no longer want them. The solution should however still allow furniture brands to profit from resales to incentivize them to design for durability and positively influence consumers to shop second-hand themselves, given how strong customer loyalty can be in the retail sector.

## **4.2 Adaptation Roadmap**

Based on the insights gathered during the ecosystem examination, potential solutions could include any or all the following interventions:

- Monetize product resales for furniture brands through royalties.
- Monetize product resales for furniture brands by helping them recover and refurbish items for resale on their platforms.
- Generate awareness of furniture footprints for consumers - educate consumers.
- Provide guidelines to brands on how to optimize product design for recycling.
- Incentivize production in countries with clean energy grids.
- Improve reselling user experience.
- Improve second-hand shopping user experience.
- Help brands get access to recyclable material.
- Enact Extended Product Responsibility (EPR) policies across nations.
- Aggregate data from different stakeholders to measure and communicate emission measurements across stakeholders.

### 4.2.1 Constructive Stakeholder Profiles

The ecosystem examination showed consumers hold a lot of the power in helping incentivize brands to invest in de-carbonization, but it also showed that consumers are currently not thinking about sustainability when shopping for furniture, even though they believe in climate change and are considering it in other types of purchases. This

means that the solution needs to raise consumer awareness and change their shopping behavior. To work through what this behavior change would entail a constructive persona was developed, using the previously done archetypes as a starting point (Figure 31). The ultimate behavior desired includes consumers being comfortable buying second hand on most purchases, reselling every time they need to get rid of an item, tracking their consumption and footprint, and being comfortable sharing their shopping data with others. Consumers will differ on the starting point but in general a significant change will need to happen, that will need to be carefully implemented to prevent the consumer from getting overwhelmed and giving up. Different incentives were identified to keep people motivated, including returns for credit and on demand, sustainability ratings to educate consumers on the impact of different products, integrated transactions, and shopping experience to facilitate browsing and interior decoration, and asset cataloguing to help consumers keep track of their spending and patrimony.

User/Stakeholder Persona

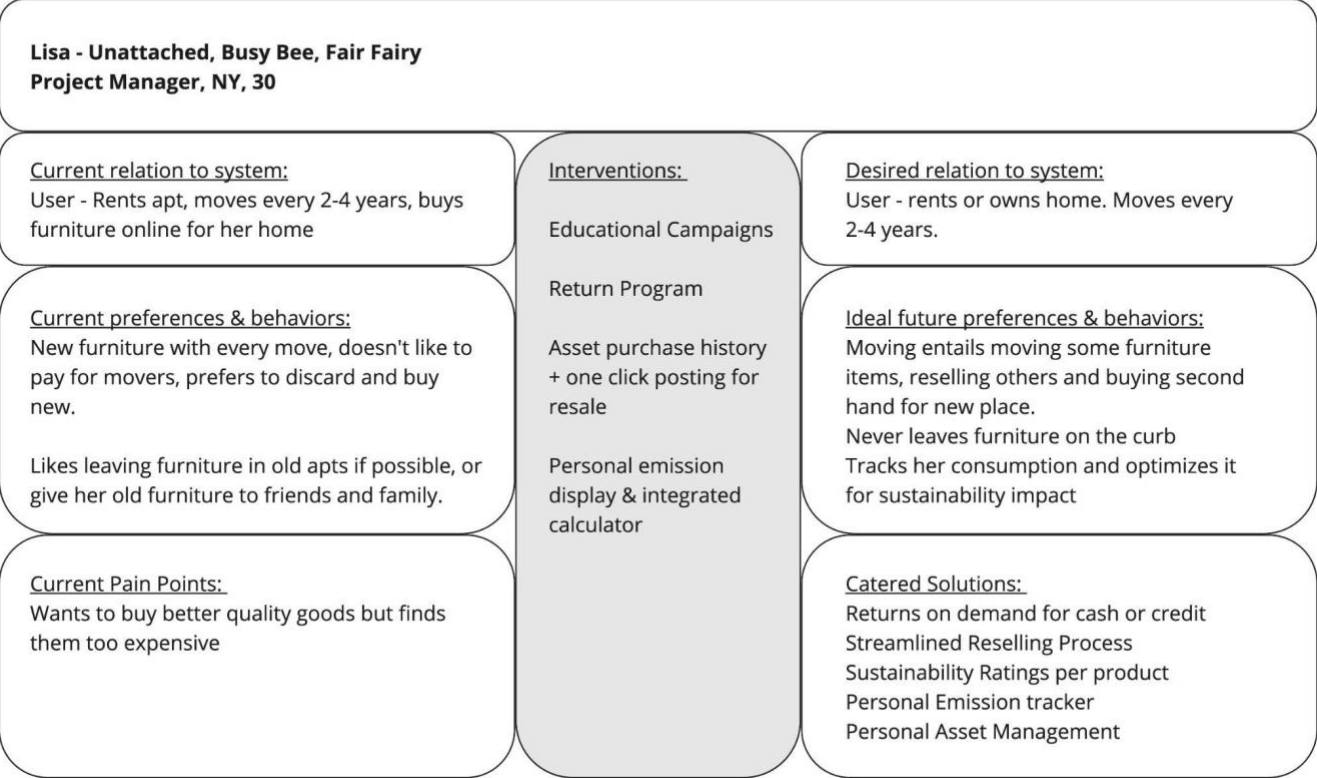


Figure 30: Constructive User Profile Example

#### 4.2.2 Solution strategies developed.

Multiple solution strategy options were developed, in an iterative fashion. The roadmaps for two of these solutions are included here for comparison. The goals, key interventions and potential failures are very similar, but the journey for the different scales change, apart from global and country level which remain the same. This is because all solutions, as mentioned previously, considered the possibility of EPRs being implemented soon in the USA. This is not essential for the solution to work but would certainly put additional pressure that would accelerate change.

Solution A (Figure 32) is focused on streamlining secondhand marketplaces and vertically integrating stakeholders in the industry. It envisions a new commercial entity able to aggregate data from various stakeholders and helping them be more connected to each other. This entity would connect reused furniture sellers with refurbishers, MRFs, liquidators and other buyers at the click of a button, by collecting data from furniture brands on their products and tracking products across their whole lifecycle. By offering a platform that is catered to consumers and makes secondhand shopping equivalent to normal shopping, this new entity can reduce friction for secondhand sales and thus reduce waste sent to landfill. Additionally, to ensure furniture brands are incentivized to participate in the solution, in exchange for data on their products this new entity would offer royalties on resales to furniture brands. This would reduce some of the pressure furniture brands have to produce new collections bi-annually and allow them to focus on product durability and improvement of their practices.

Solution B (Figure 33) is similar to solution A but recognizes that brands might still be reluctant to reduce production and might simply integrate secondhand sales to increase revenue. If consumption is not managed per person, it is possible people will consume more than they do today, given that secondhand sales are now easier and promoted as sustainable, which reduces a certain level of guilt that already exists in the customer base. For these reasons, solution B is focused on raising awareness of the footprint of each product, while still improving the user experience for shoppers. In this case, the new entity who connects different stakeholders in the industry would not necessarily host any transactions but would instead serve as a shopping assistant and search



engine to consumers. It would allow consumers to compare the footprint of different products across different brands and help them find the lowest carbon option available in the market. Royalties would no longer be available to furniture brands, and instead the incentive used to motivate them to change is the showcasing of their product footprints in comparison with other brands.

Goals	Key Interventions	Potential Failures	Journey
<p>USA</p> <ul style="list-style-type: none"> <li>Yearly emission reports across different stakeholders</li> </ul>	<p>Expecting EPRs to pass for furniture industry in USA and Globally</p>	<p>No EPRs</p>	
<p>Furniture Industry</p> <ul style="list-style-type: none"> <li>Industry wide emissions measurement and monitoring</li> <li>Zero Waste</li> </ul>	<ul style="list-style-type: none"> <li>Digital twins for every product</li> <li>Carbon footprint calculations per product</li> <li>Data aggregation</li> <li>Incoming product data for recyclers</li> </ul>	<ul style="list-style-type: none"> <li>Material not valuable enough</li> <li>Lack of infrastructure for re-distribution of used materials</li> <li>Dishonesty in data shared for emissions calculations</li> </ul>	
<p>Furniture Brands</p> <ul style="list-style-type: none"> <li>Reasonable Emissions per product</li> <li>Maintain or increase jobs</li> <li>Zero waste</li> </ul>	<ul style="list-style-type: none"> <li>Second-hand sale royalties</li> <li>Emission Certifications</li> <li>Access to consumer preference data</li> </ul>	<ul style="list-style-type: none"> <li>Royalties are not enough to lower production rates</li> <li>Dishonesty in data shared for emissions calculations</li> </ul>	
<p>Furniture Customers</p> <ul style="list-style-type: none"> <li>Reasonable Emissions per transaction</li> <li>Reasonable Consumption per person</li> <li>Equivalent experience of new or second hand shopping</li> </ul>	<ul style="list-style-type: none"> <li>Verified second hand marketplace buyers &amp; sellers</li> <li>Items returnable for credit anytime</li> <li>Personal assets organization</li> <li>One click posting for sales</li> <li>Item Pick up</li> </ul>	<ul style="list-style-type: none"> <li>Product deterioration hinders second hand sales</li> <li>Ease of resale reduces guilt and increases consumption and circulation (transport) significantly</li> </ul>	

Figure 31: Solution A - Adaptation Roadmap

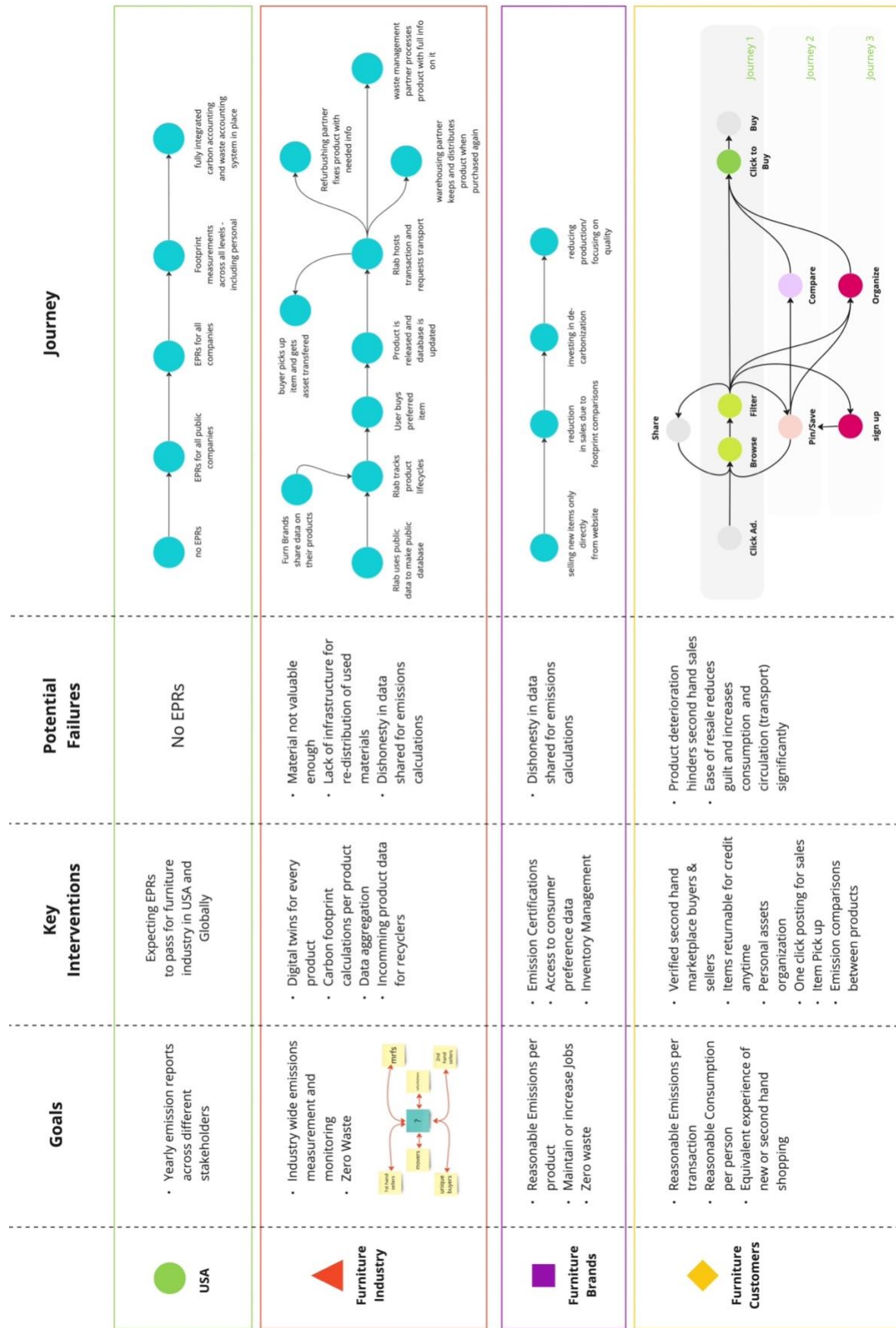


Figure 32: Solution B - Adaptation Roadmap

### 4.3 Integrated Viability Analysis

	Status Quo Marketplace	Solution B	Second Hand Marketplace	Solution A
Marginal Carbon Emissions (5 points)	+ 600 kg	0 - 600 kg	0 - 600 kg	0 - 600 kg
Marginal Profit (1 Point)	%20 Revenue	%5 Revenue	%10 Revenue <small>High operational costs from logistics &amp; inventory</small>	%5 Revenue <small>High operational costs from logistics &amp; inventory</small>
Enterprise Level SDG Performance  (+/-1/2 point per SDG) ■ Positive Impact ● Negative Impact	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Total Points	-1/2	7.5	6.5	7
Rank & Notes		lower operational costs than solution B - less capital intensive to begin with	high operational costs, difficult to scale	Incentives for brands to lower production

Figure 33: Integrated Viability Analysis Example

The two solution options discussed previously were compared to the status quo situation and existing secondhand marketplace options, which offer similar opportunities. The status quo marketplace refers to marketplaces like Amazon or Wayfair, that are focused on selling new items and do not consider sustainability as a primary feature in their product offering.

The comparison for the marginal carbon emissions is based on the sale of a generic lounge chair. A status quo marketplace would normally offer options that are produced in Asia and shipped to the USA by cargo ship. These are later distributed across the USA by truck and kept in warehouses until an order is received. The embedded carbon for such products was estimated using public data from marketplace websites with product details for similar products. The same was done with a variety of websites to uncover the possible difference in embedded carbon between products of the same category from different brands. This analysis resulted in a possible difference in

embedded carbon of up to 90%, depending on where the product was manufactured, where the user is ordering the product from, the materials the product includes the product dimensions and weight and its packaging dimensions for shipping.

The carbon emissions delta between status quo product options and unique sustainable brand options provides a reasonable comparison data point for the different solution proposals. Traditional second-hand marketplaces offer products that could be displacing the production of new items by other brands. Most second-hand marketplaces will consider a full displacement for any product sold on their platform, but unfortunately this carbon offset is difficult to prove. This would mean every sale has 0 kg carbon emissions attached to it, because the alternative would be for that person to buy new which would be (for example) 600 kg for the same item type. If in fact the person chose the status quo option then the emissions attached to it would have happened, but given that they chose otherwise, then no emissions are counted. There is a mistake in this logic though because production is not done on demand, instead companies hold inventory. Additionally, carbon emissions remain in the atmosphere, whether a sale was done or not. For a secondhand purchase to truly displace the carbon emissions of an equivalent newly made product, production would have to be dynamically optimized based on demand, something that with time the solutions proposed could be able to do. However, given the lack of integration across the industry today, furniture brands do not have visibility over such shopping behavior, and it would take some time for the market to correct itself if in fact second-hand sales increase significantly enough for them to start noticing it.

Therefore, the embedded carbon emissions of a second-hand product were considered based on their age instead; determining a reasonable durability for certain product types and a yearly discounting of the carbon emissions made. This method considers the time it will take the market to correct its production levels according to consumer demand for second-hand products and will provide a fair distribution of responsibility of carbon emissions across stakeholders and furniture owners. The viability comparison considers the emissions for a second-hand alternative to vary between 0-600kg - to account for the different possible product ages and the possibility of them

being antiques, in which case the decision was to consider anything above 50 years to be worth 0kg. The same condition would apply to either of the two alternative solutions proposed, given that they also would offer secondhand products in addition to new products.

Given that the status quo solution produces more carbon emissions than any other alternatives, and that the alternatives are matching each other on their potential marginal carbon emissions, the best choice is ultimately determined by their impact in other areas and how that could change the absolute emissions result as well. Although the status quo solution is likely to have a higher profit margin, it does significantly worse on the SDG front. The two solutions proposed can claim climate action, as they are integrating different players in the industry and systemically raising awareness of sustainability practices. By either providing royalties or disclosing product footprint data to consumers, the new entities proposed would incentivize change across the industry at a faster rate than a traditional secondhand marketplace. The data aggregation these solutions propose will essentially make every product a SPIME (Sterling, 2005) providing better measurement of the emissions of the industry as a whole and helping with EPR policy development.

Lastly, the comparison between solution A and B is focused on one SDG, which is SDG 7 - affordable and clean energy. The reason why solution B can claim this while solution A cannot, is because solution A uses energy grid data to calculate product emissions and makes the calculation and result public, which is a clear incentive for brands to invest in clean energy initiatives so they may lower their emissions. Solution A is focused on increasing reuse only, not on reducing carbon per product, and so does not incentivize investment in clean energy as Solution B could.

## 4.4 Monitoring Plan

Table 3: Monitoring Plan – Example

KPI	Measurement Cadence	Method	Responsible Entity	Reporting Entity	Review Cadence
Avrg CO2/product/category	Daily & Monthly Avrg	Recalculated after each new product upload	Algorithm / PM	C-Suite	Yearly
Avrg Items/ person	Monthly	Profiles	Algorithm / PM	C- Suite	Yearly

Although more KPIs would be included in the real monitoring plan for a solution like solution B, Table 3 provides an example of the type of information that would be included. Given that the overall goal is to lower absolute emissions, being able to measure emissions per transaction and average emissions per product type would be crucial. Additionally, to manage overall consumption per person and be able to give consumers incentives to consume less or consume better, the average items per person would be required also.

The measurement cadence for each of these KPIs includes a monthly cadence, but in the case of the average per product type, it would also need to happen daily, as this information would need to be available to customers as they shop on the platform. The method refers to the type of feature that will collect the data or the moment when the calculation will be done. For the average CO2 per product type a method or recalculation after each new product upload is listed to signify that the average for the day will be the last calculation of the previous day. Responsible entities correspond to the people that will be constantly keeping track of these KPIs (responsible entity) versus those who will review it periodically to assess if a strategy re-design is necessary.

## **CHAPTER 5 - Conclusions & Next Steps**

Ideas have intrinsic value. Human society is based on in the exchange of ideas, without them none of the systems we have built would have been possible. Behind every human project there is a designer or a group of designers that have taken the time to analyze the world around them and project themselves to the future, to envision how it might be different or the same. Design is intertwined with every human activity, across different levels of complexity. It is at its most basic level a natural capability of humans, to envision something new.

We are in an age where design, as it relates to the production of something new that uses natural resources, can no longer be an automatic process that relies on current social norms. It should instead be structured and critical. Our systems are increasingly complex and interconnected at a global scale and are hurting the environment that provides the means for our collective survival and wellbeing. We need to raise our collective awareness of climate change and its effect on our lifestyles and professions. Designers must recognize the potential impact of their ideas and the responsibility they carry.

The Responsible Design method proposed in this thesis is a starting point. It does not pretend to provide designers with all the frameworks needed to develop sustainable designs, but it lays a foundation for more work on the subject to happen. Human Centered Design was an incredible development in the design industry that now needs to evolve as our vision for the future has evolved.

Using the case study in this thesis as an example, we can see that Responsible Design is able to deliver solutions that are much more sustainable than what HCD would have normally delivered. If for example a constructive profile or adaptation roadmap had not been used, it's likely that a solution would have been focused on the reduction of costs across the supply chain as fast furniture has done, or on the production of items that use recycled material but do not manage consumption. The design would have been focused on the current pain points expressed by customers and on maximizing profit alone. It would have been biased to current social norms, allowing for profitability in the



short term for the designer and their client or company, while ignoring certain potential detrimental effects on the environment.

Doctors get paid by their patients, but they do not let that hinder the types of recommendations they offer their clients. There will always be professionals that deviate from the norm, but the understanding is that doctors are able to look past the transaction value and offer an objective diagnosis and solution. Similarly, although designers may get paid by client companies, investors, or customers directly, they should not let that affect the quality of the ideas they share.

Imagine, for example, a person is faced with cardiovascular disease and the potential for a heart attack. A doctor will get paid to recommend that person to increase levels of exercise, reduce stress, eat healthy, and essentially stop all their existing habits that may be contributing to their risk level. The patient will have to decide if in fact they want to reduce their risk of a heart attack, but this will not change the type of advice the doctor gives, and the patient does not expect it to be so. The difficulties designers encounter with behavior change when dealing with climate change are like those doctors' encounter when dealing with human health conditions. There is one major difference though, when it comes to environmental health, those who refuse to change their behavior will not necessarily be the ones who suffer the consequences directly. This means that designers must do everything in their power to find solutions that convince their patients to change, in favor of our collective wellbeing, if in fact they are believers of climate change and the sustainability movement. For this reason, customer centric innovations will always be necessary, as otherwise product adoption would be impossible. However, it must be done strategically, with an understanding of the overall goals for the system, applying customer centric frameworks to other stakeholder groups as well.

Additional work is needed to make the Responsible Design method more comprehensive. Some of the opportunities that have been identified so far include further study in need theory to give a more structured approach to the differentiation between intrinsic human needs and luxuries. Additionally, further study on good ways for designers to set limits on their KPIs is needed so that crossing these boundaries can alert designers and make it easier to know when to re-assess the original design or

apply countermeasures to it. Finally, although a marginal impact assessment as it relates to carbon accounting and life cycle assessment is necessary, there is also a need to provide designers with an easy way to predict absolute impact and be able to compare it across solutions.

The case study shared as an example should also be understood as an idea in development, which would likely change based on customer testing, additional conversations with other stakeholders, and further study on carbon accounting details. Nevertheless, by using a structured approach to the solution development, as long as it remains consistent the comparison between solutions will be a powerful tool to determine to best path to move forward with. Additional work that would be needed on this project would include specific features, potential co-benefits to each solution, further study of carbon discounting, potential consumer target market optimization and integration with other industries to manage potential rebound effects.

## **BIBLIOGRAPHY**

- B Corp. "B Corp Certification demonstrates a company's entire social and environmental impact." *B Corp*, 2023, <https://www.bcorporation.net/en-us/certification/>. Accessed 5 May 2023.
- Beausoleil, Angèle M. *Business Design Thinking and Doing : Frameworks, Strategies and Techniques for Sustainable Innovation*. Springer Nature Switzerland, 2022. *Springer Link*.
- Beyondly. "The Environmental Audit Committee recommends EPR for furniture." *Beyondly*, <https://www.beyond.ly/educate/news/the-environmental-audit-committee-recommends-epr-for-furniture/>. Accessed 9 May 2023.
- Birch, Kate. "Big business slowly gravitating towards being more B Corps." *Business Chief*, 14 November 2022, <https://businesschief.com/sustainability/big-business-slowly-gravitating-towards-being-more-b-corps>. Accessed 5 May 2023.
- Brinkhof, Tim. "Devil's advocate used to be an actual job within the Catholic Church." *Big Think*, 11 July 2022, <https://bigthink.com/high-culture/devil-advocate-catholic-church/>. Accessed 6 May 2023.
- Brundtland Commission. *Our Common Future*. Oxford University Press, 1987. *Our Common Future*, chrome-extension://efaidnbmnnnibpcajpcgclefindmkaj/<https://sustainabledevelopment.un.org/content/documents/5987our-common-future.pdf>.
- Burkey, Tormond. *Ethics for a full world*. Clairview Books, 2017.
- Daher, Bassel, et al. "Developing Socio-Techno-Economic-Political (STEP) Solutions for Addressing Resource Nexus Hotspots." *Sustainability*, vol. 10, no. 2, 2018, -. *MDPI*, <https://www.mdpi.com/2071-1050/10/2/512>.
- Dasilva, Calyton. "Imagining decline or sustainability: Hope, fear, and ideological discourse in Hollywood speculative fiction." *Elementa Science of the Athropocene*, vol. 7, no. 7, 2019, -.
- de Jong, Meno D.T. "Different Shades of Greenwashing: Consumers' Reactions to Environmental Lies, Half-Lies, and Organizations Taking Credit for Following Legal Obligations." *SAGE Journals Home*, vol. 34, no. 1, 2020, pp. 38-76, <https://journals.sagepub.com/doi/full/10.1177/1050651919874105>.

Downey, Gary. "Are Engineers Losing Control of Technology?: From 'Problem Solving' to 'Problem Definition and Solution' in Engineering Education." *Elsevier*, vol. 83, no. 6, 2005, pp. 583-595. *Science Direct*, <https://www.sciencedirect.com/science/article/abs/pii/S0263876205727362>.

Dunne, Anthony, and Fiona Raby. *Speculative Everything*. The MIT Press, 2013.

EPA. "Durable Goods: Product-Specific Data | US EPA." *Environmental Protection Agency*, 3 December 2022, <https://www.epa.gov/facts-and-figures-about-materials-waste-and-recycling/durable-goods-product-specific-data>. Accessed 8 May 2023.

EPA. "Inventory of U.S. Greenhouse Gas Emissions and Sinks | US EPA." *Environmental Protection Agency*, <https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks>. Accessed 9 May 2023.

EPI. "Environmental Performance Index." *Environmental Performance Index*, 2022, <https://epi.yale.edu/epi-results/2022/component/epi>. Accessed 11 May 2023.

EY. "Why business must harness the power of purpose." *EY*, 15 December 2020, [https://www.ey.com/en\\_gl/purpose/why-business-must-harness-the-power-of-purpose](https://www.ey.com/en_gl/purpose/why-business-must-harness-the-power-of-purpose). Accessed 5 May 2023.

Gendron, Corine, et al. "Science-fiction literature as inspiration for social theorizing within sustainability research." *Journal for Cleaner Production*, vol. 164, no. -, 2017, pp. 1553-1562. *Science Direct*, <https://www.sciencedirect.com/science/article/abs/pii/S0959652617314725?via%3Dihub>.

Gibbons, Sarah. "Journey Mapping 101." *Nielsen Norman Group*, 9 December 2018, <https://www.nngroup.com/articles/journey-mapping-101/>. Accessed 3 May 2023.

Goralnik, Lissy. "Encyclopedia of Applied Ethics." *Science Direct*, vol. -, no. 2, 2012, pp. 145-155. *Anthropocentrism*, <https://doi.org/10.1016/B978-0-12-373932-2.00349-5>.

Gore, Tim. *CONFRONTING CARBON INEQUALITY Putting climate justice at the heart of the COVID-19 recovery*. Oxfam, 2020, <https://policy-practice.oxfam.org/resources/confronting-carbon-inequality-putting-climate-justice-at-the-heart-of-the-covid-621052/>.

Gough, Ian. "Recomposing consumption : defining necessities for sustainable and equitable wellbeing." *Philosophical Transactions A*, vol. 375, no. 20160379, 2017, .

Gutowski, Timothy G. "A Critique of Life Cycle Assessment; Where Are the People?," *Elsevier*, vol. 69, no. -, 2018, pp. 11-15. *Science Direct*, <https://doi.org/10.1016/j.procir.2018.01.002>.

Hansen, J. "Rockström et al. 2009: Planetary boundaries: Exploring the safe operating space for humanity." *GISS Publications*, 26 January 2023, <https://pubs.giss.nasa.gov/abs/ro06010m.html>. Accessed 4 May 2023.

"History and Origins of Participatory Design." *The UX Book: Agile UX Design for a Quality User Experience*, by Rex Hartson and Pardha S. Pyla, Elsevier Science, 2018. *Science Direct*. Accessed 11 May 2023.

Hoekstra, Rutger. *replacing GDP by 2030 : Towards a Common Language for the Well-Being and Sustainability Community*. Cambridge University Press, 2019.

IDEO. "Design Thinking." *IDEO Design Thinking*, 2023, <https://designthinking.ideo.com/>. Accessed 12 May 2023.

IPCC. *SYNTHESIS REPORT OF THE IPCC SIXTH ASSESSMENT REPORT. 2023. AR6 Synthesis Report*, <https://www.ipcc.ch/report/ar6/syr/>.

Ivanova, Diana, and Richard Wood. "The unequal distribution of household carbon footprints in Europe and its link to sustainability." *Cambridge University Press*, vol. 3, no. e18, 2020, -. -.

Johnson, Brian D. *Science Fiction Prototyping : Designing the future with Science Fiction*. Morgan & Claypool, 2011.

Kantar. "WhoCares? Who Does?" *Kantar*, 2021, <https://kantar.turtl.co/story/whocares-who-does-2021-p/page/1>. Accessed 11 May 2023.

Kantar. "Who Cares? Who Does?" *Kantar*, 2022, <https://www.kantar.com/campaigns/who-cares-who-does-in-the-fmcg-industry>. Accessed 11 May 2023.

Kaplan, Kate. "UX Research, Training, and Consulting." *Nielsen Norman Group*, 31 July 2016, <https://www.nngroup.com/articles/customer-journey-mapping/>. Accessed 5 May 2023.

Kasser, Tim. *The High Price of Materialism*. The MIT Press, 2002.

Klaniecki, Kathleen, et al. "Behaviour Change for Sustainable Development." *Encyclopedia of Sustainability in Higher Education*, 2018, pp. 1-10. *Springer Link*, [https://doi.org/10.1007/978-3-319-63951-2\\_161-1](https://doi.org/10.1007/978-3-319-63951-2_161-1).

Kopnina, Helen, et al. "Anthropocentrism: More than Just a Misunderstood Problem." *Journal of Agricultural and Environmental Ethics*, vol. 31, 2018, pp. 109-127. *Springer Link*, <https://link.springer.com/article/10.1007/s10806-018-9711-1>.

Lasagna, Louis. "NOVA | Doctors' Diaries | The Hippocratic Oath: Modern Version." *PBS*,  
[https://www.pbs.org/wgbh/nova/doctors/oath\\_modern.html](https://www.pbs.org/wgbh/nova/doctors/oath_modern.html). Accessed 3 May 2023.

Lutz, Damien. "The Life-centred Design Guide." *Medium*, 2022. *Medium*,  
<https://damienlutz.medium.com/the-life-centred-design-guide-120a3d40e0fc>.

McCarthy, Steven. "Design Thinking? Thank an Engineer." *Dialectic*, vol. III, no. I, 2021, pp. 39-57.

McDonough, William. *Cradle to Cradle*. North Point Press, 2002.

McKinsey. "Do consumers care about sustainability & ESG claims?" *McKinsey*, 6 February 2023,  
<https://www.mckinsey.com/industries/consumer-packaged-goods/our-insights/consumers-care-about-sustainability-and-back-it-up-with-their-wallets>. Accessed 11 May 2023.

Nickerson, Charlotte. "The Yerkes-Dodson Law of Arousal and Performance." *Simply Psychology*, 15 February 2023, <https://www.simplypsychology.org/what-is-the-yerkes-dodson-law.html>. Accessed 5 May 2023.

Owens, Jonathan. "10 Principles of Life Centered Design | by Johnathyn Owens | The Sentient Files." *Medium*, 3 June 2019, <https://medium.com/the-sentient-files/10-principles-of-life-centered-design-3c5f543414f3>. Accessed 3 May 2023.

Oxenham, Simon. "Lessons from Psychology in How to Stick to Your Goals." *Big Think*, 6 January 2016, <https://bigthink.com/surprising-science/lessons-from-psychology-in-how-to-keep-your-new-years-resolution/>. Accessed 3 May 2023.

Pallotta, Nicole. "Ecuador's Constitutional Court Rules Wild Animals Are Subjects of Legal Rights Under the Rights of Nature." *Animal Legal Defense Fund*, 4 January 2023, <https://aldf.org/article/ecuadors-constitutional-court-rules-wild-animals-are-subjects-of-legal-rights-under-the-rights-of-nature/>. Accessed 4 May 2023.

Papanek, Victor. *Designer for the Real World*. Thames Hudson, 2019.

Pearce, Fred. "What Is the Carbon Limit? That Depends Who You Ask." *Yale E360*, 6 November 2014, [https://e360.yale.edu/features/what\\_is\\_the\\_carbon\\_limit\\_that\\_depends\\_who\\_you\\_ask](https://e360.yale.edu/features/what_is_the_carbon_limit_that_depends_who_you_ask). Accessed 7 May 2023.

Rockstrom et al, Johan. "Planetary Boundaries: Exploring the Safe Operating Space for Humanity." *Ecology & Society*, vol. 14, no. 2, 2009, p. 32, <https://www.ecologyandsociety.org/vol14/iss2/art32/>.

RTS. "Furniture waste – The forgotten waste stream." *Recycle Track Systems*, 10 November 2020, <https://www.rts.com/blog/furniture-waste-a-growing-issue/>. Accessed 8 May 2023.

Shaikh, Kashif. "A Reflection on The Hippocratic Oath - Insights on Residency Training." *NEJM Journal Watch Medical Blogs*, 28 December 2016, <https://blogs.jwatch.org/general-medicine/index.php/2016/12/reflection-hippocratic-oath/>. Accessed 3 May 2023.

Slater, Daniel. "The Imperatives of Customer-Centric Innovation | AWS Executive Insights." *Amazon AWS*, <https://aws.amazon.com/executive-insights/content/the-imperatives-of-customer-centric-innovation/>. Accessed 3 May 2023.

Statista. "Furniture - United States." *Statista*, 2023, <https://www.statista.com/outlook/cmo/furniture/united-states>. Accessed 8 May 2023.

Stead, Michael. "Spimes and speculative design: Sustainable product futures today." *Strategic Design Research Journal*, vol. 10, no. 1, 2017, pp. 12-22. *Research Gate*, [https://www.researchgate.net/publication/326635004\\_Spimes\\_and\\_speculative\\_design\\_Sustainable\\_product\\_futures\\_today](https://www.researchgate.net/publication/326635004_Spimes_and_speculative_design_Sustainable_product_futures_today).

Sterling, Bruce. *Shaping Things*. MEDIAWORK, 2005.

Swiffer. "How Swiffer Changed The Way The World Cleans." *Swiffer*, <https://www.swiffer.com/en-us/our-commitment-to-clean/how-swiffer-changed-the-way-the-world-cleans>. Accessed 3 May 2023.

Thunberg, Greta. *The Climate Book*. Penguin Press, 2023.

Torry, Jennifer. "Why purpose driven design is the new human centered design Jennifer Torry." *Medium*, 2022. *Medium*, <https://medium.com/@jennifertorry/why-purpose-driven-design-is-the-new-human-centered-design-99c281d68b1b>.

Verified Market Research. "OFF-THE-SHELF Second Hand Furniture Market Size, Share & Forecast." *Verified Market Research*, 2021, <https://www.verifiedmarketresearch.com/product/off-the-shelf-second-hand-furniture-market/>. Accessed 9 May 2023.

Woolhouse, Megan. "In Swiffer, a pet project that went big." *The Boston Globe*, 22 March 2016, <https://www.bostonglobe.com/business/2016/03/22/product-development-race-goes-swiffer/ddjA1UKErXX33B2Vx1rdsJ/story.html>. Accessed 3 May 2023.

- World Bank. "CO2 emissions (metric tons per capita) - United States." *World Bank Data*, 2020,  
<https://data.worldbank.org/indicator/EN.ATM.CO2E.PC?locations=US>. Accessed 10 May 2023.
- Yagoda, Ben. "Cognitive Biases and the Human Brain." *The Atlantic*, 15 September 2018,  
<https://www.theatlantic.com/magazine/archive/2018/09/cognitive-bias/565775/>. Accessed 3  
May 2023.
- Zaidi, Leah. "Worldbuilding in Science Fiction, Foresight and Design." *Journal of Future Studies*, vol. 23,  
no. 4, 2019, pp. 15-26,  
[https://www.researchgate.net/publication/334304881\\_Worldbuilding\\_in\\_Science\\_Fiction\\_Fore  
sight\\_and\\_Design](https://www.researchgate.net/publication/334304881_Worldbuilding_in_Science_Fiction_Foresight_and_Design).