Design

Data-Driven Design

As we humans go about our daily business, we produce massive amounts of data, which is useful for designing better products. There are many approaches to design and the majority share the common goal of designing for a good user experience.

Interaction Design

Platform Economy

Network Effects, the more people use a platform, the more valuable it becomes. Rise of the *platform economy* has created global marketplace companies like Airbnb and Uber that match idle resources with retail demand and optimize how our cities work.

By continuously adding features (and provided consumer legislation allows it), platforms can evolve into superapps. Superapps are possible thanks to **Nudge, Economies of Scale, Network Effects, Behaviour Design.** The most successful businesses today (as measured in terms of the number of users) look at the whole user experience. Popular consumer platforms strive to design solutions that feel personalized at every touchpoint on the user journey (to use the language of service design) but doing so at the scale of hundreds of millions (or even billions) of users - personalization at scale. Superapps are honeypots of data that is used for many types of behavior modeling. For example Suarez, G. et al. (2021) suggests using alternative data from super-apps to estimate user income levels, including 4 types of data: Personal Information, Consumption Patterns, Payment Information, and Financial services. Also Roa et al. (2021) finds super-app alternative data is especially useful for credit-scoring young, low-wealth individuals. The massive amounts of data generated by these companies are used by smart cities to re-design their physical environments.

Enablers of Platform Economics	Good	Bad
Network effects	The more people use a platform, the more valuable it becomes.	Data is not portable. You can't leave because you'll lose the audience.
Scalability		
Data-driven		
Behaviour Design		

- Superapps are more prevalent in China and South-East Asia. Giudice (2020) argues WeChat has had a profound impact on changing China into a cashless society, underlining how one mobile app can transform social and financial interactions of an entire country. Vecchi and Brennan (2022) China is the home of many superapps and this paper discusses the strategies taken to expand to other markets. Shabrina Nurqamarani et al. (2020) discusses the system consistency and quality of South–East Asian superapps Gojek and Grab.

- Uber is creating an all-purpopse platform; only 4.1% of rides were electric Levy (2023)

- Twitter (X) is becoming a superapp.

Could there be Sustainability Superapps?

- How to design sustainability superapps? Lots of options in a single app. Fleet Management Weekly (2022) "Sustainability and superapps top Gartner's Top 10 2023 Trends List". Dave Wallace (2021) "The rise of carbon-centric super apps". goodbag (2023) "goodbag: Sustainable Super App". What would a sustainable investment platform that matches green investments with the consumers look like, if one saw the side-by-side comparison of investment vehicles on their ESG performance? Also Bernard (2022).

- Undheim (2024) Ecotech

- Lori Perri (2022)

- Anon. (2022a)

- Anon. (2021a) PayPal dominance

- Zeng (2015) **(need to pay for article!)**

- Huang and Miao (2021) **(need to pay for article!)**

- Anon. (2022b)

- Cuppini, Frapporti and Pirone (2022) a historical overview of the development of capitalism from linear **Fordism** through platform economy and logistics' revolution which allows for circular economies to happen in a city.

- Adaptive AI

Speculative Design

In order to build a future, it's relevant to imagine and critique a future.

Speculative design makes use of future scenarios to envision contexts and interactions in future use. The term *speculative design* was invented by Dunne and Raby (2013) in their seminal book to question the intersection of user experience design and speculative fiction. For example Barendregt and Vaage (2021) explores the potential of speculative design to stimulate public engagement through thought experiments that spur public debate on an issue chosen by the designer.

Phil Balagtas, founder of The Design Futures Initiative at McKinsey, discusses the value of building future scenarios at his talk at Google. One of his examples, the Apple Knowledge Navigator, from an Apple vision video in 1987, took two decades to materialize in the real world. It was inspired by a similar device first shown in a 1970s episode of Star Trek as a **magic device** (a term from participatory design), which then inspired subsequent consumer product development. It took another 2 decades, until the launch of the iPhone in 2007 - a total of 40 years. Imagination is crucial for change (Google Design, 2019).

Digital Health

- Quantified Self is an example
- Tracking air pollution and realizing how bad the over in my grandma's house is: add picture

There is a lot of research on *quantified self*. Wearable devices like Apple Watch, Oura Ring, combined with apps help users track a variety of health metrics. Apart from health, wearable devices have been used to track other metrics. Giannakos et al. (2020) used wearable devices to measured physiological parameters of students at school to determine their learning efficiency. Could one track personal sustainability in a similar fashion?

Shin et al. (2019) synthesis review of 463 studies shows wearable devices have potential to influence behavior change towards healthier lifestyles. Saubade et al. (2016) finds health tracking is useful for motivating physical activity. Apple is a leader in health tracking. Apple (2022a): In a 2022 report Apple outlines its plans to : "Empowering people to live a healthier day". Apple (2022b) Apple's HealthKit provides a growing list of health metrics. Liu et al. (2019) tracks how wearable data is used for tracking sleep improvements from exercise. Grigsby-Toussaint et al. (2017) Sleep apps and behavioral constructs.

Blood sugar trackers. Bloog glucose tracking is popular even for people without diabetes, to optimize their activity Anon. (2021b)

Another aspect is tracking one's mental health. Tyler, Boldi and Cherubini (2022) surveys the use of self-reflection apps in the UK (n=998).

Use technology Wearables to be more aware of one's health.

- Popular Strava (100 million users) sports assistant provides run tracking and feedback (**stravaStravaGlobalCommunity2022?**).
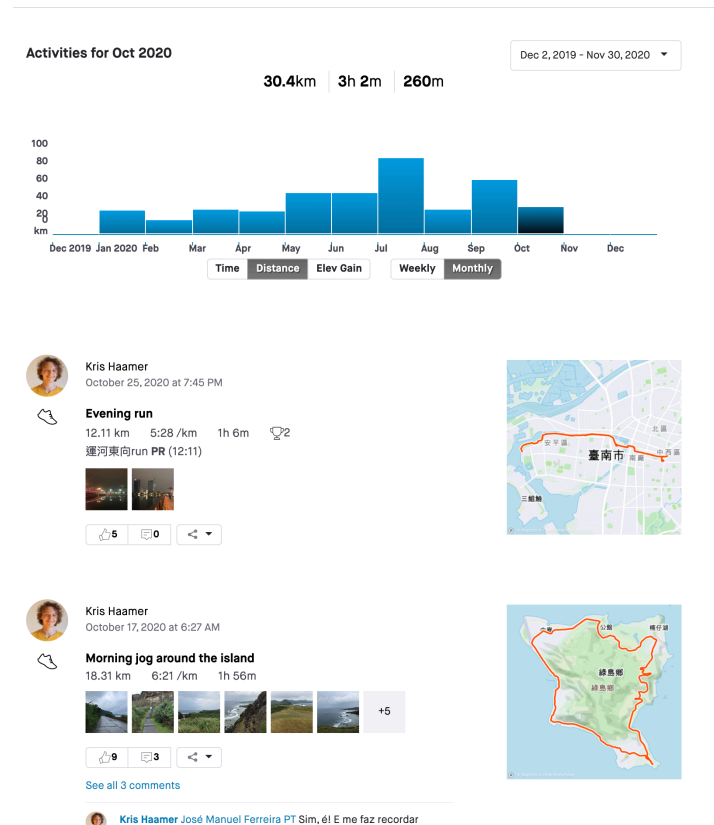

Figure 1: Popular Strava sports assistant provides run tracking and feedback

- AI Financial Advisors will need to go further to motivate users.

- There is a parallel in health to sustainability and indeed both are inextricably linked.

- Tracking urine consistency inside your toilet with WithThings

- Tracking blood sugar with app and patches

- "urban metabolism" (Claire Moran, 2018; Shi et al., 2021), city in-out flows accounting method

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- The urban environment has an influence on health. Delclòs-Alió et al. (2022) discusses walking in Latin American cities. Walking is the most sustainable method or transport but requires the availability of city infrastructure, such as sidewalks, which many cities still lack.

- Tsai et al. (2019)

- Burger, White and Yearworth (2019)

- Aromatario et al. (2019) behavior changes

- Ayoola et al. (2018) wellbeing data

- Godfrey et al. (2018)

- Thomas et al. (2018)

- Tonne et al. (2017)

- Anselma, Mazzei and De Michieli (2017)

- Forlano (2017) post-humanism and design

- Greenbaum and Gerstein (2016)

- Millings et al. (2015)

- Reis et al. (2015)

- Bower and Sturman (2015)

- Fletcher (2022)

- Ryan (2022) uses the "capability methodology" to evaluate if apps help people eat healthily.

- Baptista et al. (2022) apps for sleep apnea

Digital Sustainability

In digital sustainability, information pertaining to emissions would flow through the economy not unlike the carbon cycle itself.

- Pan and Nishant (2023) important

Affective Design

User Interfaces

What is the user interface of the green transformation?

McKeough (2018) business consultancies have begun to recognize the importance of design to business. They advise their corporate clients to bring user experience design to the core of their business operations.

There's a number of user interface design patterns that have provide successful across a range of social media apps. Such ***user experience / user interface*** (UX/UI) patterns are copied from one app to another, to the extent that the largest apps share a similar look and feature set. Common UX/UI parts include the Feed and Stories. By using common UI parts from social media users have an easier time to accept the innovative parts. add Viz charts. Avatars are increasingly common and new generations are used to talking to computers.

Table 2: Common Social Media UI Parts

Feature	Examples
Feed	
Post	Apple App Store
Stories	IG, FB, WhatsApp, SnapChat, TikTok
Comment	
Reactions	

There are also more philosophical approaches to ***Interface Studies:*** David Hoang (2022), the head of product design at Webflow, suggests taking cues from art studies to ***isolate the core problem***. "An art study is any action done with the intention of learning about the subject you want to draw". As a former art student, Hoang looks at an interface as *"a piece of design is an artwork with function"*.

Indeed, art can be a way to see new paths forward, practicing "fictioning" to deal with problematic legacies: Anon. (2023a)

Personal Carbon Trackers

Similar to personal health trackers, personal CO_2 trackers help one track emissions and suggests sustainable actions.

Table 3: A selection of personal sustainability apps. See *greenfilter.app* for an updated database.

App	Description
Commons (Formerly Joro)	Finacial Sustainability Tracking + Sustainable Actions
Klima	Offset Subscription
Wren	Offset Subscription
JouleBug	
eevie	
Aerial	
EcoCRED	
Carbn	
LiveGreen	
Earth Hero	

Digital Product Design

Design is as much about how it works as it's about the interface.

Digital product design can be seen as a specific discipline under the umbrella of **Experience Design**. In Michael Abrash (2017) Meta Oculus augmented reality incubation general manager Laura Fryer: "People buy experiences, not technology."

Young people expect a product. Intelligent Interfaces use interaction design to provide relevant and personalized information in the right context and at the right time.

Ceschin and Gaziulusoy (2016) shows how design for sustainability has expanded from a product focus to systems-thinking focus placing the product inside a societal context of use. For example Anon. (n.d.a), Recycled clothing maker FREITAG offers sustainability-focused services such ass cargo bikes so you can transport your purchases and a network for *shopping without payment* = swapping your items with other members, as well as repairs of their products. Loaning terminology from ***service design***, the user journey within an app needs to consider each touchpoint on the way to a state of success.

Weinschenk (2011) says "People expect most online interactions to follow the same social rules as person-to-person interactions. It's a shortcut that your brain uses to quickly evaluate trustworthiness."

The small screen estate space of mobiles phones and smart watches necessitates displaying content in a dynamic manner. Virtual reality glasses (called AR/VR or XR in marketing speak) need dynamic content because the user is able to move around the environment. Both are questions that interaction design is called upon to solve. Hoang (2022): "Dynamic interfaces might invoke a new design language for extended reality".

Speaking is one mode of interaction that's become increasingly possible as machines learn to interpret human language.

Table 4: Modes of interaction

Mode of Interaction
Writing
Speaking
Touching
Moving

Coputer

Humans respond well to ***storytelling***, making ***character design*** and ***narrative design*** relevant to interaction design. Large language models (LLMs) such as ChatGPT are able to assume the personality of any character that exists inside of its training data, creating opportunities for automated narrative design.

One mode

- Konings (2020)
- "Digital sustainability principles"
- Eminent journal Design Studies, 1st design journal
- Part of digital product design are **design systems** to keep consistency across the experience. Create a design system to best to showcase my analytic skills:

  - Anon. (n.d.b)
  - Suarez, M. et al. (n.d.)
  - Anon. (n.d.c)
  - Anon. (n.d.d)

- Kolko and Connors (2010) and IxDF (n.d.) believe interaction design is still an emerging (and changing) field and there are many definitions. I prefer the simplest version: interaction design is about creating a conversation between the product and the user.
- AI gives designers new tools. In AI development, design is called alignment. What is the role of an AI Designer? Linden (2021)
- Anon. (n.d.e)
- Anon. (n.d.f)
- Parundekar (2021)
- Richard Yang (2021) and Justin Baker (2018) say some of the tools used by interaction designers include
- AI for design: Figma (2023)

The concept of **Social Objects** is People need something to gather around and discuss. Sharing.Lab (2015): I'm interested in the concept of a "social object".

Red Route Analysis is an user experience optimization idea inspired by the public transport system of London (Oviyam (2019); Anon. (2021c) and Xuan (2022)).

Large Digital Platforms have a very small number of workers relative to the number of users they serve. This creates the necessity for using automation for both understanding user needs and providing the service itself. Creating a good product that's useful for the large majority of users depends on **Data-Driven Design.**

- Product marketers focus on the **stickiness** of the product, meaning low attrition, meaning people keep coming back.
- What percent of all design is "sustainable design" ? Promoting sustainable design.
- Josh Luber (2021) Trading cards are cool again
- Jesse Einhorn (2020)
- Connie Loizos (2021)
- Natasha Mascarenhas (2021)
- JEFF JOHN ROBERTS (April 23, 2020 at 2:00 PM GMT+3)

Narrative Design

- The rising availability of AI assistants may displace Google search with a more conversational user experience. Google itself is working on tools that could cannibalize their search product. The examples include Google Assistant, Google Bard and large investments into LLMs.

- Alethea AI (2021): discusses writing AI Characters, creating a personality.

- Writing as training data? large language models. GTP3.

- Stories start with a character.

Behavioral Design

For decades, marketers and researchers have been researching how to affect human behavior towards increasing purchase decisions in commerce, both offline and online, which is why the literature on behavioral design is massive. One of the key concepts is *nudge*, first coined in 2008 by the Nobel-winning economist Richard Thaler; nudges are based on a scientific understanding of human psychology and shortcuts and triggers that human brains use and leverages that knowledge to influence humans in small but powerful ways (**thalerNudgeImprovingDecisions200?**).

The principles of nudge have also been applied to sustainability. For example, a small study (n=33) in the Future Consumer Lab in Copenhagen by Perez-Cueto (2021) found that designing a "dish-of-the-day" which was prominently displayed helped to increase vegetarian food choice by 85%. Guath, Stikvoort and Juslin (2022) experiments (n=200) suggested nudging can be effective in influencing online shopping behavior towards more sustainable options. A larger scale study of behavior change in Australia maps how to avoid "16 billion paper coffee cups are being thrown away every year" (Novoradovskaya et al., 2021).

Google uses nudges in Google Flights and Google maps, which allow filtering flights and driving routes by the amount of CO_2 emissions, as well as surfacing hotels with Green Key and Earth-Check credentials, while promising new sustainability features across its portfolio of products Sundar Pichai (2021). Such tools are small user interface nudges which Google's research calls *digital decarbonization*, defined by Implement Consulting Group (2022) as "Maximising the enabling role of digital technologies by accelerating already available digital solutions".

In Kate Brandt and Matt Brittin (2022), Google's Chief Sustainability Officer Kate Brandt set a target of "at least 20-25%" CO_2 emission reductions in Europe to reach a net-zero economy and the global announcement set a target of helping 1 billion people make more sustainable choices around the world (Jeni Miles, 2022). In addition to end–users, Google offers digital decarbonization software for developers, including the Google Cloud Carbon Footprint tool and invests in regenerative agriculture projects (Anon., 2021d; Google, 2023).

Sarah Perez (2022) shows how google added features to Flights and Maps to filter more sustainable options

Justine Calma (Oct 6, 2021, 10:01 AM GMT+3) Google UX eco features

How CO2 is shown by Google starts hiding emissions? Anon. (2022c)

Google VERY IMPORTANTT Google (2021)

Anon. (2021e) Google green routes

Wizzair Check carbon impact Anon. (n.d.g)

Table 5: Examples of CO_2 visibility in Google's products.

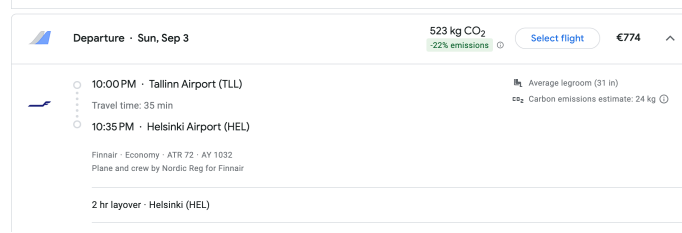| Feature	Product	Nudge
Google Maps AI suggests more eco-friendly driving routes Mohit Moondra (n.d.)	Google Maps	Show routes with lower CO_2 emissions
Google Flights suggests flights with lower CO_2 emissions	Google Flights	Show flights with lower CO_2 emissions

Figure 2: Google's view of flight emissions

- The founder of the Commons (Joro) consumer CO_2 tracking app recounts how people have a gut feeling about the 2000 calories one needs to eat daily and daily CO_2 tracking could develop a gut feeling about one's carbon footprint (Jason Jacobs, 2019).

Some notable examples:

- Eriksson, Christensen and Malefors (2023) discusses best practices for reducing food waste in Sweden.
- Acuti, Lemarié and Viglia (2023) makes the point that physical proximity to a drop-off point helps people participate in sustainability.
- Wee, Choong and Low (2021) proposes types of nudging technique based on an overview of 37 papers in the field.

Table 6: Types of nudge by Wee, Choong and Low (2021)

Name	Technique
Prompting	Create cues and reminders to perform a certain behavior
Sizing	Decrease or increase the size of items or portions
Proximity	Change the physical (or temporal) distance of options
Presentation	Change the way items are displayed
Priming	Expose users to certain stimuli before decision-making
Labelling	Provide labels to influence choice (for example CO_2 footprint labels)
Functional Design	Design the environment and choice architecture so the desired behavior is more convenient

- Bain et al. (2012) "Promoting pro-environmental action in climate change deniers" **(Need access!)**
- Allcott (2011) "Social norms and energy conservation" **(Need access!)**
- Schuitema and Bergstad (2018) "Acceptability of Environmental Policies" **(Need access!)**
- Nilsson et al. (2016) "The road to acceptance: Attitude change before and after the implementation of a congestion tax" **(Need access!)**

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- Berger, M., Lange and Stahl (2022) **(Need access!)**
- Anon. (2022d)
- United Nations Conference on Trade and Development (last) (2023)
- Climatiq (2023) Automate GHG emission calculations
- EarthCheck (2023) sustainable tourism certification
- LFCA (2023) corporate climate action
- Greenhouse Gas Protocol (2023) standards to measure and manage emissions
- Playing for the Planet Alliance (2021)

Gamification

- Students in Indonesia enjoy using Kahoot and it's gamification elements are perceived to have positive impact on individual learning outcomes so they are happy to continue using it (Wirani, Nabarian and Romadhon, 2022).
- Anon. (n.d.h) game company going green
- Ant Forest ( ) is a success story of gamified nature protection. Success stories integrating previously distinct experiences with sustainability have shown positive results, for example, Alibaba's Ant Forest simultaneously raising money for planting forests and building loyalty, leading the company to consider further avenues for gamification and eco-friendliness.
- Gamification makes uses of nudges.

Table 7: Table of Ant Forest assisted tree planting. Data compiled from (and , 2017; Yang et al., 2018; UNFCCC, 2019; Wang, X. and Yao, 2020; Anon., 2021f; Wang, S., Ibrahiem and Li, 2022; Zhang, Hu and Gu, 2022; Cao and Liu, 2023; Zhou, F., Lin and Mou, 2023).

Year	Users	Trees	Area
2016	?	0	
2017	230 million	10 million	
2018	350 million	55 million	6500 acres??
2019	500 million	100 million	112,000 hectares / 66, 000 hectares?
2020	550 million	200 million	2,7 million acres?
2021	600 million	326 million	
2022	650 million	400 million	2 million hectares

```python
# importing the modules
import numpy as np
import matplotlib.pyplot as plt
```

```
import matplotlib.patches as mpatches

# data to be plotted
x_years = [2016, 2017, 2018, 2019, 2020, 2021, 2022]
y_trees = [0, 10000000, 55000000, 100000000, 200000000, 326000000, 400000000]
y_users = [0, 23000000, 35000000, 500000000, 550000000, 600000000, 650000000]

# plotting
plt.title("Ant Forest Growth")
plt.xlabel("Years")
plt.ylabel("Trees and Users")
plt.plot(x_years, y_trees, color = "green")
plt.plot(x_years, y_users, color = "black")
plt.legend(handles=[mpatches.Patch(color='black', label='Users'), mpatches.Patch(color='gr
plt.show()
```
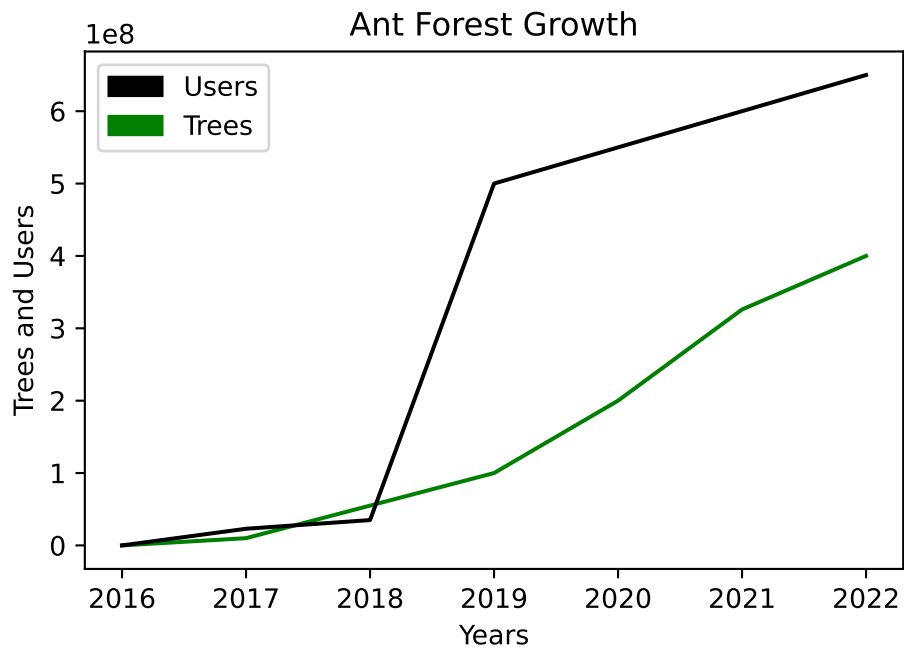
Design for Sustainability

Life-Centered Design

While Human-Centered Design has become popular, the effect humans are having on biodiversity leads to the idea of Life-Centered Design. Borthwick, Tomitsch and Gaughwin (2022) proposes a framework for life-centered design, "the design phase of a physical product accounts for 80% of its environmental impact".

Sustainability touches every facet of human existence and is thus an enormous undertaking. Making progress on sustainability is only possible if there's a large-scale coordinated effort by humans around the planet. For this to happen, some technological tools are helpful.

- Sanchez et al. (2022) LoRaWAN

Provenance & Traceability

- Anon. (2022e)
- Katie Gustafson (2022) proposes a **"Uniform traceability system for the entire supply chain"** for seafood
- Muñoz et al. (2023) Is there such a thing as sustainable fishing? Bottom trawling is the worst and should be banned.
- Anon. (2021g) "Real Time ESG Tracking From StockSnips"
- Mamede et al. (2022) proposes *Seafood tracing*: Fingerprinting of Sea Urchin.
- Waters (2015) **(Need access!)**
- Cawthorn and Hoffman (2016) **(Need access!)**
- Gamborg and Jensen (2017) **(Need access!)**
- Neethirajan and Kemp (2021) using biometric sensors to track livestock sustainability.
- Ray (2023) comprehensive overview of Web3.
- Rehash: A Web3 Podcast (2022) human-centered web3
- Patel et al. (2023) livestock products (meat) are 15% of agricultural foods valued at €152 billion in 2018.
- Inc (n.d.)
- Tim Nicolle (2017)

Supply Chains

Freight (transport of goods by trucks, trains, planes, ships) accounts for 1.14 gigatons of CO_2 emissions as per 2015 data or 16% of total international supply chain emissions (Wang, Y. et al., 2022).

- Platzer (2023), a scientist working on the Apollo space programme, calls for emergency action to develop *green aviation*.

- "Transport greenhouse gas emissions have increased every year since 2014" Anon. (2023b)

- Finkenstadt and Handfield (2021) COVID19 pandemic highlighted the need to have real-time visibility into supply chains.

Table 8: Share of CO_2 of CO_2 emissions by type of transport (Statista and IEA, 2022)

Type of Transport	Percentage
Passenger cars	39%
Medium and heavy trucks	23%
Shipping	11%
Aviation	9%
Buses and minibuses	7%
Light commercial vehicles	5%
Two/three-wheelers	3%
Rail	3%

Circular design is possible if supply chains become circular.

- Wagenvoort (2020) Self-driving supply chains.. (contact Japanese factory?)

- California Transparency in Supply Chains Act

How to Trace Supply Chains?

- Knight et al. (2022) new tools are needed to map supply chains.

- Dutta et al. (2020) hundreds of paper researching blockchain use in supply change operations since 2017.

- Van Wassenaer et al. (2023) Compares use cases for blockchains in enhancing traceability, transparency and cleaning up the supply chain. There are several technologies for tracking goods across the supply chain, from shipping to client delivery.

- Ashraf and Heavey (2023) Solana blockchain and Sigfox internet of things (IoT) Integration for supply chain traceability.

- Blockchain ledgers are useful for data sharing and auditing, as the time and place of data input can be guaranteed, and it will be easier to conduct a search on who inputted incorrect data, however the system still relies on correct data input. As the saying goes, "garbage in, garbage out".

- Several startups are using distributed ledgers (blockchains) to track source material arriving to the factories and product movements from factories to markets. While blockchains enable securely tracing data, which is immutable (no possible to change the same record, only add data in new records).

Table 9: Blockchain supply chain companies as of summer 2023 include.

Company	Link	Literature	Comments
Ocean Protocol	oceanprotocol.com		
Provenance	provenance.io		
Ambrosius	ambrosus.io		
Modum	modum.io		
OriginTrail	origintrail.io		
Everledger	everledger.io		
VeChain	vechain.org		
Wabi	wabi.io		
FairFood	fairfood.org		
Bext360	bext360.com		
SUKU	suku.world	Miller (2019) SUKU makes supply chains more transparent	Seems to have pivoted away from supply chains

Ethics & Cruelty

Can data transparency provide tools for reducing cruelty.

- Traceability and animal rights. Animal rights vs animal welfare. Ethereum blockchain and animal rights. "Blockchain can provide a transparent, immutable record of the provenance of products. This can be especially useful for verifying claims made about animal welfare. For example, products claiming to be "free-range," "organic," or "sustainably sourced" could have their entire lifecycle recorded on the blockchain, from birth to shelf, allowing consumers to verify these claims."

- Cruelty free brands

- BCorp

- ESG

- Trash found in ocean / nature etc

- Increase your investment point by matching with your contribution /.

- Point of Sales integration (know the SKU you buy). Integrate to the financial eco footprint (no need to scan the product). What's the name of the startup that does this?

- Precision Fermentation and Cultivated Meat: Meat products without farm animals

Open Data

Data-driven design requires access to data, making the movement towards *open data sharing* very important. Some countries and cities are better than others at sharing data openly.

Table 10: Examples of cities and countries that share data openly.

Country	Project	Reference
Sweden	Swedish open data portal	Anon. (n.d.i)

- When will Bolt show CO_2 emissions per every trip?
- Sustainable finance data platform:
- WikiRate (2021) WikiRate defines Data Sharing Archetypes

Type	Example
Transparency Accountability Advocate	
Compliance Data Aggregator	
Data Intelligence Hub	
Worker Voice Tool	Caravan Studios (2022): **"Worker Connect"**
Traceability tool	trustrace.com
Open data platform	
Knowledge sharing platform	business-humanrights.org

- WikiRate is a tool for checking green credentials Transparency
- Laureen van Breen et al. (2023)
- Wikirate (2022a)
- Anon. (n.d.j)

Taxes

- There have been proposal of a "meat tax".

Carbon Labels

Adding CO_2 labels for consumer products have been discussed for decades (Adam Corner, 2012). Cohen and Vandenbergh (2012) argues carbon labels do influence consumer choice towards sustainability. Academic literature has looked at even minute detail such as color

and positioning of the label (Zhou, S. et al. (2019)). There is some indication consumers are willing to pay a small premium for low-CO_2 products (Xu and Lin (2022)). All else being equal, consumers choose the option with a lower CO_2 number (Carlsson, Kataria and Lampi (2022)). Nonetheless, the idea of *Carbon Labelling* is yet to find mainstream adoption.

There's some evidence to suggest labeling low CO_2 food enables people to choose a *climatarian diet* in a large-scale study Lohmann et al. (2022) of UK university students, however the impact of carbon labels on the market share of low-carbon meals is negligible. Labels alone are not enough. underlines Edenbrandt and Lagerkvist (2022) in Sweden in a study which found a negative correlation between worrying about climate impact and interest in climate information on products, suggesting a need for wider environmental education programs. Asioli et al. (2022) found differences between countries, where Spanish and British consumers chose meat products with *'No antibiotics ever'* over a *Carbon Trust* label, whereas French consumers chose CO_2 labeled meat products.

Carbon labeling is voluntary and practiced by only a handful of companies. The U.S. restaurant chain *Just Salad* , U.K.-based vegan meat-alternative *Quorn* and plant milk *Oatly* are some example of companies that provide carbon labeling on their products (Brian Kateman, 2020). ClimatePartner (2020): Companies like ClimatePartner and Carbon Calories offers labeling consumer goods with emission data as a service. The Carbon Trust (n.d.): The Carbon Trust reports it's certified 27 thousand product footprints.

Table 12: Companies with Carbon Labels (Brian Kateman, 2020)

Company	Country
Just Salad	U.S.A.
Quorn	U.K.
Oatly	U.K.

Table 13: Organization to Certify Carbon Labels (ClimatePartner, 2020).

Organization	Country	Number of Product Certified
ClimatePartner		
Carbon Calories		
Carbon Trust		27000

- Digitalisation and digital transformation; Digital Receipts are one data source for tracking one's carbon footprint (Anon., n.d.k).

- Ivanova et al. (2020) "establish consumption options with a high mitigation potential measured in tonnes of CO_2 equivalent per capita per year."

- 55% of emissions come from energy production.

- Carto (2023) Making advanced maps to convince people to make changes

Digital Product Passports

Digital product passports are a further development of the idea of carbon labels.

- The European Commision has proposed a *Digital Product Passports* to help companies transfer environmental data (Nissinen, Seppälä and Heinonen, 2022). Carbon labels are needed for green transformation.

- Reich et al. (2023) "Information gaps are identified as one of the major obstacles to realizing a circular economy."

- Jensen et al. (2023) "support decision-making throughout product life cycles in favor of a circular economy."

- King, Timms and Mountney (2023) "influence consumer behavior towards sustainable purchasing and responsible product ownership by making apparent sustainability aspects of a product life cycle."

- Berger, K., Rusch, et al. (2023) "support Sustainable Product Management by gathering and containing product life cycle data. However, some life cycle data are considered sensitive by stakeholders, leading to a reluctance to share such data."

- Plociennik et al. (2022) "Digital Lifecycle Passport (DLCP) hosted on a cloud platform and can be accessed by producers, users, recyclers"

- Berger, K., Baumgartner, Weinzerl, Bachler and Schöggl (2023) challenges with Electric Vehicle Batterys. Berger, K., Baumgartner, Weinzerl, Bachler, Preston, et al. (2023) proposes Digital Battery Passports

- Van Capelleveen et al. (2023) literature overview

- Sustainable Product Management: Korzhova (2020)

- Gitcoin Passport Sybil Defense. Made Simple. [@gitcoinpassport] (2023) discusses ow to build an antifragile scoring system (antifragile passport) inspired by Nassim Taleb's popular book that discusses antifragile systems that get better in difficult situations (Taleb, 2012).

Designing Industries

It's possible to re-design entire industries and that is exactly the expectation sustainability sets on businesses. Across all industries, there's a call for more transparency. Conversations about sustainability are too general and one needs to look at the specific sustainability metrics at specific industries to be able to design for meaningful interaction. There's plentiful domain-specific research showing how varied industries can develop eco-designed products. I will here focus on 2 industries that are relevant for college students.

Fashion

Young people are the largest consumers of fast fashion (Anon., n.d.l). In European Environment Agency (2022), European Environment Agency (EEA) estimates based on trade and production data that EU27 citizens consumed an average 15kg of textile products per person per year.

Sustainable Fashion, Textile Design

- There are signs of young Chinese consumers valuing experiences over possessions Jiang (2023).

- Millward-Hopkins, Purnell and Baurley (2023) shows how half of the textile waste in the UK is exported to other countries.

- Story of Patagonia Chouinard (2005)

Across industries, reports are saying there isn't enough transparency.

- US EPA (2016) GHG emission inventory by sector

- **Problem**: Emily Chan (2022a) report says there's not enough transparency in fashion:

- Fashion greenwashing, fashion is 2%-8% of total GHG emissions, 2.4 Trillion USD industry, 100B USD lost to lack of recycling, contributes 9% of microplastics: Adamkiewicz et al. (2022)

- Centobelli et al. (2022) per year uses 9B cubic meters of water, 1.7B tonnes of CO_2, 92 million tonnes of textile waste.

- Köhler et al. (2021): Globally 87% of textile products are burned or landfilled after 1st consumer use.

- Marrucci, Marchi and Daddi (2020) Italian retail supermarkets carbon footprint?

- Leung and Luximon (2021) There's a growing know-how on how to produce sustainably and which materials to use. "Handbook of Footwear Design and Manufacture" Chapter 18 - Green design.

- Emily Chan (2022b) New Standard Institute's proposed "Fashion Act" to require brands doing business in New York City to disclose sustainability data and set waste reduction targets.

- Wikirate (2022b): "Among the Index's main goals are to help different stakeholders to better understand what data and information is being disclosed by the world's largest fashion brands and retailers, raise public awareness, educate citizens about the social and environmental challenges facing the global fashion industry and support people's activism."

- Mabuza, Sonnenberg and Marx-Pienaar (2023) shows consumer knowledge of apparel coloration is very limited.

- Gyabaah et al. (2023) research across several dumpsites across Ghana revealed up to 12% of the landfill consisted of textile waste.

- imperfectidealist (2020) Fashion sustainability vs greenwashing

- Anon. (2023c) Ethical Shopping

- Anon. (2023d) Ethical brand?

- Good On You (2023) Sustainable fashion company evaluations

- Anon. (n.d.m) Garment Worker's rights

- Emily Chan (2022c): fashion companies can't be held accountable for their actions (or indeed, their lack of action).

- WikiRate (2023)

- Anon. (2022f): "Political consumerism", "Instant Gratification for Collective Awareness and Sustainable Consumerism"

- FashionChecker (2023)

- Eesti Disainikeskus I Estonian Design Centre (2021) Circular textiles

- Eesti Kunstiakadeemia (2022) Sustainable Fashion education

- Fashion Revolution Foundation (2022) Fashion transparency index

- Anon. (n.d.n)

- "The mainstream fashion industry is built upon the exploitation of labor, natural resources and the knowledge of historically marginalized peoples."

- Anon. (n.d.o)

- "Secrecy is the linchpin of abuse of power…its enabling force. Transparency is the only real antidote." Glen Greenwald, Attorney and journalist.

- Stand.earth (2023)

- Anon. (n.d.p)

- Anon. (n.d.q) Bangladesh Garment Manufacturers and Exporters Association

- ERR (2022) European Commission wants to reduce the impact of fast fashion on EU market.

- Minimize shopping, buy quality, save CO_2, invest.

- Textile Exchange (2023) Ethical fashion materials matter

- Textile Exchange (2021): Policy request

- Free clothes

- Vanish UK (2021) "Generation rewear" documentary, sustainable fashion brands

- Storbeck (2021) and Remington (2020): Zalando says Fast fashion must disappear

- Infinited Fiber (2023)

- Cleantech Group (2023) Global cleantech 100

- Anon. (2023e) Alterations and repairs made easy

- Anon. (2023f) Ethical brand ratings

Food

- EAT-Lancet diet

- Eshe Nelson and Ana Swanson (2023) increased volatility in food prices

- Chang et al. (2021) fish fraud is a large global problem but it's possible to use DNA-tracking to prove where the fish came from. In "2019, the 27 KURA SUSHI branches in Taiwan sold more than 46 million plates of sushi. in Taiwan"

Perennial Crops

- Multi-year crops reduce inputs of gasoline, labor, etc. Aubrey Streit Krug and Yin Lu (2023)

- Large agritech like Monsanto rely on selling seeds annualy for profits, which has lead to farmer suicides when crops fail.

Culture, Community, Cuisine, Storytelling

- Tsing (2015) mushrooms

Food is about enticing human imagination and taste buds.

- Potato used to be a newcomer and innovative crop in Europe, and not it's so common, we forget it's no originally from here.

- Aubrey Streit Krug and Yin Lu (2023) food is also about cuisine and culture; foods become popular if we hear stories and see cuisine around a particular crop.

- "The agricultural sector contributes to approximately 13.5% of the total global anthropogenic greenhouse gas emissions and accounts for 25% of the total CO_2 emission" Nabipour Afrouzi et al. (2023). Poore and Nemecek (2018) suggests 26% of carbon emissions come from food production. Saner et al. (2015) reports dairy (46%) and meat and fish (29%) products making up the largest GHG emission potential. Springmann et al. (2021) proposes veganism is the most effective decision to reduce personal CO_2 emissions.

Complex supply chains make seafood (marine Bivalvia, mollusks) logistics prone to fraud, leading to financial losses and threats to consumer health (Santos et al., 2023). The same is true for cocoa beans, which are at risk from food fraud (Fanning et al., 2023).

- IARC warns aspartame (artificial sweetener found in many soft drinks) could cause cancer [CITE].

- Yap et al. (2023) Singapore disposes of 900,000 tonnes of plastic waste out of which only 4% is recycled.
- Kiessling et al. (2023) Single-use plastics make up 44-68% of all waste mapped by citizen scientists.

Food Waste

There are several initiatives to reduce food waste by helping people consume food that would otherwise be throw away.

Table 14: Food saving apps

Name	Link
Karma	apps.apple.com/us/app/karma-save-food-with-a-tap/id1087490062

Name	Link	
ResQ Club	resq-club.com	Kristina Kostap (2022) ResQ Club in Finland and Estonia for reducing food waste by offering a 50% discount on un-eaten restaurant meals before they are thrown away.
Kuri		Haje Jan Kamps (2022) Less impact of food
Social media groups (no app)		

- Röös et al. (2023) identified 5 perspectives in a small study (*n=106*) of views on the Swedish food system:

Table 15: Perspective on food systems in Sweden.

Perspective	Content
"The diagnostic perspective"	*"All hands on deck to fix the climate"*
"The regenerative perspective"	*"Diversity, soil health and organic agriculture to the rescue"*
"The fossil-free perspective"	*"Profitable Swedish companies to rid agriculture and the food chain of fossil fuel"*
"The consumer-driven perspective"	*"A wish-list of healthy, high-quality and climate-friendly foods"*
"The hands-on perspective"	"Tangible solutions within the reach of consumers and the food industry"

- Kommenda et al. (2022) Carbon Food Labels

- Food Sovereignty: "The global food sovereignty movement, which had been building momentum since its grassroots conception in the late '90s, quickly gained traction with its focus on the rights of people everywhere to access healthy and sustainable food. One of the pillars of the movement lies in using local food systems to reduce the distance between producers and consumers."

- CAITLIN STALL-PAQUET (2021): "We can grow foods just as well in the inner city as we can out in the country because we're agnostic to arable land," says Woods. "Because we grow indoors and create our own weather, [climate change] doesn't affect our produce."

- Renée Salmonsen (2018): Vertical farm in Taoyuan

- Catherine Shu (2023): *Intensive Farming Practices vs* Farm to table

- Akshat Rathi (2021) and Lowercarbon Capital (2023) climate startup funding.

- Only make what is ordered.

Farm to Fork

Farm to fork is a European Union policy to shorten the supply chain from the producer to the consumer and add transparency to the system.

Supply chain innovation in agriculture.

- Farm to Fork Financial Times (2022)

Construction

- According to Debnath et al. (2022) 39% of global CO_2 emissions comes from the building sector.
- Construction is large emitter because of the use of concrete; super tall buildings are very CO_2 intensive (Zhao and Qin, 2015).
- embodied carbon
- Oikos Denktank (2021) circular material procurement requires new skills. How to reuse old paint? Small projects can have large social impact.
- For example, Duriez et al. (2022) shows how simply by reducing material weight it's possible to design more sustainable transportation.

Design Implications

- App shows traceability.

- Help consumers to demand more.

- Make open data easy to use in everyday life.

- The key idea is making CO_2 Visible.

- Rank companies based on sustainability

- Help you to decide: what to buy, how to save, where to invest.

- What if there was a "Green Filter" on every product everywhere?

- Become a Sustainability-Aware App or Game.

- Focus on how college students can invest in specific industries?

- Where to shop rankings for groceries: list worst offenders in terms of products; shop and invest according to your values.

- What Quantified Self look like for sustainability?

- Empowering people to live a sustainable day

- What if there was a "Green Filter" on every product everywhere?

- Become a Sustainability-Aware App or Game.

- Guidance could help young people beat climate anxiety by taking meaningful action.

- The app is just as much about helping people deal with climate anxiety as it's with solving the climate issue.

- List of metrics that should be tracked to enable useful analytics. Ex: % of beach pollution, air pollution, water pollution (I had this idea while meditating). In essence, "green filter" is a central data repository not unlike "Apple Health for Sustainability".

- Health and fitness category apps

- Using "green filter" you can get a personalized sustainability plan and personal coach to become healthy and nature-friendly.

- All green categories — Green hub — Ask the user to prioritize

- In my "green filter" AI advisor app's scenario, the AI is scanning for opportunities matching the user's sustainable investment appetite and risk profile, using different methods of analysis, including alternative data sources. Traditionally, financial analysts only looked at traditional data, such as company reports, government reports, historic performance, etc., for preparing advisory guidance to their clients. With the advent of AI and big data analysis, many other options of research data have become available, for example, accurate weather predictions for agriculture can affect guidance, because of expected future weather disasters in the area. Other examples include policy predictions, pollution metrics, etc.

- Professional financial advisors use automated tools to analyze data and present it in human form to clients. Today's ubiquitous mobile interfaces, however, provide the opportunity to 'cut out the middleman' and provide similar information to clients directly, at a lower cost and a wider scale, often without human intervention. Additional (more expensive) "human-judgment- as-a-service", a combination of robots + human input, can help provide further personalized advice for the consumer, still at a cheaper price than a dedicated human advisor. Everyone can have a financial advisor.

- Narrative design bring together film school **storytelling** experience with design.

- Rebuilt the app as a personalized, narrative lifestyle feed.

- Your shopping products mostly come from Protector and Gamble (3x) and Nestle. These are large conglomerates with a massive CO_2 footprint. See the index to find some alternatives.

- How the design can connect people to sustainable outcomes while shopping and investing? Perhaps even forming a community of sustainable action. What I showed in class looks like an app but it could also be a physical object (a speculative design). From the presentations I saw most students seemed to be interested in form and light (many lamps) and a couple were about medical uses. I don't remember seeing one that could be compatible with the environmental sustainability focus unfortunately...

- **Guided Sustainability** "refers to a concept of using technology, such as AI and machine learning, to help individuals and organizations make more sustainable decisions and take actions that promote environmental and social sustainability. This can include things like analyzing data on resource usage and emissions, providing recommendations for reducing the environmental impact of operations, or helping to identify and track progress towards sustainability goals. The goal of guided sustainability is to make it easier for people to understand their impact on the environment and to take steps to reduce that impact."

- Young people are stuck inside platforms. You don't own the data you put on TikTok. You can't leave because you'll lose the audience.

- With this perspective of scale, what would a shopping experience look like if one knew at the point of sale, which products are greener, and which are more environmentally polluting?

- AI Financial Advisors will need to go further to motivate users. because of the nature of the technology, which is based on the quality of the data the systems ingest, they are prone to mistakes.