Design

Young Adults

- Is getting people to go to nature more a good way to increase ecological awareness?

Climate Anxiety

Design to reduce climate anxiety

- Thompson (2021) Young people have climate anxiety.
- Hickman et al. (2021) anxious kids
- Designing for Health and Sustainability: Health and sustainability are intrinsically connected. Kjrgård et al. (2014) shows how *"By understanding health and sustainability as a duality, health both creates conditions and is conditioned by sustainability, understood as economic, social and environmental sustainability, while on the other hand sustainability creates and is conditioned by human health."*
- Whitmarsh et al. (2022) shows how climate anxiety is more prevalent among young people and is a possible motivator for climate action.
- Ogunbode et al. (2022) finds climate anxiety in 32 countries and also supports the idea that climate anxiety leads to climate activism.
- Finds that climate anxiety predicts joining climate action movements
- How to support the youth?
- Design for Human Rights UNFCCC Conference of the Parties serving as the meeting of the Parties to the Paris Agreement (CMA) (2022) text refers to "human right to a clean, healthy and sustainable environment".

Guided Sustainability

- **Design: Guidance can help young people beat climate anxiety by taking meaningful action.**
- **Design:** The app is just as much about helping people deal with climate anxiety as it's with solving the climate issue.

- 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 required.
- 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). IIn 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
- There are many examples of combination of AI and human, also known as "human-in-the-loop". For example health apps like Welltory, Wellue and QALY. Food delivery apps like Starship Robots who ask for human help when crossing the road.
- How would you rate your knowledge on sustainability?
- How would you rate your ability to put sustainability into practice?
- "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."

Empowering Design

The design should empower young people.

- Ross et al. (2016) says most people in the US don't act on climate change. "Action on climate change has been compromised by uncertainty, aspects of human psychology".
- Rooney-Varga et al. (2019) shows the effectiveness of ***The Climate Action Simulation*** in educating users about success scenarios.
- Younger people show higher motivation (participants in climate protests). How to be relevant for a younger audience?
- Yet action remains low.
- OpenSea (2022) Taiwanese digital influencers as NFTs.
- *For young people, investing mostly means buying cryptocurrencies?*

Platform Economy

- 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.
- Network Effects: The more people use a platform, the more valuable it becomes.
- 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.
- The rise of the platform economy has given us marketplace companies like Airbnb and Uber that match idle resources with retail demand and optimize how our cities work. The massive amounts of data generated by these companies are used by smart cities to re-design their physical environments. 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?
- 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?

Community

- People exist in relation to other people.
- Psychology of 'fundraising clubs' vs individual investing
- "UkraineDAO Is Bidding on Ukrainian Flag | PartyBid" (n.d.) Ukraine DAO
- POAPs:

Group Purchases

Food ordering apps are popular.

- Buying in bulk for more savings.
- Through group purchases and community investing while also reducing consumption.
- People want to help and make a difference. Give people things to do.
- Choose Your Climate Solutions
- Find Your Composting Community

- Monoculture -> regenerative food forests Oil -> electric cars / bicycles

Service Design

- *Cargo Bike | FREITAG* (n.d.), 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.
- *Design Implication*: Your shopping products mostly come from Protector and Gamble (3x) and Nestle. These are large conglomerates with a massive CO2 footprint. See the index to find some alternatives.

Experience Design

- In Michael Abrash (2017) Meta Oculus AR Incubation GM Laura Fryer: "People buy experiences, not technology."
- Loaning terminology from service design, the user journey within an app needs to consider about touchpoint on the way to a state of success.

Interaction Design

- Kolko & Connors (2010); IxDF (n.d.) believes 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.
- 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."
- Richard Yang (2021) and Justin Baker (2018) say some of the tools used by interaction designers include
- Red Route Analysis
- AI for design: (**AINextChapter2023?**)
- 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"*.

Product Design

Young people expect a product.

- Konings (2020)
- "Digital sustainability principles"

Design Studies

- Eminent journal Design Studies, 1st design journal
- Ceschin & 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.

Design Systems

Create a design system!!!! best to showcase my analytic skills

- *A Comprehensive Guide to Design Systems | Inside Design Blog* (n.d.)
- M. Suarez et al. (n.d.)
- "Method Podcast, Episode 18" (n.d.)
- *Atomic Design by Brad Frost* (n.d.)

Data-Driven Design

- Rebuilt the app as a personalized, narrative lifestyle feed
- Product marketers focus on the ***stickiness*** of the product, meaning low attrition, meaning people keep coming back.
- Social Objects: People need something to gather around and discuss. Sharing.Lab (2015): I'm interested in the concept of a "social object".
- 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…
- What percent of all design is "sustainable design" ? Promoting sustainable design.

Question: What does investing mean for you? NFTs, Crypto, Stocks, Real-estate? If you have 1000 EUR, what will you buy?

- "Any community on the internet should be able to come together, with capital, and work towards any shared vision. That starts with empowering creators and artists to create and own the culture they're creating. In the long term this moves to internet communities taking on societal endeavors."
- 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)

Biodesign

- Neri Oxman, biomaterials MIT media lab, 15. sept. 2020
- Neri Oxman's expressions: "ecology-indifferent" "naturing""mother naturing" "design is a practice of letting go of all that is unnecessary" "nature should be our single client"
- Use imagination
- Societal movements change things: implication for design: build a community
- Processes sustain things: implication for design: built an app

Personas

- Use personas to articulate assumptions
- Persona: I care mostly about… fashion, art, …
- Don't Look Up (n.d.) Don't look up five user models / roles Consumer, Investor, Activist, ..

Mobile Design

Young people are mobile-first.

There's a number of user interface design patterns that have provide successful across a range of social media apps, copied from one to another, to the extent that the largest social media apps share a similar look and feature set.

- Mobile-first
- Provides a community for pooling money with like-minded investors

- Social
- Educational
- Edutainment
- Fun
- Stories section like IG / app store
- Common UI parts. Feed. 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.
- aespa (2020): Karina from Korea. It makes sense your sustainability assistant would talk to you. Studies show gen N is speaking to computers all the time. Interacting with the user is on the rise. For example, Chime makes tipping suggestions on the place of purchase.

Narrative Design

Bring together film school **storytelling** experience with design… Does branding also go here?

- Older research on young adults by Kate Moran (2016) (Millenials at the time) highlights how Millenials "use Google as a reference point for ease of use and simplicity".
- The rising availability of AI assistants however may displace Google search with a more conversational UX. Indeed, Google itself is working on smarter tools to displace their own main product, as exemplified by Google Assistant and large investments into LLMs.

Nudge

- The literature on *nudge* is wide, as researches try to find ways to affect human behaviors towards sustainability. Some notable examples:
- Wee et al. (2021) proposes 7 types of nudging technique based on an overview of 37 papers in the field.

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 CO2 footprint labels)

Name	Technique
Functional Design	Design the environment and choice architecture so the desired behavior is more convenient

- Eriksson et al. (2023) discusses best practices for reducing food waste in Sweden.
- Acuti et al. (2023) makes the point that physical proximity to a drop-off point helps people participate in sustainability.
- A small study (n = 33) Perez-Cueto (2021) in the Future Consumer Lab in Copenhagen found that designing a "dish-of-the-day" which was prominently displayed helped to increase vegetarian food choice by 85%.
- Guath et al. (2022) experiments (n=200) suggested nudging can be effective in influencing online shopping behavior towards more sustainable options.
- M. Berger et al. (2022) **(Need access!)**
- Google and X have offered the "Green Filter" on Maps, Flights, etc. What if there was a "Green Filter" on every product everywhere?

- One example of *nudge* are the small UI updates released by Google across its portfolio of products: Google Flights and Google maps. Google's research introduces the concept of *digital decarbonization*, which Implement Consulting Group (2022) defines as "Maximising the enabling role of digital technologies by accelerating already available digital solutions".
- In Kate Brandt & Matt Brittin (2022), Google's Chief Sustainability Officer Kate Brandt suggests "Digital solutions play an important enabling role for at least 20-25% of the reductions required to achieve a net-zero economy in Europe".

№	Product	Nudge
1	Google Maps	Show routes with lower CO2 emissions
2	Google Flights	Show CO2 emissions

- Becoming a Sustainability-Aware App or Game.
- Jeni Miles (2022) suggests "Google recently shared its goal to help one billion people make more sustainable choices by embedding carbon emissions information into Google Flights and surfacing whether a hotel is Green Key or EarthCheck certified."
- Kate Brandt & Matt Brittin (2022)
- "Support a Clean Energy Future with Nest Renew" (2022)
- Climatiq (2023) Automate GHG emission calculations
- Google (2023) Google Cloud Carbon Footprint tool.
- Sundar Pichai (2021) sustainability tools inside Google's products.

- EarthCheck (2023) sustainable tourism certification
- LFCA (2023) corporate climate action
- Greenhouse Gas Protocol (2023) standards to measure and manage emissions
- *Space Ape Games* (n.d.) game company going green
- Playing for the Planet Alliance (2021)

Superapps

- Superapps are possible **thanks to Nudge.**
- How to design superapps? Lots of options in a single app.
- "Will Europe Get a Superapp, and Who Will It Be?" (2022)
- WeChat
- Adaptive AI
- Vecchi & 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.
- Zeng (2015) **(need to pay for article!)**
- Huang & Miao (2021) **(need to pay for article!)**
- G. Suarez 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.
- Roa et al. (2021) finds super-app alternative data is especially useful for credit-scoring young, low-wealth individuals.
- Giudice (2020) MA thesis's 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.
- Fleet Management Weekly (2022) "Sustainability and superapps top Gartner's Top 10 2023 Trends List"
- Bernard (2022)
- Dave Wallace (2021) "The rise of carbon-centric super apps"
- Lori Perri (2022)

- "Partnership Brings Sustainability Mobility into Superapps" (2022)
- goodbag (2023) "goodbag: Sustainable Super App"
- "The Company Now Dominating European Fintech Is… Paypal" (2021) PayPal dominance

Speculative Design

- Dunne & Raby (2013) invented the term *'speculative design'* in their seminal book as the question on the intersection of user experience design and speculation. Speculative design makes use of future scenarios to envision contexts and interactions in future use. Phil Balagtas, founder of The Design Futures Initiative at McKinsey, discusses the value of building future scenarios at his talk at Google (Google Design, 2019). One of his examples, the Apple Knowledge Navigator, from an Apple vision video in 1987, took two decades to materialize in the real world, 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 - and then another 2 decades, until the launch of the iPhone in 2007 - a total of 40 years!
- 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.
- **"Speculative Design" for a sustainability assistant**
  - Barendregt & 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.
  - Google Design (2019)
  - All green categories — Green hub — Ask the user to prioritize

Fast Fashion

"Young Consumers' (Complicated) Love For Fast Fashion In 3 Stats" (n.d.): Young people are the largest consumers of fast fashion.

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

Sustainable Fashion, Textile Design

- 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 tons of CO2, 92 million tons of textile waste.
- 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. Köhler et al. (2021): Globally 87% of textile products are burned or landfilled after 1st consumer use.
- Marrucci et al. (2020) Italian retail supermarkets carbon footprint?
- Leung & 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."
- Millward-Hopkins et al. (2023) shows how half of the textile waste in the UK is exported to other countries.
- Mabuza et al. (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.
- 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.
- imperfectidealist (2020) Fashion sustainability vs greenwashing
- "Transparency and Sustainability Platform - Renoon" (2023) Ethical Shopping
- "Sheep Inc. - Softcore Radicals" (2023) Ethical brand?
- Good On You (2023) Sustainable fashion company evaluations
- *Lily | Mindful + Active Living on Instagram* (n.d.) Garment Worker's rights

- **Problem**: Emily Chan (2022a) report says there's not enough transparency in fashion:
- Emily Chan (2022c): fashion companies can't be held accountable for their actions (or indeed, their lack of action).
- WikiRate (2023)
- *Instant Gratification for Collective Awareness and Sustainable Consumerism* (2022): "Political consumerism", "Instant Gratification for Collective Awareness and Sustainable Consumerism"
- FashionChecker (2023)
- Eesti Disainikeskus I Estonian Design Centre (2021) Circular textiles
- (**EKAArendasEuroopa2022?**) Sustainable Fashion education
- Fashion Revolution Foundation (2022) Fashion transparency index
- "Clean Clothes Campaign" (n.d.)
- "The mainstream fashion industry is built upon the exploitation of labor, natural resources and the knowledge of historically marginalized peoples."
- *Textile Genesis* (n.d.)
- "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)
- "New Standard Institute" (n.d.)
- *BGMEA | Home* (n.d.) 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 CO2, 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
- *SOJO - Door-to-Door Clothing Alterations and Repairs* (2023) Alterations and repairs made easy
- "Good On You - Sustainable and Ethical Fashion Brand Ratings" (2023) Ethical brand ratings

Food Waste

- Nabipour Afrouzi et al. (2023): "The agricultural sector contributes to approximately 13.5% of the total global anthropogenic greenhouse gas emissions and accounts for 25% of the total CO2 emission."

There are several initiatives to reduce food waste by helping people consume food that would

otherwise be throw away.

Name	Link	
Karma	https://apps.apple.com/us/app/karma-save-food-with-a-tap/id1087490062	
ResQ Club	https://www.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)		

- Poore & 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 CO2 emissions.
- Röös et al. (2023) identified 5 perspectives in a small study (*n=106*) of views on the Swedish food system:

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"

- ***Design Implication***: Where to shop rankings for groceries — list worst offenders in terms of products — shop and invest according to your values.
- 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 Financial Times (2022)

Quantified Self

There is a lot of research on quantified self. the Wearable devices like Apple Watch, Oura Ring and apps help users track a variety of health metrics. Can we also track personal sustainability in a similar fashion?

- Delclòs-Alió et al. (2022) discusses walking in Latin American cities. Walkin is the most sustainable method or transport but requires the availability of city infrastructure, such as sidewalks, which many cities still lack.
- Giannakos et al. (2020) used wearable devices to measured physiological parameters of students at school to determine their learning efficiency.
- Shin et al. (2019) synthesis review of 463 studies shows wearable devices have potential to influence behavior change towards healthier lifestyles.
- Tsai et al. (2019)
- Burger et al. (2019)
- Aromatario et al. (2019) behavior changes
- X. Liu et al. (2019) tracks how wearable data is used for tracking sleep improvements from exercise
- Ayoola et al. (2018) wellbeing data
- Godfrey et al. (2018)
- Thomas et al. (2018)
- Tonne et al. (2017)
- Grigsby-Toussaint et al. (2017) Sleep apps and behavioral constructs
- Anselma et al. (2017)
- Forlano (2017) post-humanism and design
- Saubade et al. (2016) motivating physical activity
- Greenbaum & Gerstein (2016)

- Millings et al. (2015)
- Reis et al. (2015)
- Bower & Sturman (2015)
- Fletcher (2022)
- Ryan (2022)
- Emir Hidayat et al. (2022)
- Tyler et al. (2022)
- Wirani et al. (2022)
- Baptista et al. (2022) apps for sleep apnea
- Almeida et al. (2022)

Circular Design

- Circle Economy (2022) reports only 8.6% of world economy is circular and *100B tonnes of virgin materials* are sourced every year.
- There's a growing number of companies providing re-use of existing items.
- Hedberg & Šipka (2021) argues digitalization and data sharing is a requirement for building a circular economy.
- *SmartSwap* (n.d.) For example, Swap furniture in Estonia
- McDonough & Braungart (2002) book
- Dull (2021) book

Designing for Sustainability encompasses all human activities, making this pursuit an over-arching challenge across all industries. Assuming that as individuals we want to act in a sustainable way, how exactly would be go about doing that?

- (see IEA, 2022) reports "Global CO2 emissions from energy combustion and industrial processes rebounded in 2021 to reach their highest ever annual level. A 6% increase from 2020 pushed emissions to 36.3 gigatonnes"
- Crippa et al. (2022) reports latest figures from the EU's Emissions Database for Global Atmospheric Research (EDGAR)
- Growing public understanding of how nature works and intersects with our use of money.
- Daniel Värjö (2022): hThe EU Copernicus satellite system reveals new greenhouse emissions previously undetected

AI can help us make sense of the vast amounts of sustainability data generated daily.

- Gupta et al. (2023) argues software is key to building more sustainable products, already for decades. More recently, companies like AutoDesk are putting CO2 calculations inside their design software.
- "Sustainability Starts in the Design Process, and AI Can Help" (n.d.): "Sustainability starts in the design process, and AI can help".

- iGenius (2020)
- "Carbon pricing is not there to punish people."
- "It's there to remind us, when we take travel, heating, consumption decisions that the true cost of fossil fuels comprises not only mining and processing, but also the damage done by the CO2 they release."
- Very simple." Lion Hirth Lion Hirth (n.d.)
- Chapman (2009) argues in his seminal paper (and later in his book) for "Emotionally Durable Design", the simple idea that we hold to things we value and thus they are sustainable. We don't throw away a necklace gifted to us by mom, indeed this object might be passed down for centuries. Rose (2015) has a similar idea, where "Enchanted Objects" become so interlinked with us, we're unlikely to throw them away.
- "Evolution of design for sustainability: From product design to design for system innovations and transitions"

Eco-Design

Legislation

- *EU Taxonomy for Sustainable Activities* (n.d.) report: The EU has a ***taxonomy of environmentally sustainable economic activities*** published by the Technical Expert Group (TEG) on sustainable finance .
- Virginijus Sinkevičius, EU Commissioner for the Environment, Oceans and Fisheries, is quoted as describing eco-design "respects the boundaries of our planet" European Commission (2022b)
- European Parliament (2022) proposal "On 30 March 2022, the European Commission put forward a proposal for a regulation establishing a general framework for setting ecodesign requirements for sustainable products, repealing rules currently in force which concentrate on energy-related products only."
- Manzardo et al. (2021) **(need access!)**
- Iñarra et al. (2022) **(need access!)**
- Munaro et al. (2022) **(need access!)**
- Bassani et al. (2022) **(need access!)**
- There are many domain-specific research showing how varied industries can develop eco-designed products. For example, Duriez et al. (2022) shows how simply by reducing material weight it's possible to design more sustainable transportation.
- Van Doorsselaer (2022) **(need access!)**

- de Otazu et al. (2022) **Life Cycle Assessment and environmental impact analysis are needed to provide ecodesign scenarios.**
- Nuez et al. (2022) shows how electric vehicles may increase CO2 emissions in some areas, such as Canary Islands, where electricity production is polluting.
- Rossi et al. (2022) shows how introducing sustainability early in the design process and providing scenarios where sustainability is a metric, it's possible to achieve more eco-friendly designs.
- Tiernan et al. (2022) microplastics are a real concern
- Arranz et al. (2022) developing circular economy is really complex
- Cheba et al. (2022)
- Ruiz-Pastor et al. (2022)
- Miyoshi et al. (2022) takes the example of ink toner bottles and shows in a case study how standardized compatibility between older and newer systems can save resources and results in sustainability savings.

Again, AI has the potential to provide the parameters for sustainability.

- Singh & Sarkar (2023) proposes an AI tool for deciding the suitable life cycle design parameters.
- Finding green products and supporting companies making them
- Supporting legislative changes
- Track you consumption, saving, investing. Shift balance towards saving and investing.
- Nastaraan Vadoodi (2022)
- European Commission (2022a) Ecodesign for sustainable products

Design for Repair

- (**pastorProposingIntegratedIndicator2023?**) proposes a **product repairability index (PRI)**
- Formentini & Ramanujan (2023)

Recycling

- Lenovo (08-29-22) "rethinking product design and inspiring consumers to expect more from their devices"
- "design is a tool to make complexity comprehensible" like the Helsinki chapel. there's either or a priest or a social worker. it's the perfect public service. "limit the barrier of entry for people to discover". elegant.

- Zeynep Falay von Flittner (n.d.)

Packaging

- Bradley & Corsini (2023) "Over 161 million tonnes of plastic packaging is produced annually."
- "Challenges and Opportunities in Sustainable Packaging Today" (2022)
- "Protein Brands and Consumers Alike Focus on Sustainability" (2022)
- "Detail-Rich Sustainable Packaging Product Database Is an Industry First" (2010)
- Lerner (2019) Coca Cola plastic pollution
- "Sulapac – Replacing Plastic" (n.d.)
- Ada et al. (2023) notes rapid growth of the packaging industry which generates large amounts of waste.

Factories

- Factories should be local and make products that can be repaired.
- Carbon-neutral factories "made in carbon-neutral factory" list of products
- Stefan Klebert (2022)
- VDI Zentrum Ressourceneffizienz (2020)
- *CO2-neutral Factories* (n.d.) and *Innocent Opens £200m Carbon-Neutral Factory in Rotterdam - Investment Monitor* (n.d.) CO2 neutral factories?
- *Make Your Website Carbon Neutral and Enhance Your Brand | CO2 Neutral Website* (n.d.) CO2 neutral websites
- Eric fogg (2020) Lights-Out Manufacturing
- Wagenvoort (2020) Self-driving supply chains.. (contact japanese factory?)
- Mowbray (2018) "World's first free digital map of apparel factories"
- Tracing emissions from factory pipes.
- "FFC - Fair Factories ClearingHouse - Compliance Solutions" (n.d.) Factory compliance - Fair Factories
- Transparency about the polluting factories where the products come from.. the product journey
- Planet Factory
- *To the Companies We Have Unveiled in the Plastic Waste Makers Index* (n.d.) Plastic waste makers index, sources of plastic waste

Supply Chains

Circular design is possible if supply chains become circular.

- *GreenDice - Reinventing the Idea of a Computer-Related Tech Purchase* (2021)
- Ärileht (23.09.2022, 12:53) Recycle your phone, FoxWay and Circular economy for PCs
- Several startups are using distributed ledgers (blockchains) to track source material to the factories ad product movements from factories to markets. While blockchains enable securely tracing data, which is immutable (no possible to change the same record, only update data in new records), the system still relies on correct data input. As the saying goes, "garbage in, garbage out". Indeed, the blockchain is most useful for auditing, as the time and place of data input can be guaranteed, it will be easier to conduct a search on who inputted incorrect data.
- The blockchain supply chain companies as of summer 2023 include:

Company	Link
Ocean Protocol	https://oceanprotocol.com/
Provenance	https://www.provenance.io/
Ambrosius	https://ambrosus.io/
Modum	https://www.modum.io/
OriginTrail	https://origintrail.io/
VeChain	https://www.vechain.org/
Wabi	https://wabi.io/
FairFood	https://fairfood.org/
Bext360	https://www.bext360.com/

- Another aspect of supply tracing is the treatment of workers and working conditions. Companies that intend to 2give supply chain a voice" by connecting workers directly to the consumer (even in anonymously, to protect the workers from retribution), include *CTMFile* and *Alexandria*.
- Matthew Gore et al. (2022) reports the International Maritime Organization (IMO) targets cutting CO2 equivalent emissions in shipping 50% by 2050 compared to 2008.
- Sepandar Kamvar (2022) "A blockchain is a database without a database admin"
- Verra (2023) Verra new Methodology Announcement Webinar
- Eisenstein?: "Money is a technology".
- Eisenstein (2011): 5 things, UBI, demurrage, …
- "Blockchain Companies Team Up To Track ESG Data" (2021)
- Ganu (2021)
- Improve product ***provenance***, blockchains offer this transparency

Transparency and Open Data

The key idea is making CO2 Visible.

- When will Bolt show CO2 emissions per every trip?
- How CO2 is shown by Google starts hiding emissions? "Google 'Airbrushes' Out Emissions from Flying, BBC Reveals" (2022)
- 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*
- Google VERY IMPORTANTT Google (2021)
- "Google mostrará por defecto la ruta más 'verde' en su GPS y ordenará los vuelos según su impacto ambiental" (2021) Google green routes
- Wizzair Check carbon impact *Offset Your Flight with WIZZ* (n.d.)

- WikiRate (2021): 7 WikiRate Data Sharing Archetypes

№	Type	Example
1	Transparency Accountability Advocate	
2	Compliance Data Aggregator	
3	Data Intelligence Hub	
4	**Worker Voice Tool**	Caravan Studios (2022): **"Worker Connect"**
5	Traceability tool	https://trustrace.com/
6	Open data platform	
7	Knowledge sharing platform	https://www.business-humanrights.org/

- WikiRate is a tool for checking green credentials Transpareencyy
- Laureen van Breen et al. (2023)
- Wikirate (2022a)
- *Home - ChainReact* (n.d.)
- "Sveriges Dataportal" (n.d.) Swedish open data portal
- Make open data easy to use in everyday life
- Digitalisation *Digital Receipts and Customer Loyalty in One Platform | ReceiptHero* (n.d.) Digital Receipts to be able to track your carbon footprint

Carbon Labels

- Adam Corner (2012): Adding CO2 labels for consumer products have been discussed for decades.

- While academic literature has looked at even minute detail such as color and positioning of the label (Zhou et al. (2019)) and there is some indication consumers are willing to pay a small premium for low-CO2 products (Xu & Lin (2022)) as well as all else being equal, choose the option with a lower CO2 number (Carlsson et al. (2022)), the idea of *Carbon Labelling* is yet to find mainstream adoption.
- Although there's some evidence to suggest labeling low CO2 food enables people to choose a *climatarian diet* in a large-scale study Lohmann et al. (2022) of UK university students, their impact on the market share of low-carbon meals is negible.
- 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 CO2 labeled meat products.
- Labels alone are not enough, as underlined by Edenbrandt & 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.
- Brian Kateman (2020): 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* provide carbon labeling on their products.
- Ibid and 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.
- Ivanova et al. (2020): The average per capita carbon footprint of North America 13.4, Europe 7.5, Africa and the Middle East 1.7 tonnes of CO2 equivalent per capita.
- Ivanova et al. (2020) "establish consumption options with a high mitigation potential measured in tons of CO2 equivalent per capita per year."
- 55% of emissions come from energy production.
- American Press Institute (2022) finds that only 37% percent of U.S. Gen-Z and Millenials follow news related to environmental issues.
- Carto (2023) Making advanced maps to convince people to make changes
- Cohen & Vandenbergh (2012) argues carbon labels do influence consumer choice towards sustainability.
- Crippa et al. (2022) shows global emissions 4.81 tonnes CO2 per capita. World Resources Institute (2020) shows the top 5 largest per capita CO2 emissions come from Oil Producers - Qatar, Kuwait, Bahrain, United Arab Emirates, Brunei Darussalam in 2020.
- European Commission. Joint Research Centre. (2022) provides CO2 emissions for all the countries around the world, per total emissions the top 10 are China, U.S.A. the European Union, India, Russia, Japan, Iran, South Korea, Indonesia, and Saudi Arabia as of 2021.

Digital Product Passports

It's a further development of the idea of carbon labels.

- Nissinen et al. (2022) reports The European Commision has proposed a *Digital Product Passports* to help companies transfer environmental data. Carbon labels are needed for green transformation.
- Jensen et al. (2023)
- King et al. (2023)
- Reich et al. (2023)
- K. Berger, Rusch, et al. (2023)
- Plociennik et al. (2022)
- K. Berger, Baumgartner, Weinzerl, Bachler, & Schöggl (2023)
- K. Berger, Baumgartner, Weinzerl, Bachler, Preston, et al. (2023)
- Van Capelleveen et al. (2023)

Extended Producer Responsibility

- Steenmans & Ulfbeck (2023) Argues for the need to engage companies through legislation and shift from waste-centered laws to product design regulations.
- Peng et al. (2023) finds that the Carbon Disclosure Project has been a crucial tool to empower ERP in Chinese auto-producers.
- K. Liu et al. (2023) reports, e–waste is growing 3%–5% every year, globally. Thukral & Singh (2023) identifies several barriers to e-waste management among producers including lack of awareness and infrastructure, attitudinal barriers, existing *informal* e-waste sector, and the need for an e-waste license.
- In Europe, there's large variance between member states when in comes to textile recycling: while Estonia and France are the only EU countries where separate collection of textiles is required by law, in Estonia 100% of the textiles were burned in an incinerator in 2018 while in France textiles are covered by an Extended Producer Responsibility (EPR) scheme leading to higher recovery rates (Ibid).
- Christiansen et al. (2021): Nonetheless, EPR schemes do not guarantee circularity and may instead be designed around fees to finance waste management in linear economy models.
- Jacques Vernier (2021): French EPR scheme was upgraded in 2020 to become more circular.

- In any case, strong consumer legislation (such as EPR) has a direct influence on producers' actions. For example, in HKTDC Research (2022)@, the Hong Kong Trade Development Council notified textile producers in July 2022 reminding factories to produce to French standards in order to be able enter the EU market.

Design implications: *ERP and CDP data should be part of Green Filter.*

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