Sustainability Webinar Series • June 2025

Systemic and concrete methods and tools to address environmental complexity and rebound effects within a design or decision-making process

Laetitia BORNES
laetitia-bornes.notion.site
linkedin.com/in/laetitia-bornes-design

PhD supervised by
Catherine LETONDAL | ENAC
Rob VINGERHOEDS | ISAE-SUPAERO

Keywords
sustainability, socio-technical systems, HCI, ICT, design, decision-making, complexity, systems thinking, systemic design, systems dynamics, indirect effects, rebound effect, socio-environmental impacts design methods, design cards, modelling, prospective scenarios

Laetitia Bornes

Academic background

2009-2012
Master of Engineering
ENTPE, Lyon, France

Bachelor of Architecture
ENSAL, Lyon, France

2012-2014
Master of Architecture
ENSAPVS, Paris, France

2016-2017
Master of Digital Design
Gobelins, Paris, France

2021-2024
PhD in Computer Science
ENAC & ISAE-SUPAERO

+ 3 months at Lancaster, UK
(Socio-Digital Sustainability)

2025
Independent researcher
Laetitia Bornes Design

2015
Architect
Architectes de l'urgence,
Amiens, France

2016-2020
UX/UI Designer
Ingenuity, Toulouse, France

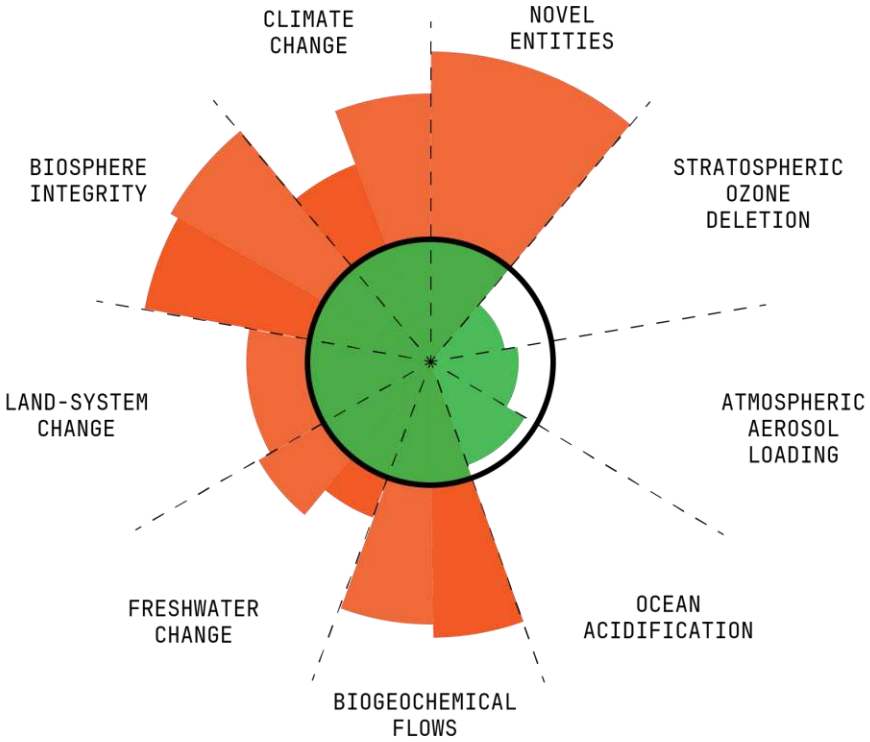
2018
Akiani, Bordeaux, France

2020-2021
UX/UI Designer
Laetitia Bornes Design,
Toulouse, France

Work experience

Context & motivation

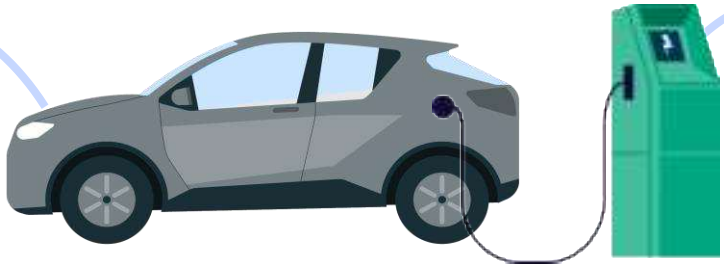
The planetary situation is alarming



The planetary boundaries framework.
Inspired from: Azote for Stockholm Resilience Centre, Stockholm University. Based on Richardson et al. 2023.

Urgent action is needed, but it's far from simple…

techno-solutionist approaches
used so far do not work



optimising car engines
↓
increasing overall fuel consumption

batteries production
↓
socio-environmental impacts due to mining

Faced with this urgent and complex situation, what can digital designers do?

Sustainable HCI*, ICT* and SE*

*'sustainability and unsustainability are conditions of a "**system as a whole**"'*

[Knowles et al., 2018]

- imagining new ways of living
- interactions between sectors
- different time scales
- all socio-environmental impacts

*'it has often fallen short on practical advice and on suitable techniques that are **concrete enough to be actionable**'*

[Raghavan & Pargman, 2017] quoted in [Bremer et al., 2022]

Could designers take a practical approach to such a huge problem without being reductive?

*HCI: Human-Computer Interaction

*ICT: Information and Communication Technology

*SE: Systems Engineering

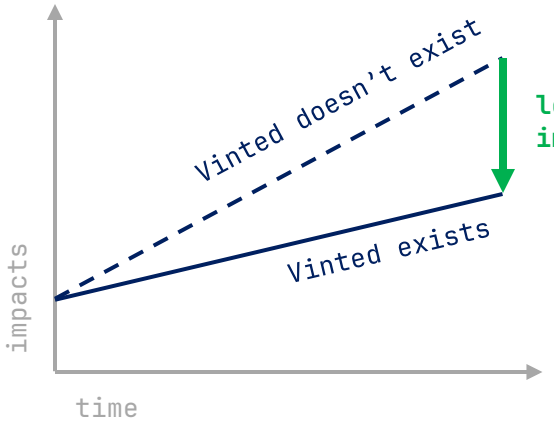
Vinted | Second hand resale platform

Vaayu study on Vinted avoided emissions

Avoided emissions = **453 ktCO2eq** (**1.8kgCO2eq** per purchase)

Vaayu, “Vinted Climate Change Impact Report,” Vaayu, 2021

What is behind this calculation?



Consequential approach

BUYERS

If Vinted didn't exist, you would have bought this item...

(a) brand new
(b) second hand (elsewhere)
(c) no, I was just browsing...

SELLERS

If Vinted didn't exist, you would have...

(a) sold this item elsewhere
(b) given this item to charities
(c) thrown it...

Consequential LCA based on a 350,000 Vinted users survey
Vaayu, "Vinted Climate Change Impact Report," Vaayu, 2021.

Some direct and indirect effects of Vinted

Considered in Vaayu study		Partially considered	Not considered	
 Impacts due to parcel delivery, digital platform and Vinted operations	 Avoided impacts due to buying second-hand items instead of new ones	 Additional impacts due to impulse buys while scrolling on the platform	 Additional impacts related to how money from sales is spent	 Decline in charities' social activities due to a drop in donations

direct impacts ··········► indirect impacts

E. Juge, "La fabrique des conso-marchands: une approche par les dispositifs sociotechniques dans le contexte de la consommation collaborative," Ph.D. dissertation, Univ. of Lille, 2018.
Vaayu, "Vinted Climate Change Impact Report," Vaayu, 2021.

Some direct and indirect effects of Vinted

Considered in Vaayu study | Partially considered | Not considered

Impacts due to parcel delivery, digital platform and Vinted operations

second-hand items instead of new ones

impulse buys while scrolling on the platform

to how money from sales is spent

Decline in charities' social activities due to a drop in donations

direct impacts → indirect impacts

→ it is complex to intervene in a sociotechnical system & achieve beneficial socioenvironmental impacts

→ the figure produced by the Vaayu report does not help designers to improve the socioenvironmental impacts

E. Juge, "La fabrique des conso-marchands: une approche par les dispositifs sociotechniques dans le contexte de la consommation collaborative," Ph.D. dissertation, Univ. of Lille, 2018.
Vaayu, "Vinted Climate Change Impact Report," Vaayu, 2021.

Research question

&

Approach

Main research question

How might designers and decision-makers be empowered with **practical methods and tools** to thoughtfully consider the **indirect and rebound effects** of their interventions throughout the design and decision-making process?

Research approach

“Systemic modelling methodology”

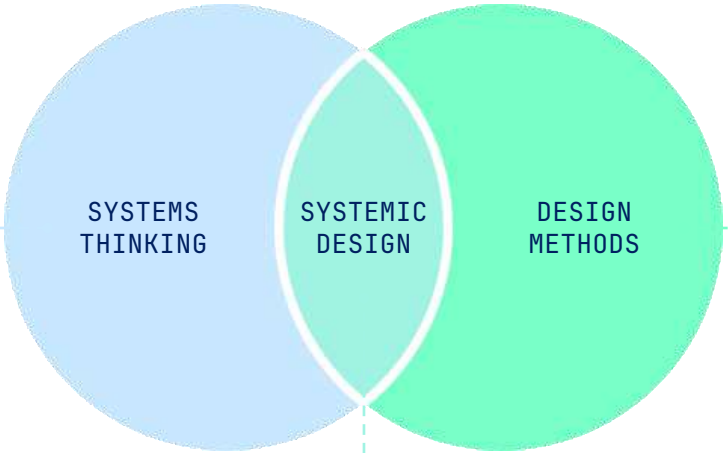
a methodology to help designers tackle rebound effects

How might designers and decision-makers be empowered with **practical methods and tools** to thoughtfully consider the **indirect and rebound effects** of their interventions throughout the design and decision-making process?

Exploratory approach

constructivist-interpretive, based on *action-research*, *research through design*, and *case study* methodology

Inspired by the consequential approach & Systemic design



Systems thinking
interdisciplinary
research field and world-view
opposed to reductionism
importance of interactions within a system, non-linear behaviours, and emergence phenomena.

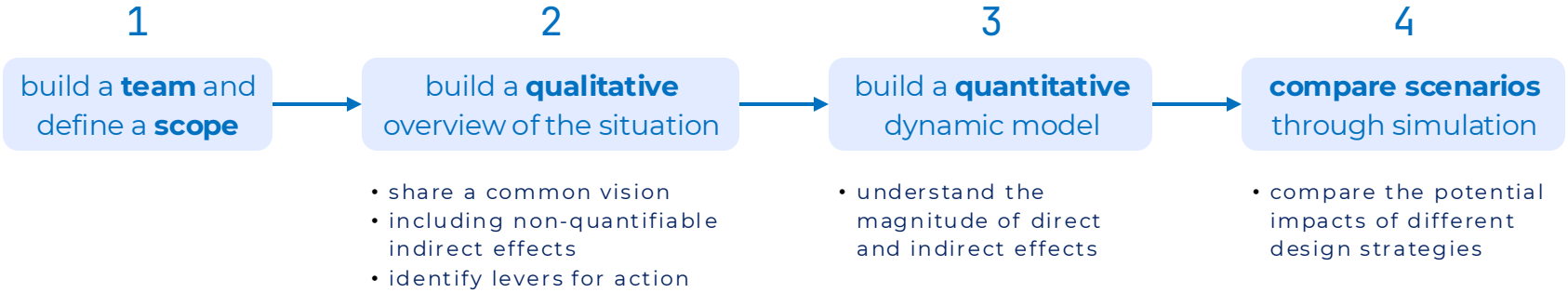
Design methods
non-linear, iterative process
understand users, challenge assumptions, redefine problems and create innovative solutions that are prototyped and tested
tackling problems that are ill-defined.

Systemic design
emerging interdisciplinary field of research
to address complex, multiscale problems
at the social and sociotechnical level
with practical methods and tools
Relating Systems Thinking and Design (RSD) conference

Systemic modelling methodology

Steps of the systemic modelling methodology

- inspired from Group Model Building -



1. Requisite variety

"getting the whole system in the room"

[Jones, 2014]

build a **team** and define a **scope** → build a **qualitative** overview of the situation → build a **quantitative** dynamic model → **compare scenarios** through simulation

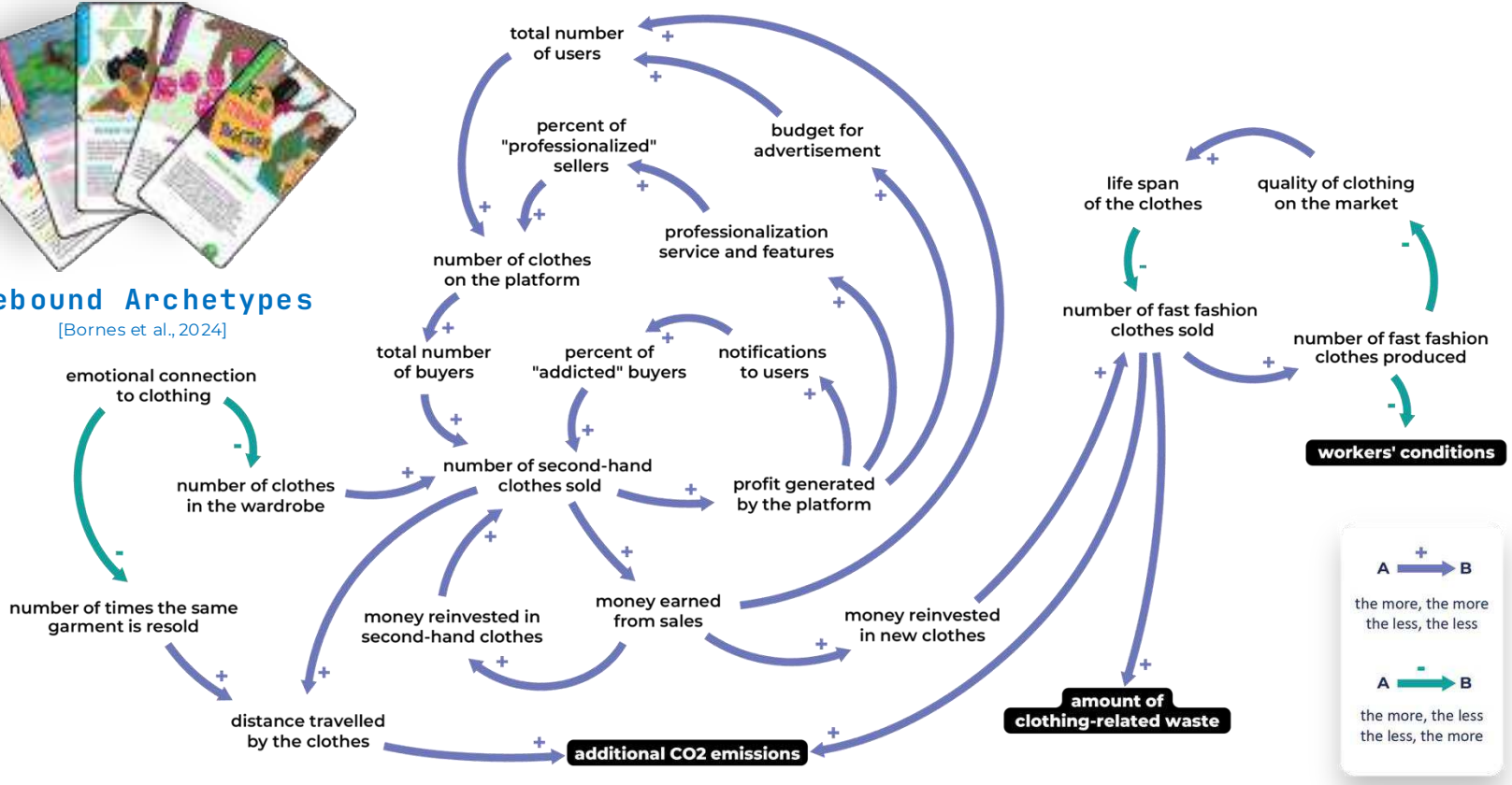
e.g. designers, decision-makers, academics, policy-makers, and citizens

could help to build a more complete picture and reduce the bias/risk of misuse

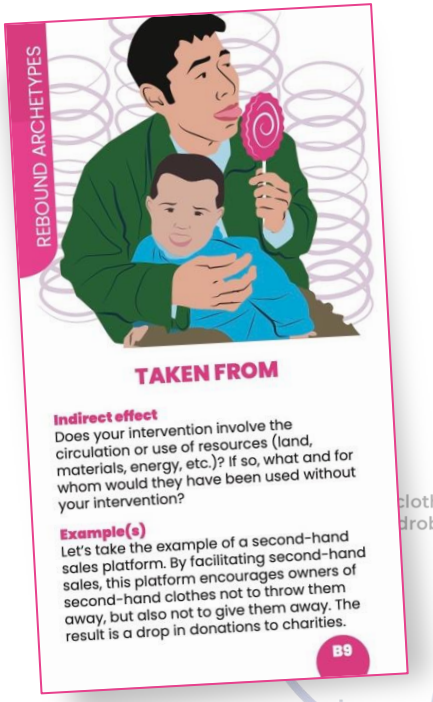
diverse interests represented

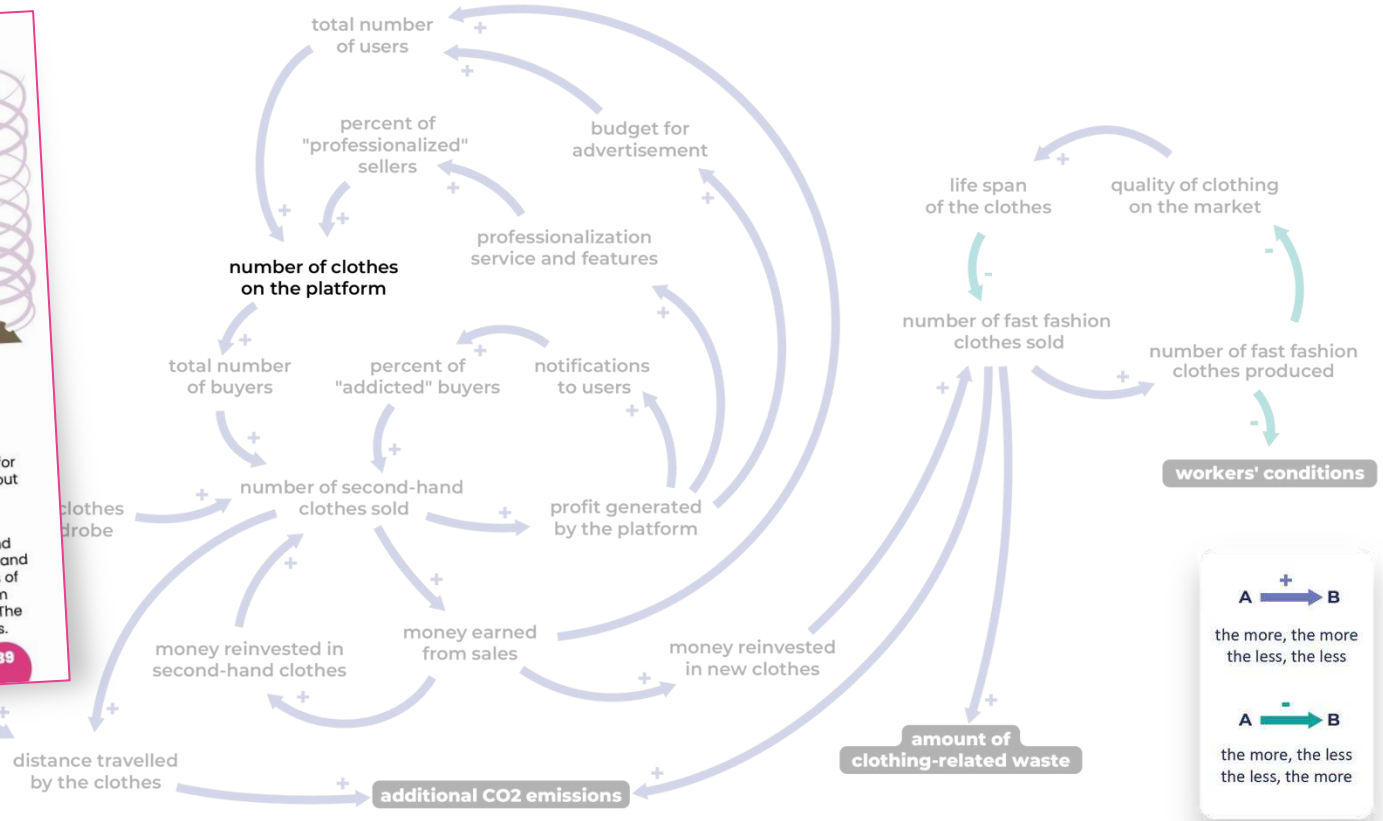
2. Qualitative overview – Causal loop diagram

Rebound Archetypes
[Bornes et al., 2024]

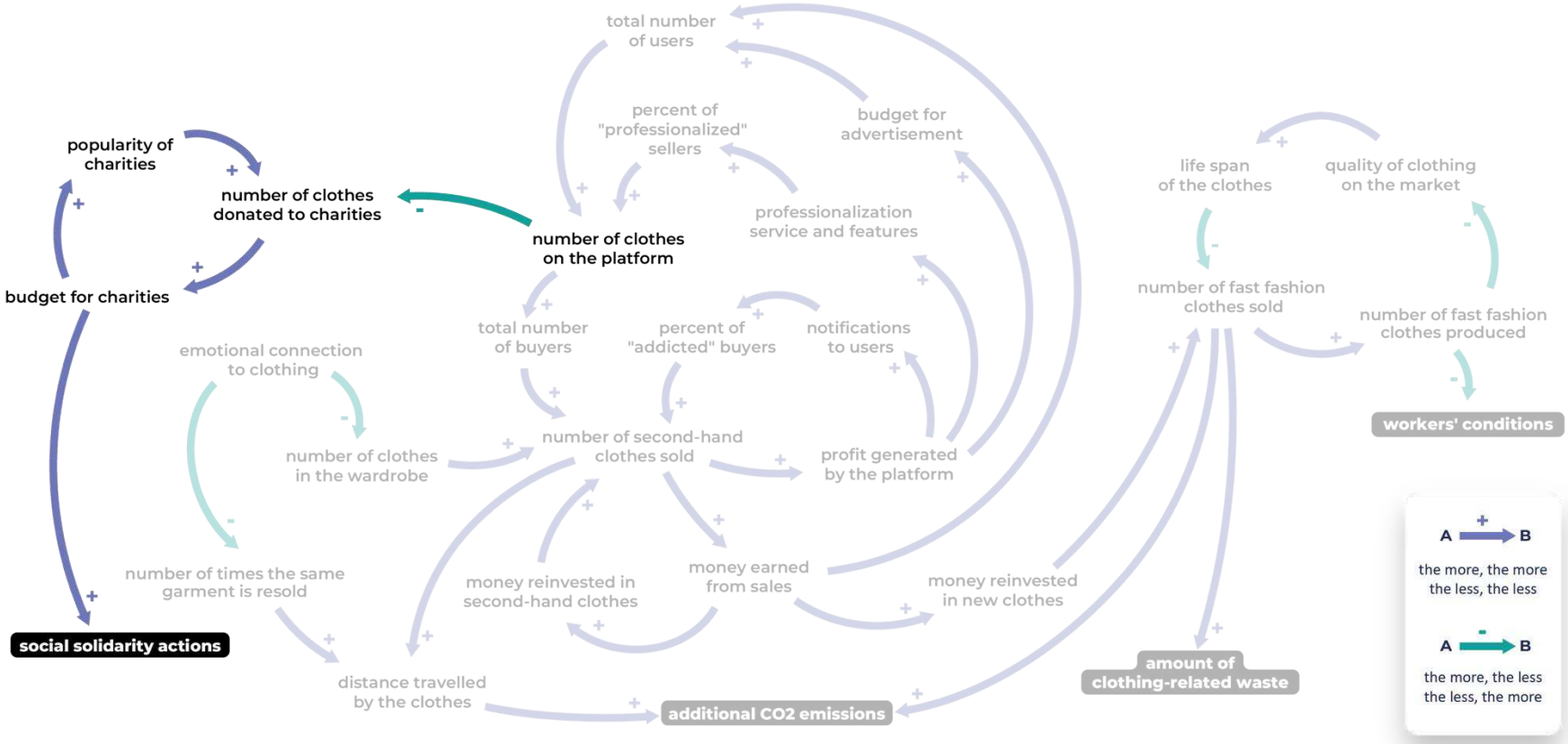


2. Qualitative overview – Causal loop diagram

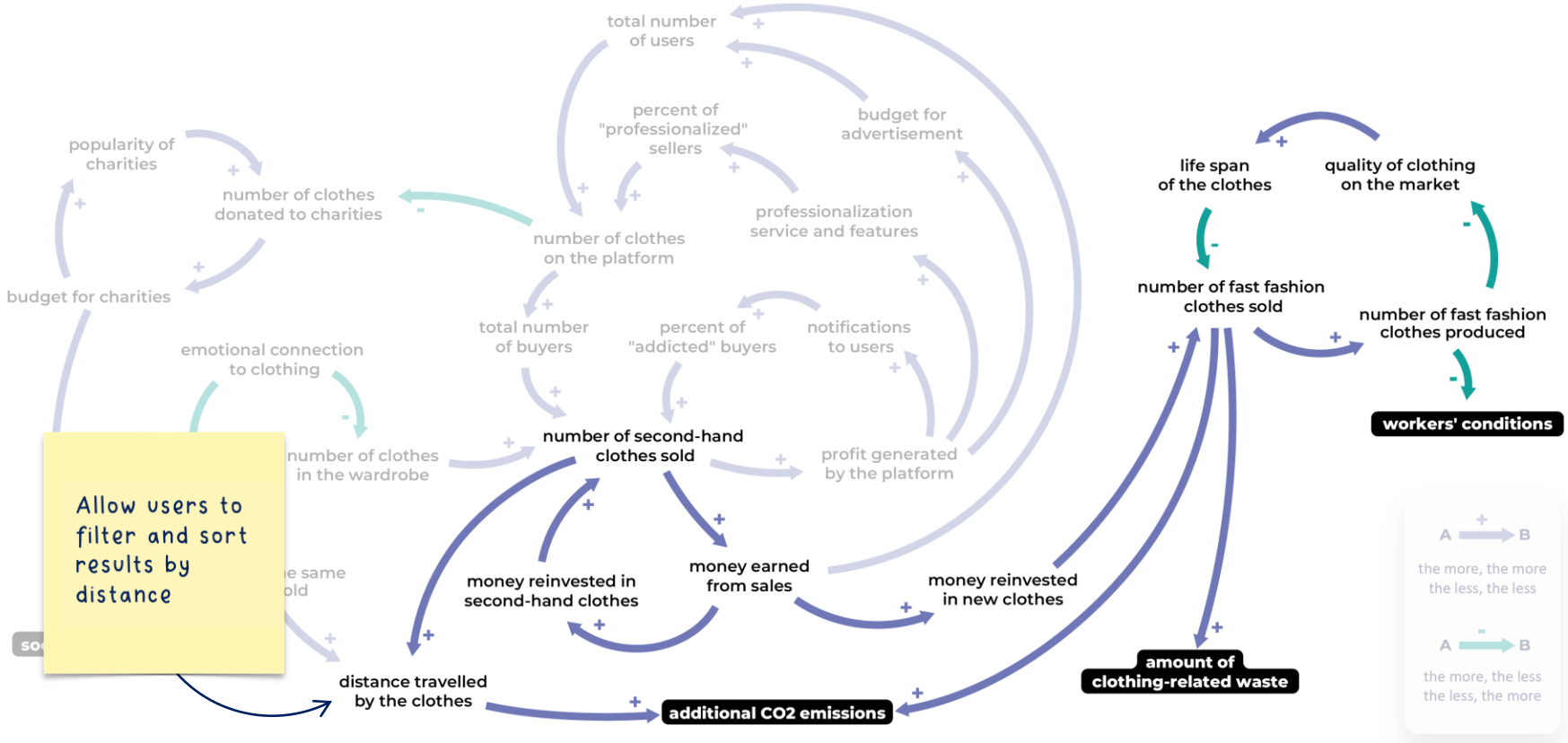




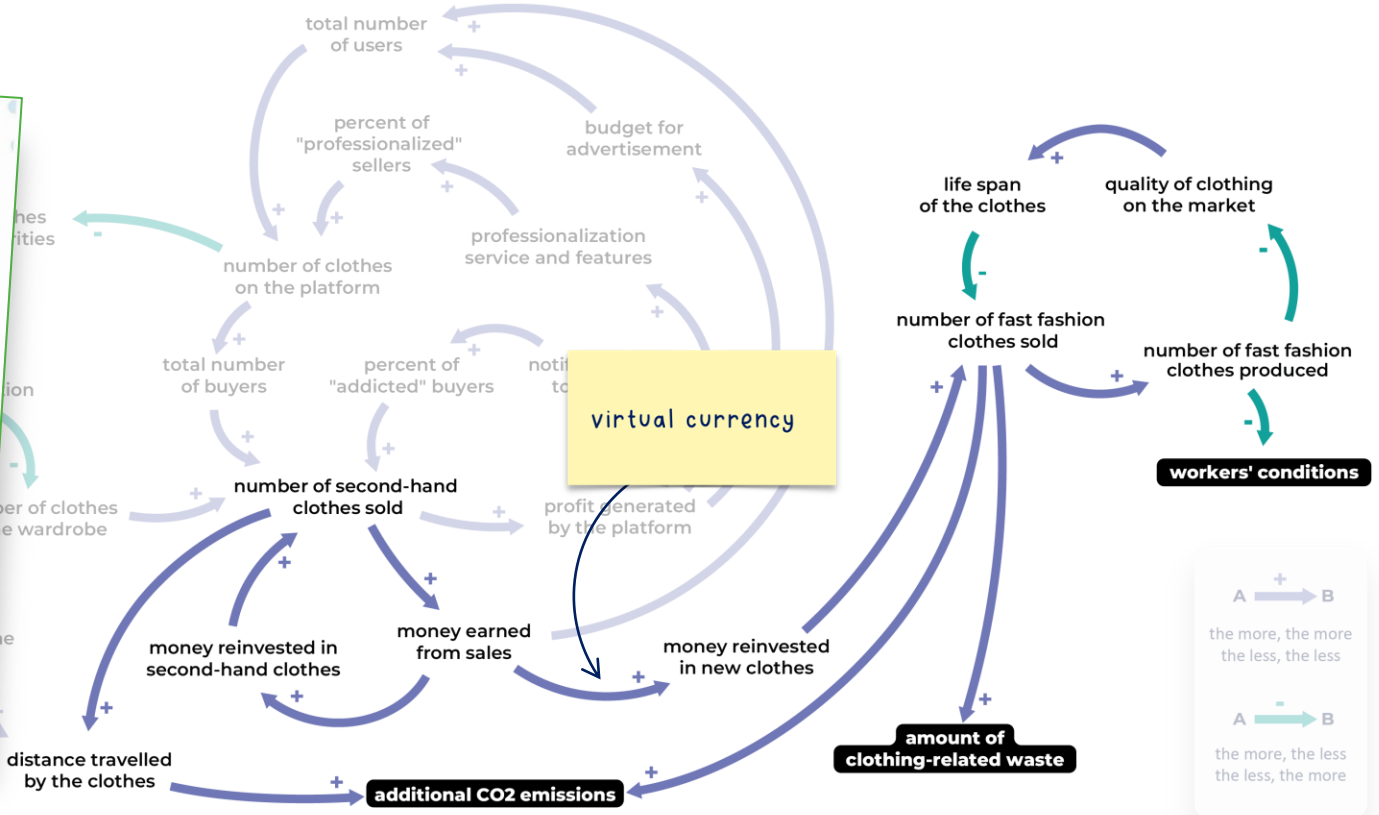
2. Qualitative overview – Causal loop diagram



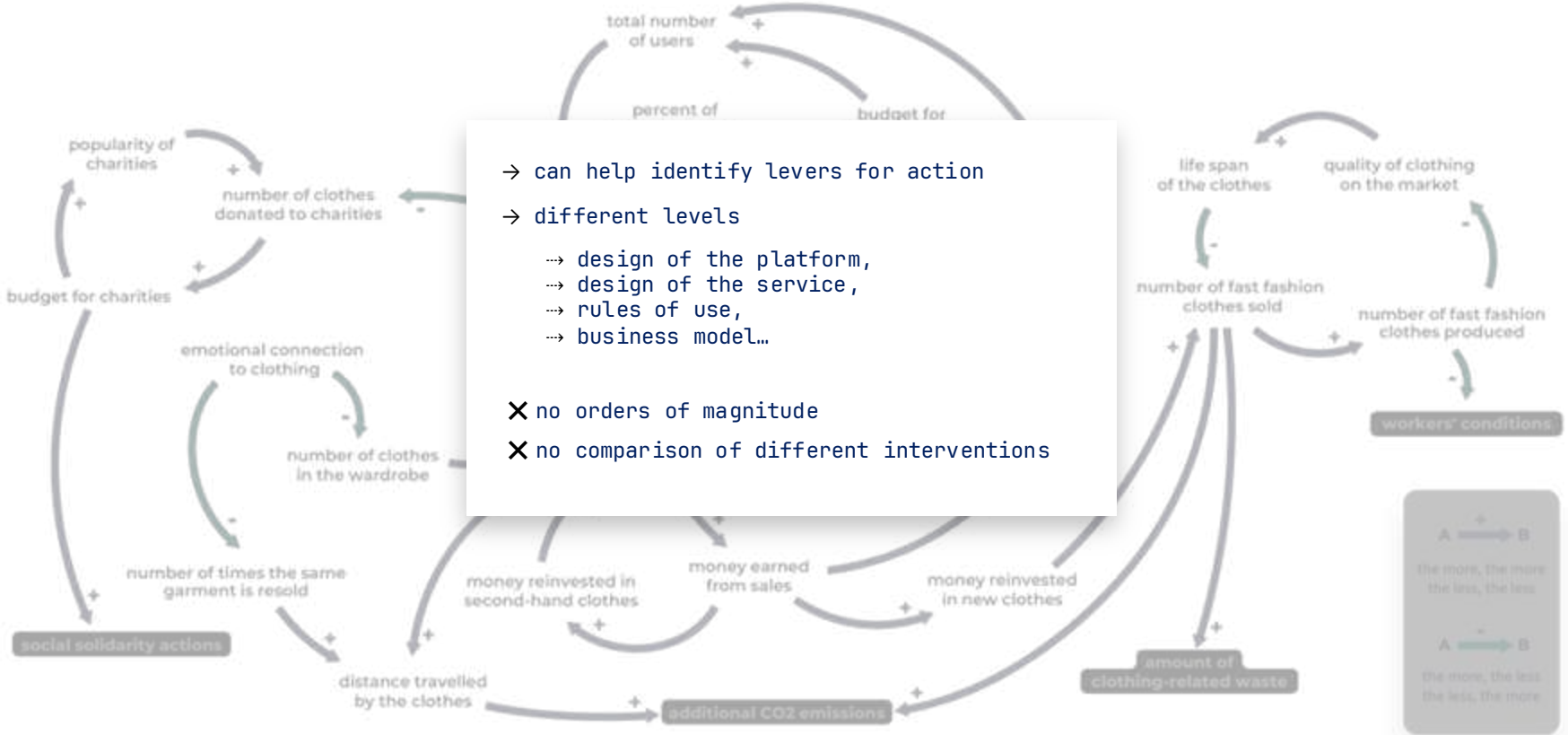
2. Qualitative overview – Causal loop diagram



2. Qualitative overview – Causal loop diagram



2. Qualitative overview – Causal loop diagram



→ can help identify levers for action

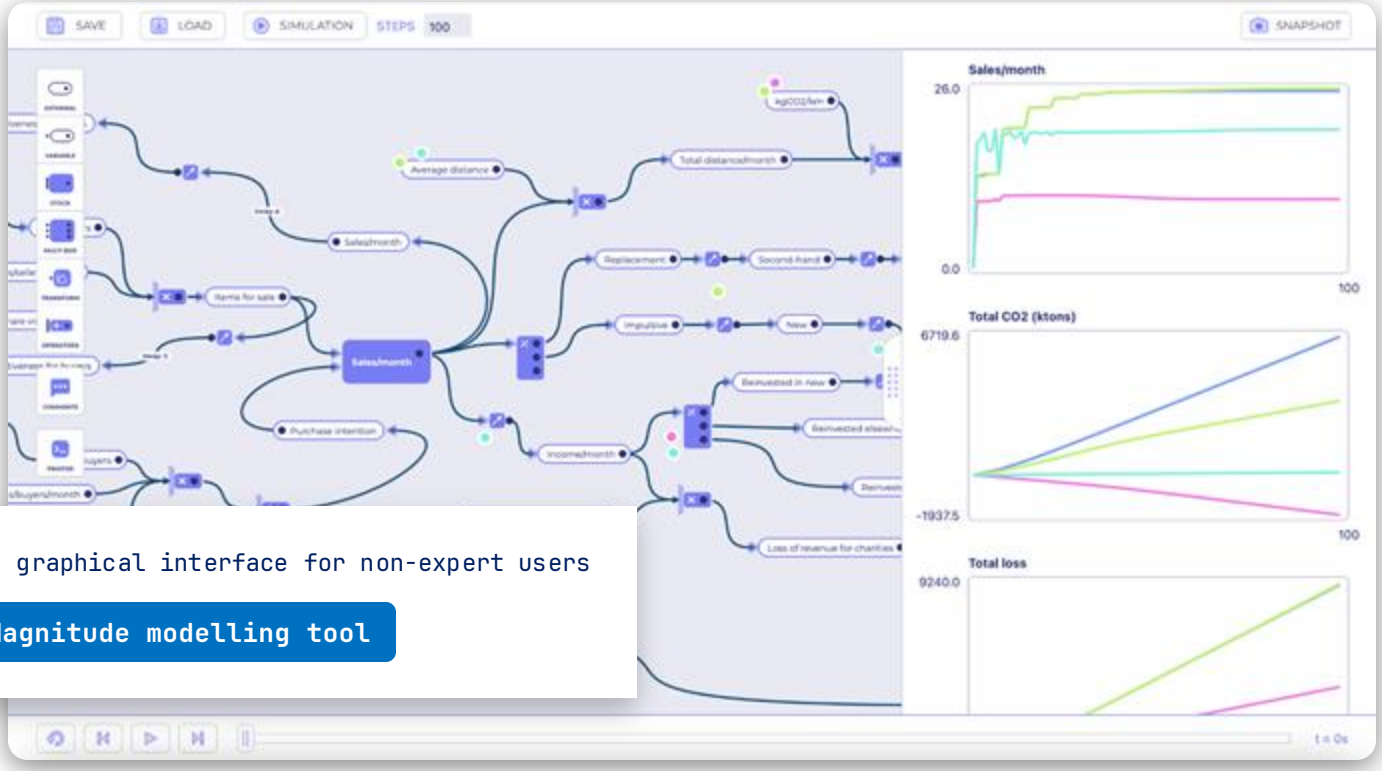
→ different levels

- ⇢ design of the platform,
- ⇢ design of the service,
- ⇢ rules of use,
- ⇢ business model…

✕ no orders of magnitude

✕ no comparison of different interventions

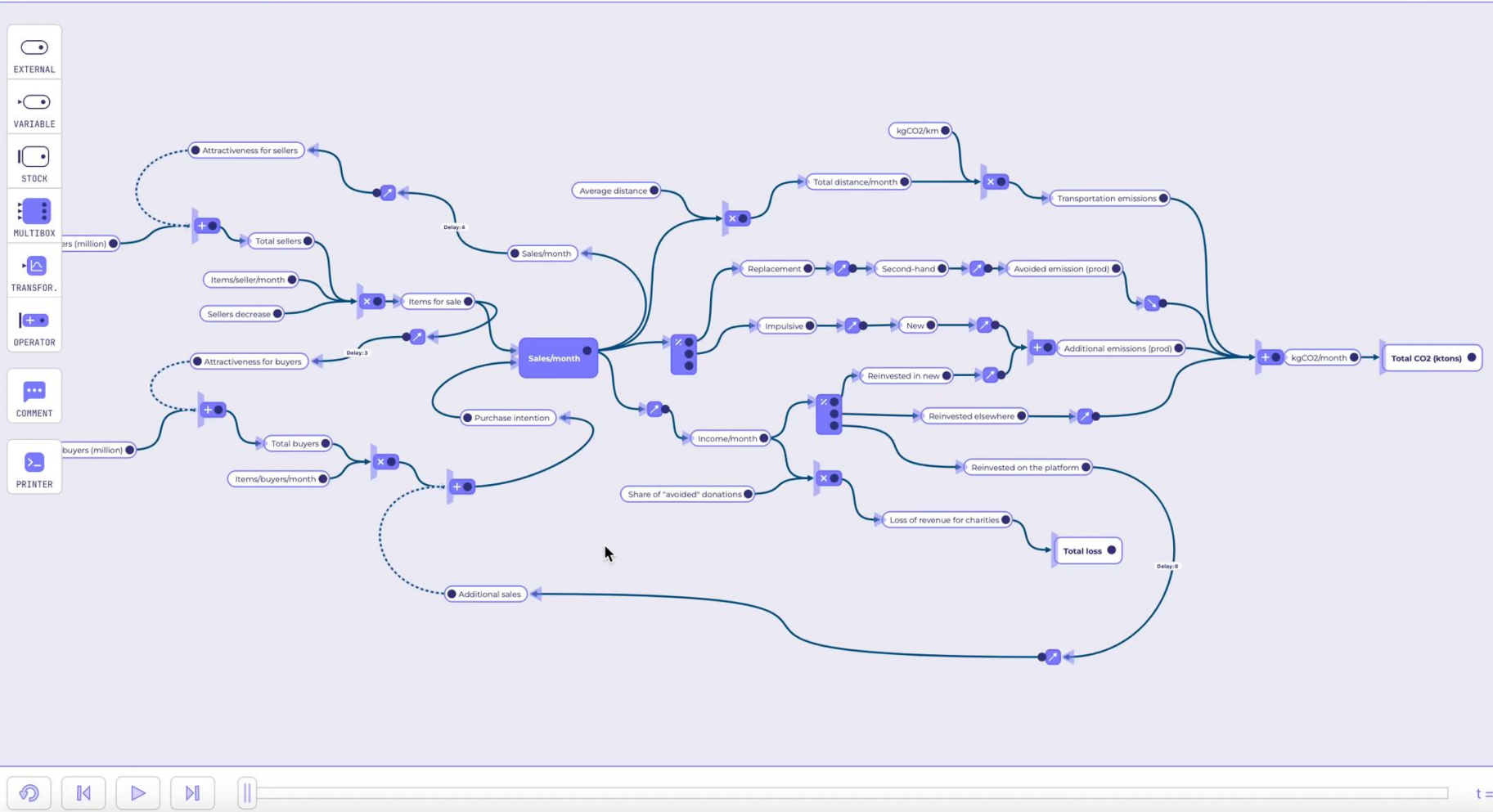
3. Quantitative dynamic model – Magnitude modelling tool



→ a graphical interface for non-expert users

Magnitude modelling tool

https://lii.enac.fr/projects/magnitude/ (interaction with smala (http://smala.io) & calculations in C++)


SAVE
OPEN
SIMULATION
STEPS
100
SNAPSHOT
EXTERNAL
VARIABLE
STOCK
MULTIBOX
TRANSFOR.
OPERATOR
COMMENT
PRINTER
Attractiveness for sellers
Total sellers
Items/seller/month
Sellers decrease
Items for sale
Delay: 4
Delay: 3
Sales/month
Attractiveness for buyers
Total buyers
Items/buyers/month
Purchase intention
Additional sales
Average distance
Total distance/month
kgCO2/km
Transportation emissions
Replacement
Second-hand
Avoided emission (prod)
Impulsive
New
Additional emissions (prod)
Reinvested in new
Reinvested elsewhere
Reinvested on the platform
Income/month
Share of "avoided" donations
Loss of revenue for charities
Total loss
Delay: 6
kgCO2/month
Total CO2 (ktons)
t = 0s

Good practices

identify potential rebound effects

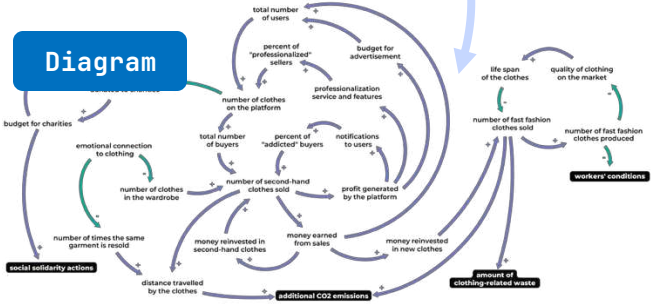
Rebound Archetypes

identify strategies to tackle them

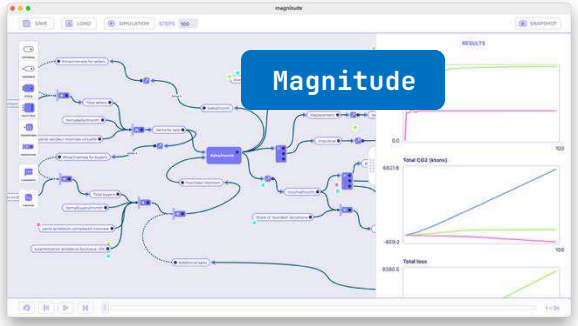
- guide stakeholders throughout the process
- can be used on their own to run quick workshops

build a **team** and define a **scope** → build a **qualitative** overview of the situation → build a **quantitative** dynamic model → **compare scenarios** through simulation

Diagram



Magnitude



Cards to think through the potential indirect effects of a case study

Actants


ACTANTS
5 cards


ACTANTS
DIRECT USERS, BUYERS, CONSUMERS, ETC...
People who are directly targeted by your intervention (e.g. users of your product or service), categorised according to their relationship to it.
Example(s)
In the case of a platform selling second-hand clothes, this would be buyers and sellers. It may be useful to differentiate between professional buyers and occasional buyers.
A1


ACTANTS
PRODUCERS, PROVIDERS, MANUFACTURERS, SELLERS...
The people up and down the supply chain that directly provide elements for and/or make use of your products and services in their businesses.
Example(s)
If your product is shipped in your branded packaging, this could be the owner of the business that prints the packaging used for your products or the person that rides the bike used in the delivery service.
A2


ACTANTS
REGULATORS, GOVERNMENT, ETC...
The people working in organisations that create and monitor the rules that regulate how your product/service can be deployed and used.
Example(s)
Policy-makers creating the laws and regulations for use of social media. Think not just locally, but also on those people working in bodies such as the European Union of the UN.
A4

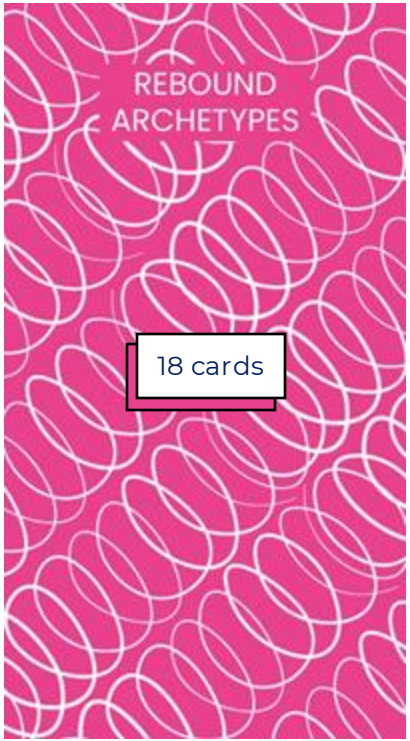
Example

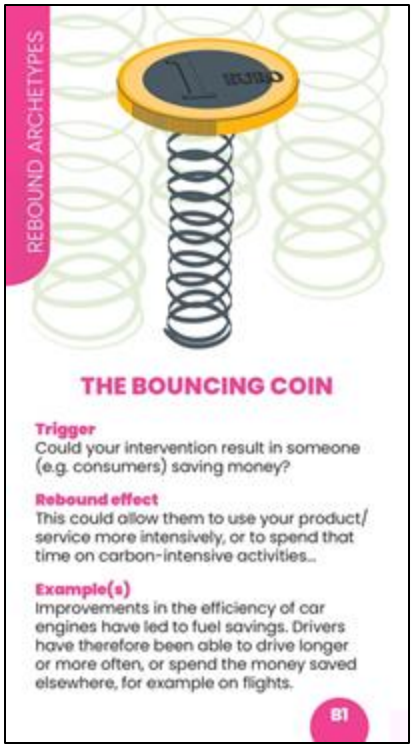
buyers

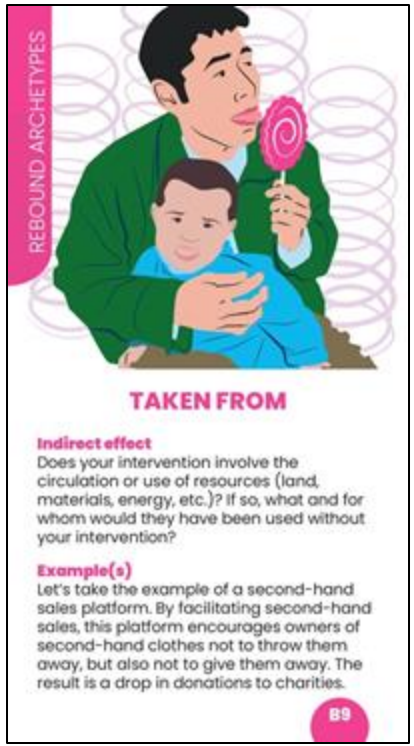
sellers

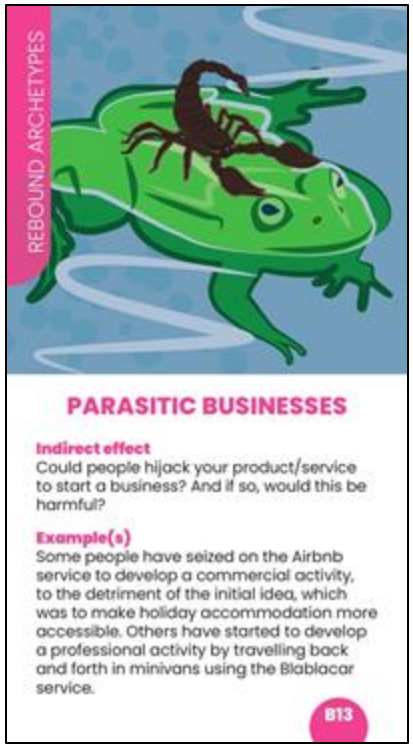
charities

Rebound Archetypes (indirect effects)

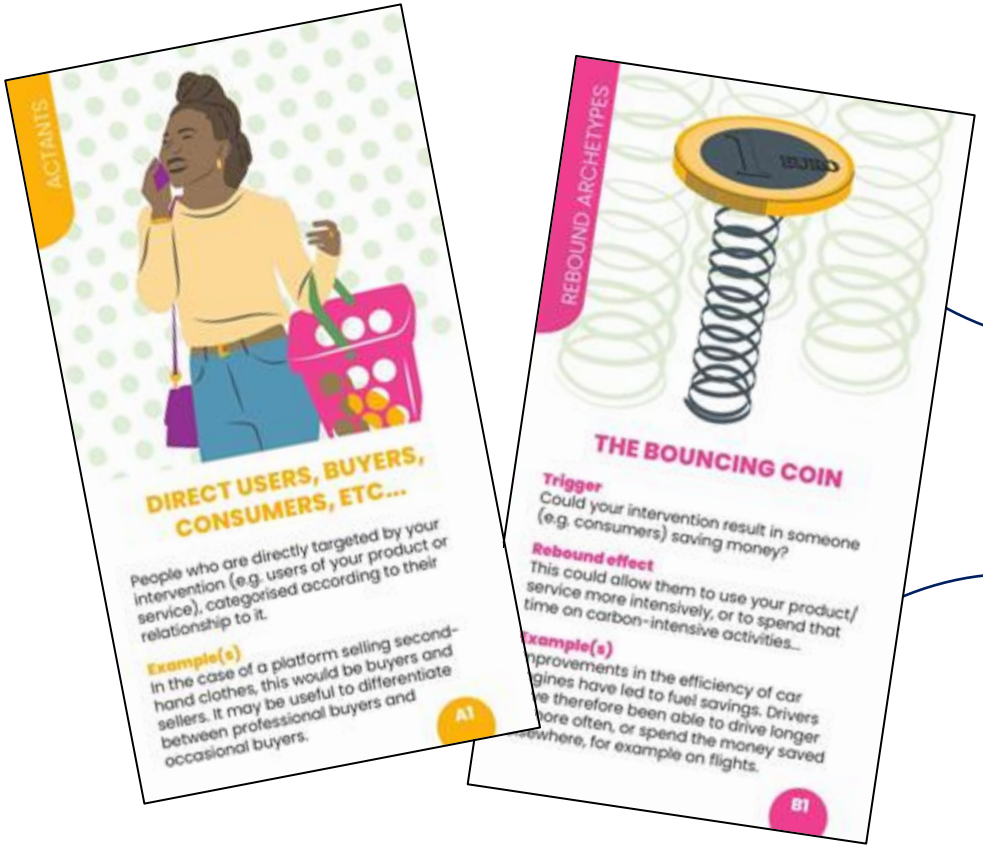








Example



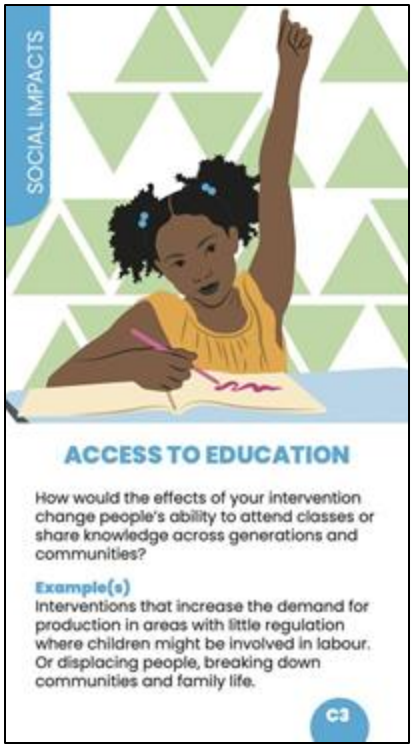
buyers save money and can buy more items (B1)

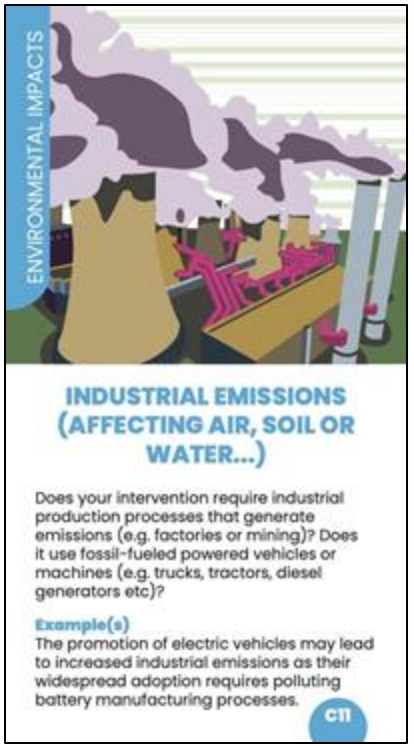
sellers earn money and can buy new fast fashion clothes (B1)

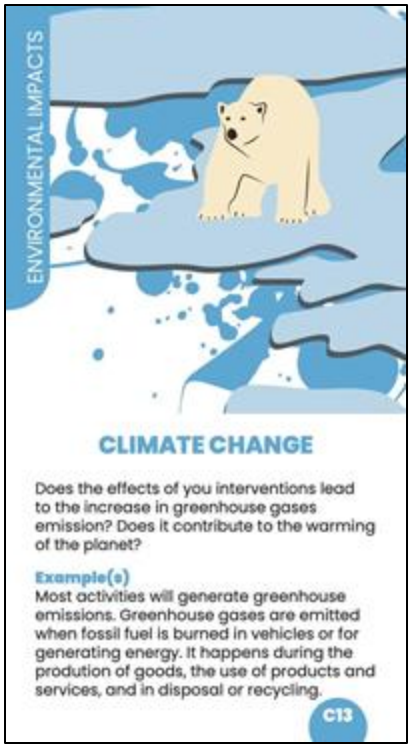
Example

charities receive fewer donations, which impact their actions (B9)

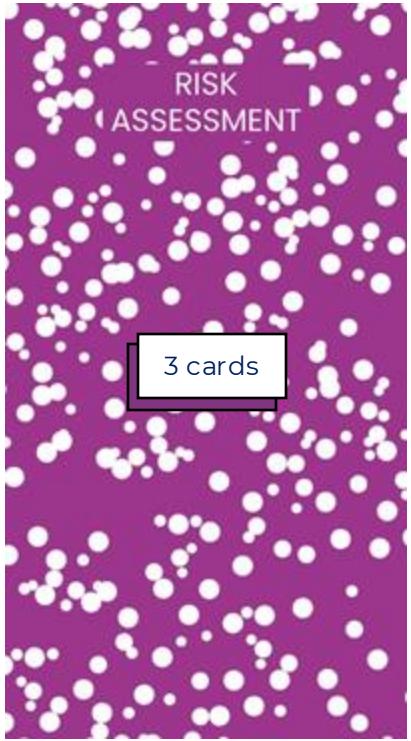
Socio-environmental impacts

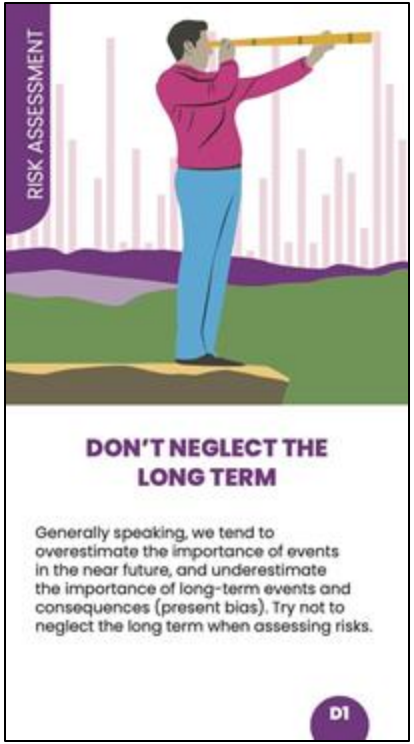


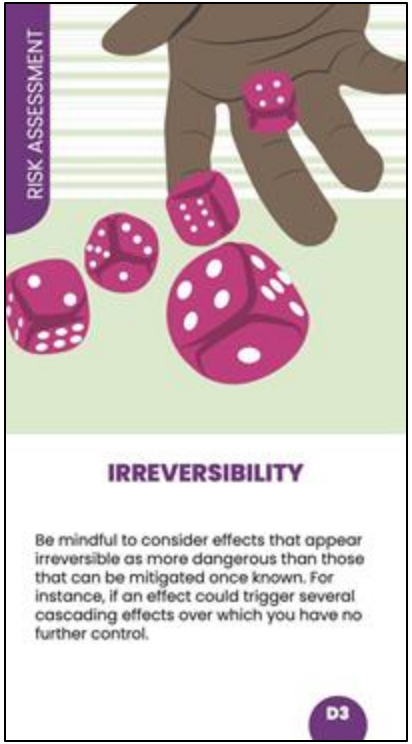


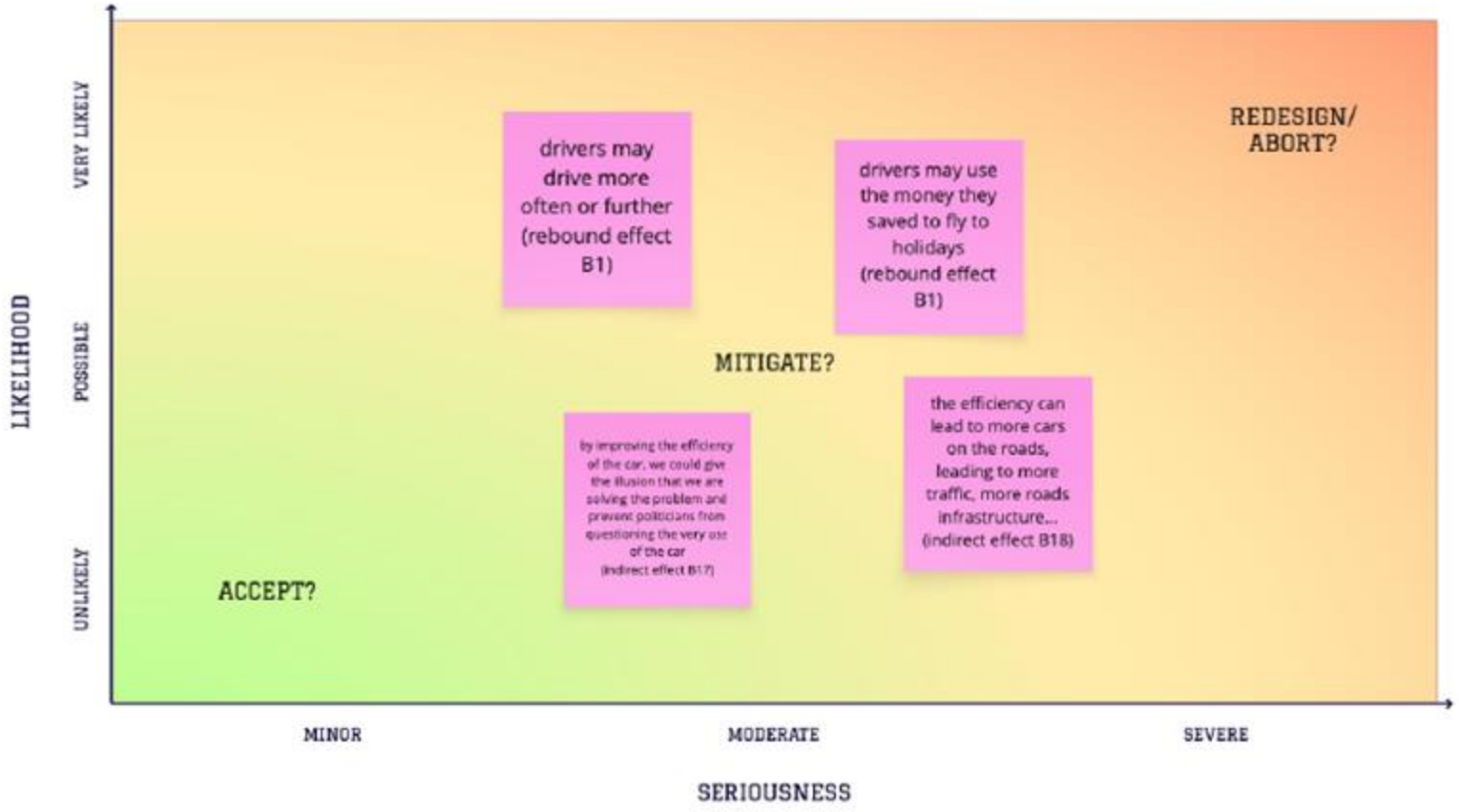


Risk assessment prompts

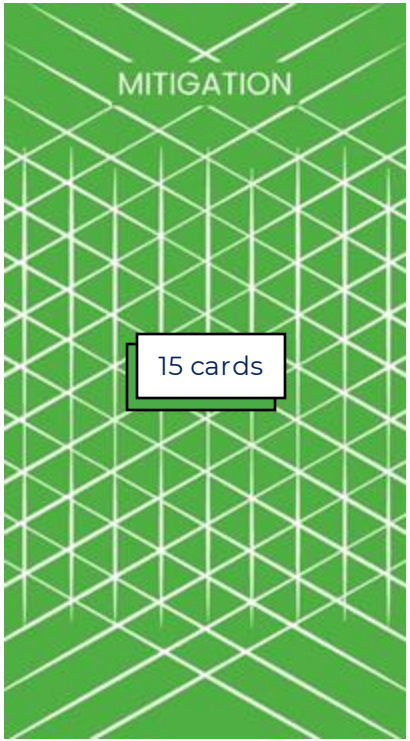


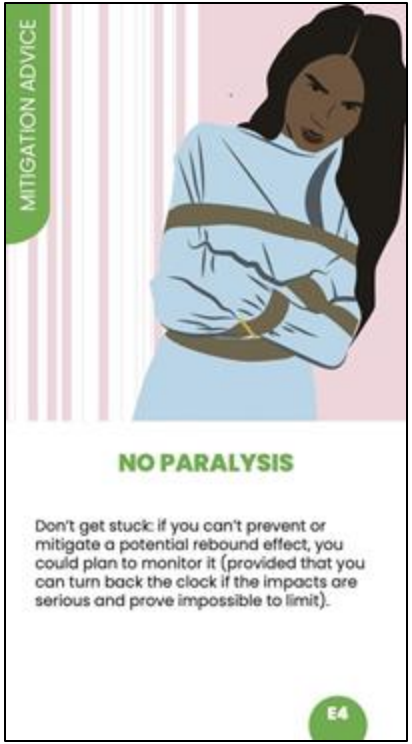




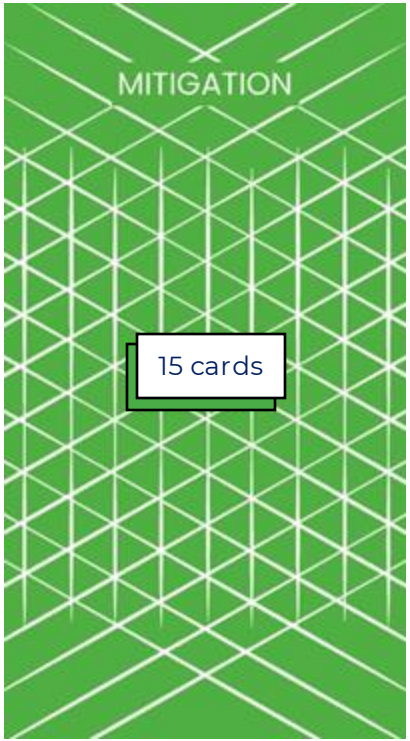

LIKELIHOOD
VERY LIKELY
POSSIBLE
UNLIKELY
drivers may drive more often or further (rebound effect B1)
drivers may use the money they saved to fly to holidays (rebound effect B1)
REDESIGN/ ABORT?
MITIGATE?
by improving the efficiency of the car, we could give the illusion that we are solving the problem and prevent politicians from questioning the very use of the car (indirect effect B17)
the efficiency can lead to more cars on the roads, leading to more traffic, more roads infrastructure... (indirect effect B18)
ACCEPT?
MINOR
MODERATE
SEVERE
SERIOUSNESS

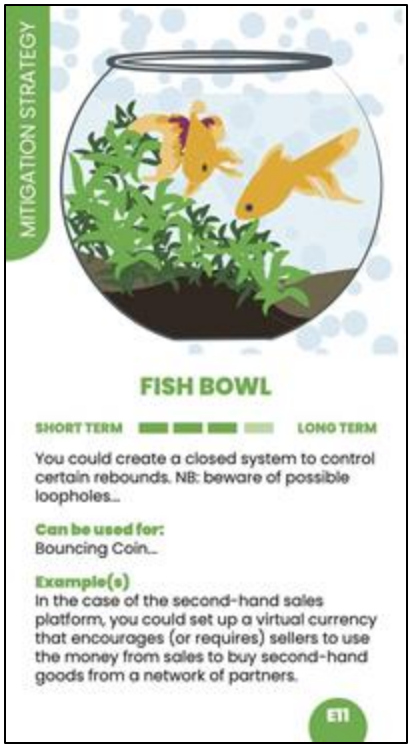
Decision making





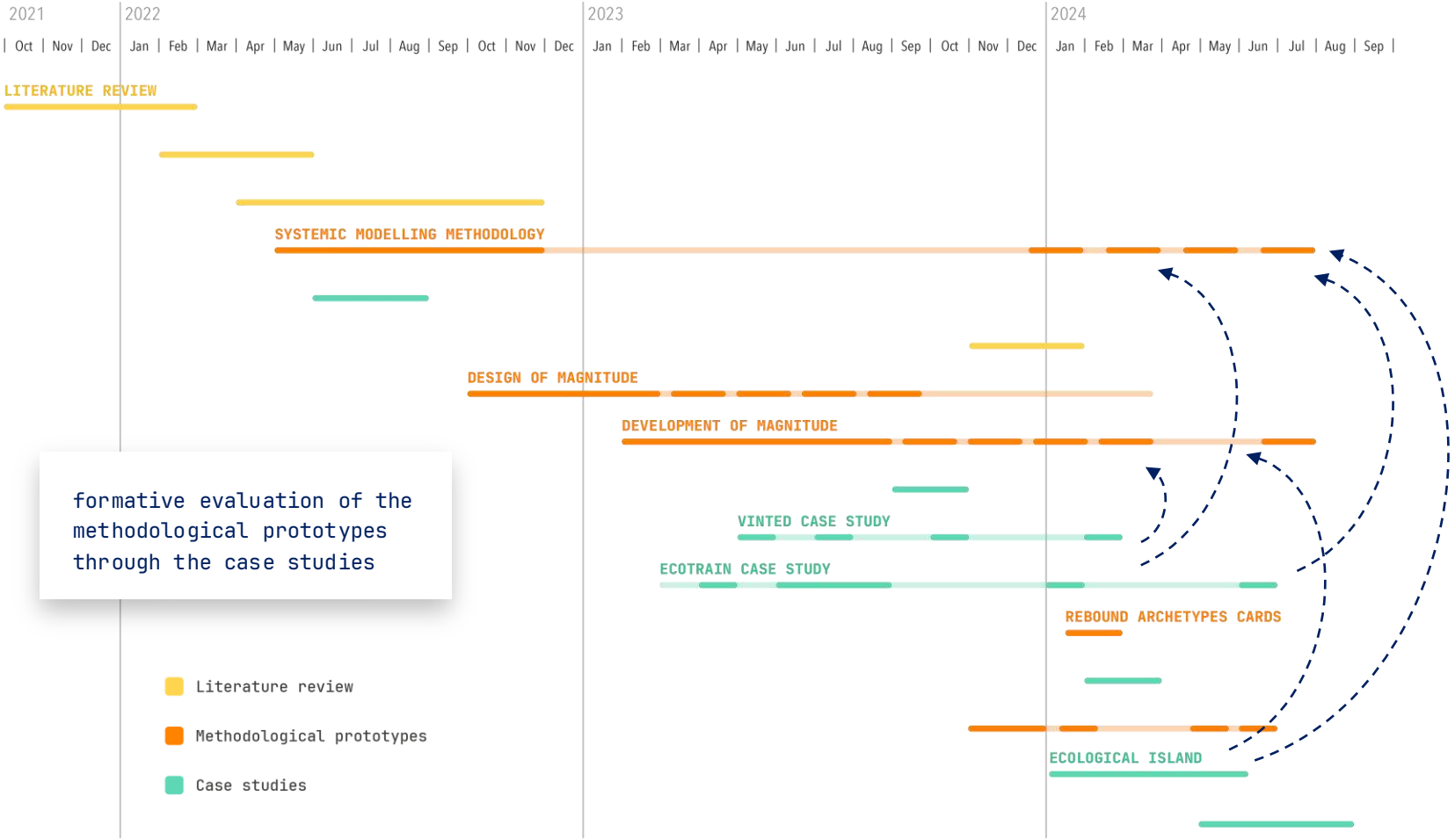
Mitigation strategies



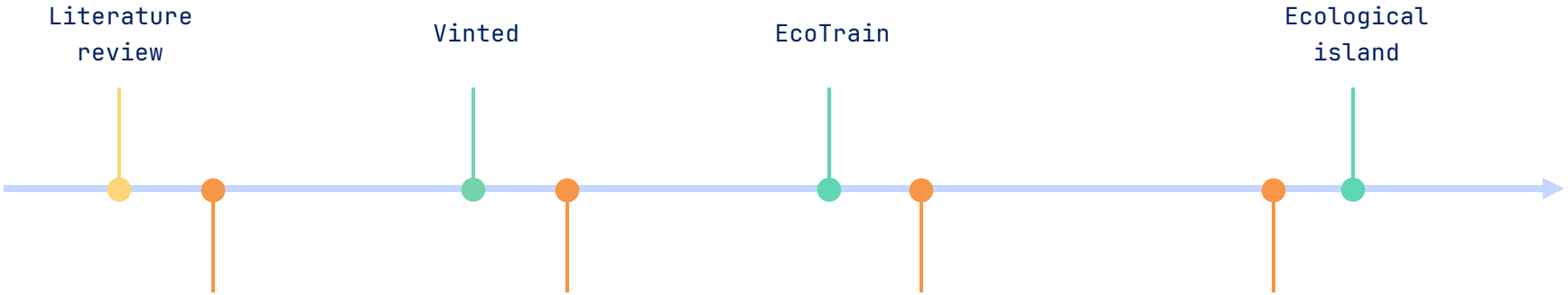



VERY LIKELY
drivers may drive mor often or furt (rebound ef B1)
encourage drivers to spend the money they save on activities with a lower environmental impact (mitigation E7)
drivers may use the money they saved to fly to holidays (rebound effect B1)
SIGN/ RT?
MITIGATION STRATEGY
DONATION
SPEND THAT MONEY!
SHORT TERM
LONG TERM
You may want to encourage people to spend their money in a way that has little impact on the environment.
Can be used for:
Bouncing Coin..
Example(s)
In the case of the second-hand sales platform, this could involve, for example, telling users how much they have saved and suggesting that they donate it or spend it on a local (low-carbon) cultural event...
E7
awareness-raising among policy-makers that there should be support for other modes of transport (mitigation E6)
roving the efficiency e car, we could give illusion that we are ng the problem and ent politicians from tioning the very use of the car direct effect B17)
the efficiency can lead to m on the leading t traffic, mo infrastru (indirect ef
promote a paradigm shift to a slower life, where we don't need to move as much (mitigation E16)
MITIGATION STRATEGY
AWARENESS RAISING
SHORT TERM
LONG TERM
Raising awareness can help people to take informed action in the short term, and can support a paradigm shift in the long term.
Can be used for:
Bouncing Coin/Time, Excessive Accessibility, Lighter Soul..
Example(s)
This might involve explaining that electricity is not carbon neutral and therefore neither are electric vehicles. It may also include promoting active modes of transport.
E6
MITIGATION STRATEGY
PARADIGM SHIFTING
SHORT TERM
LONG TERM
Paradigm shift is a powerful lever for long-term change. You can help to pave the way for a desirable future through your message.
Can be used for:
Systemic Change..
Example(s)
In the case of the second-hand sales platform, this could involve allowing clothes to be exchanged rather than sold. It could also involve encouraging users to repair and/or refresh the style of their clothes.
E16
MODERATE
SEVERE
SERIOUSNESS

Case studies
&
some results


2021
2022
2023
2024
Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep |
LITERATURE REVIEW
SYSTEMIC MODELLING METHODOLOGY
DESIGN OF MAGNITUDE
DEVELOPMENT OF MAGNITUDE
VINTED CASE STUDY
ECOTRAIN CASE STUDY
REBOUND ARCHETYPES CARDS
ECOLOGICAL ISLAND
formative evaluation of the methodological prototypes through the case studies
Literature review
Methodological prototypes
Case studies

Evolution of the systemic modelling methodology



Systemic modelling V0

combining qualitative and quantitative tools

Systemic modelling V1

integrating into a design/decision process

Systemic modelling V1+

good practices for collecting and analysing the data

Systemic modelling V2

narrative scenarios as the glue between quali & quanti

Evolution of the systemic modelling methodology

Literature review

Vinted

EcoTrain

Ecological island

→ collective modelling was perceived as very useful:

- ⇢ engaging stakeholders,
- ⇢ making things tangible,
- ⇢ deepen the discussion,
- ⇢ moving towards action…

→ stakeholders appreciated being involved in the process

→ they were very aware of the uncertainties

→ they considered the model as a discussion tool

Systemic modelling V0

combining qualitative and quantitative tools

integrating into a design/decision process

good practices for collecting and analysing the data

Systemic odelling V2

narrative scenarios as the glue between quali & quanti

Some contributions

&

Perspectives

Concrete tools *used by practitioners*

Rebound Archetypes

Cards to print & Miro template to facilitate online workshops

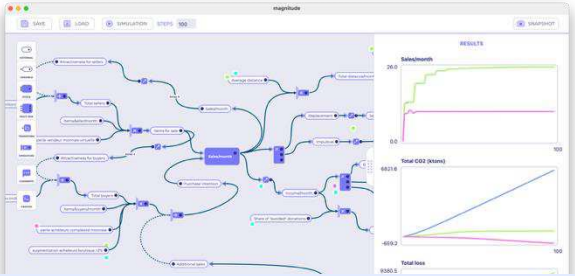
developed with
used by:

Lancaster University

> Designers Ethiques
> hackathon + festival (AI impacts)
> Master Transition (ENAC & ISAE)
> Alt-impact (ADEME program)

Magnitude

Open access modelling tool
Models examples



developed with
used by:

ENAC LAB Interactive Informatics

> Ctrl S (design agency)
> DiaLog (public project)
> business ecosystems modelling
> people asking for the Linux version...

Challenges & recommendations for environmental decision-making

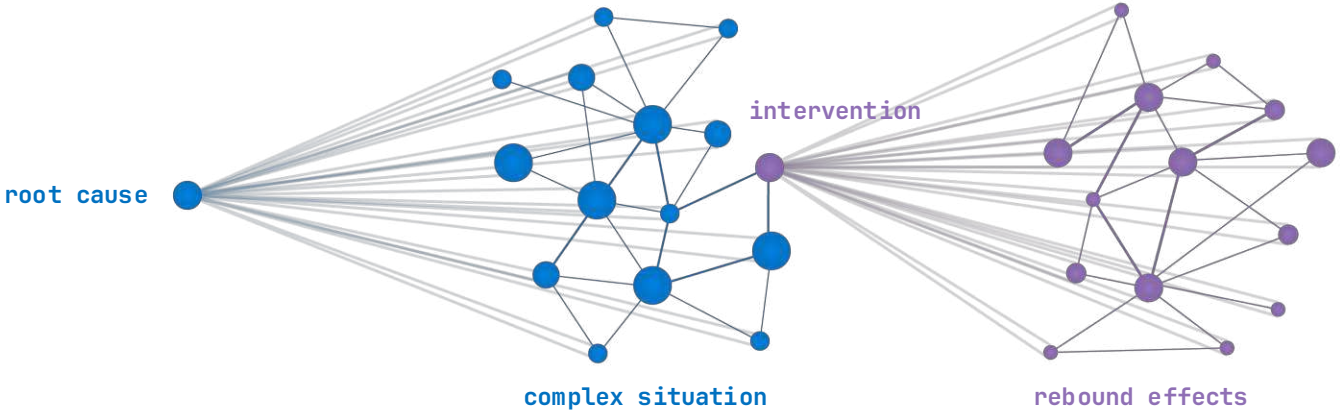
Challenges	Recommendations	Alternative tools, methods, good practices
Uncertainty	Embrace uncertainty	• Requisite variety • Causal Layered Analysis • Group Model Building
	Expose uncertainty	• Causal Loop Diagram • Systems dynamics • Model exploration
Complexity	Problem-oriented vision	• Group Model Building • Causal Loop Diagram
	Comprehension of the dynamics	• Systems dynamics modelling & simulation
Inspiration	Define an objective and a pathway	• Normative scenarios & backcasting
	Identify levers and anticipate effects	• Causal Layered Analysis • Causal Loop Diagram • Meadows' twelve leverage points • Quantitative modeling
	Support decision rather than claims	• Comparing several scenarios rather than comparing one to a hypothetical baseline
Robustness	Plurality of perspectives	• Requisite variety • Value Sensitive Design

Ekchajzer, D., Bornes, L., Combaz, J., Letondal, C., & Vingerhoeds, R. (2024, June). Decision-making under environmental complexity: the need for moving from avoided impacts of ICT solutions to systems thinking approaches. In 2024 International Conference on ICT for Sustainability (ICT4S).

Rebound effects are inherently systemic…

Rebound effects are *'the ways in which a system resists the change that you're trying to make'.*

[quote from an interview with a systemic designer]



Considering rebound effects is a systemic & concrete approach to sustainability

Some of the research avenues

- → Furthering and exploring other methodological opportunities
- → Building on these findings to move towards a democratic dimension
- → Working on scenarios for multi-criteria decision-making
  - → scenarios facilitate dealing with complexity and understanding future alternatives
  - → prospective scenarios could be a key-tool to inform the public debate and societal choices

- → How are prospective scenarios constructed (IPCC, ADEME, etc.)?
- → How are prospective scenarios used?
- → Could and should we rethink the methodology used to build these scenarios?
- → What role HCI could play in making them interactive and more transparent?

PROGRAMME DE RECHERCHE NUMÉRIQUE COLLABORATIF

PEPR eNSEMBLE

Collaborating on IPCC scenarios:

Rethinking digital tools and human processes to meet current challenges

Scenarios are the 'backbone' of collaboration between IPCC WGs (Meinshausen et al., 2024).

→ Rethinking the collaboration on these scenarios…

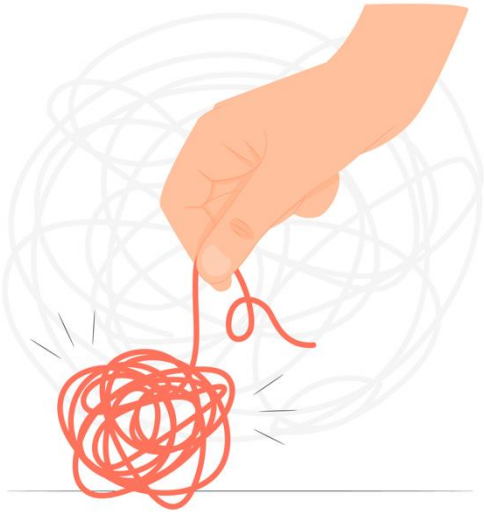
- rethinking human processes and digital tools

→ … to meet current challenges

- volume and diversity of the literature (Hermansen et al., 2023).
- inadequacy of the length of assessment cycles with the urgency of the situation.
- political inaction / destabilisation of the IPCC by the Trump administration (Tollefson, 2025).

→ Opportunities identified during a feedback workshop on the 6th assessment cycle

- setting up a 'community-driven database'.
- need for a digital tool but also 'a framework and a formalised process' (Pirani, 2024).



Collective modelling as a means to engage with a complex situation

Thank you!

Publications

Long paper	**Bornes, L.***, Smith M.*, Bates O., Blair G., Letondal C., and Vingerhoeds R. (2024, October). Rebound Archetypes: A Card-based Tool to Help Designers Think Through the Rebound Effects when Designing for Sustainability. In Proceedings of Relating Systems Thinking and Design (RSD13) Symposium. * Authors contributed equally
Long paper	**Bornes, L.**, Letondal, C., Vingerhoeds, R. (2024, July). Systemic Sustainable HCI: Integrating Collaborative Modeling into a Design Process to Address Rebound Effects. In Proceedings of the 2024 ACM Designing Interactive Systems Conference.
Long paper (best paper award)	Ekchajzer, D.*, **Bornes, L.***, Combaz, J.*, Letondal, C., Vingerhoeds, R. (2024, June). Decision-Making under Environmental Complexity: Shifting from Avoided Impacts of ICT Solutions to Systems Thinking Approaches. In Proceedings of the 11th International Conference on ICT for Sustainability. * Authors contributed equally
Long paper	**Bornes, L.**, Letondal, C., Vingerhoeds, R. (2022, October). Could Systemic Design Methods Support Sustainable Design of Interactive Systems?. Proceedings of Relating Systems Thinking and Design (RSD11) Symposium.
Short paper (journal)	**Bornes, L.**, Letondal, C., & Vingerhoeds, R. (2023). Understanding the Indirect Effects of Interactive Systems Within Systems of Systems. INSIGHT, 26(4), 18-21.
Short paper	Letondal, C., Laplace, I., Druot, T., Bieder, C., Pauchet, S., & **Bornes, L.** (2024, April). Approches alternatives pour penser et construire le futur du transport aérien : exemples d'expériences pédagogiques. In Entretiens de Toulouse.
Short paper	Letondal, C., **Bornes, L.**, Garcia, J., Duchevet, A., Conversy, S., Pauchet, S., & Vo, D. B. (2024, March). Un cockpit pour l'aviation du futur ? Par quel prisme de l'IHM approcher la question ?. In IHM'24-35e Conférence Internationale Francophone sur l'Interaction Humain-Machine.
Extended abstract (CHI Doctoral consortium)	**Bornes, L.** (2023, April). A Methodology and a Tool to Support the Sustainable Design of Interactive Systems: Adapting systemic design tools to model complexity in interaction design. In Extended Abstracts of the 2023 CHI Conference on Human Factors in Computing Systems (pp. 1-5).
Workshop (animation)	**Bornes, L.**, Letondal, C., & Vingerhoeds, R. (2023, October). Using a Quali-Quantitative Modelling Tool to Explore Scenarios for More-Than-Sustainable Design. In Proceedings of Relating Systems Thinking and Design (RSD12) Symposium.
Poster (best poster award)	Best poster award at ISAE PhD day. (2023, June).
Poster (best poster award)	Best poster award at a AFIS (Systems engineering) conference. (2022, December).

References

C. T. Bieser, R. Hintemann, L. M. Hilty, and S. Beucker, “A review of assessments of the greenhouse gas footprint and abatement potential of information and communication technology,” Environmental Impact Assessment Review, vol. 99. Elsevier BV, p. 107033, Mar. 2023. doi: 10.1016/j.eiar.2022.107033.

Bremer, C., Gujral, H., Lin, M., Hinkers, L., Becker, C., & Coroamă, V. C. (2023). How viable are energy savings in smart homes? A call to embrace rebound effects in sustainable HCI. ACM Journal on Computing and Sustainable Societies, 1(1), 1-24.

V. C. Coroamă, P. Bergmark, M. Höjer, and J. Malmodin, “A Methodology for Assessing the Environmental Effects Induced by ICT Services – Part I: single services,” Proceedings of the 7th International Conference on ICT for Sustainability. ACM, Jun. 21, 2020. doi: 10.1145/3401335.3401716.

DiSalvo, C., Sengers, P., & Brynjarsdóttir, H. (2010, April). Mapping the landscape of sustainable HCI. In Proceedings of the SIGCHI conference on human factors in computing systems (pp. 1975-1984).

Hancock, T., & Bezold, C. (1994, March). Possible futures, preferable futures. In The Healthcare Forum Journal (Vol. 37, No. 2, pp. 23-29).

Jones, P. H. (2014). Systemic design principles for complex social systems. Social systems and design, 91-128.

Juge, E. (2018). La fabrique des conso-marchands: une approche par les dispositifs sociotechniques dans le contexte de la consommation collaborative (Doctoral dissertation, Université de Lille).

Kim, D. H. (1992). Guidelines for drawing causal loop diagrams. The Systems Thinker, 3(1), 5–6.

Knowles, B., Bates, O., & Håkansson, M. (2018, April). This changes sustainable HCI. In Proceedings of the 2018 CHI Conference on human factors in computing systems (pp. 1-12).

Le Carpentier, M., Bornes, L., Letondal, C., & Druot, T. (2024). Imagining ecological mobility scenarios for an island at the horizon 2050 (Research initiation project, Université de Toulouse).

Raghavan, B., & Pargman, D. (2017, May). Means and ends in human-computer interaction: Sustainability through disintermediation. In Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems (pp. 786-796).

Rockström, J., Steffen, W., Noone, K., Persson, Å., Chapin III, F. S., Lambin, E., ... & Foley, J. (2009). Planetary boundaries: exploring the safe operating space for humanity. Ecology and society, 14(2).

Vaayu, “Vinted Climate Change Impact Report,” Vaayu, 2021.

Woodward, I. (2007). Understanding Material Culture. SAGE Publications Ltd. https://doi.org/10.4135/9781446278987