THE ETHICS OF SAFE-BY-DESIGN CIRCULAR PRODUCTS

Circular Design Forum

Sharing session: Substances of concern

Ida Krstulović

29-08-2024

Introduction

- Common flame retardants used in mattresses are substances of concern, but addressing this issue causes trade-off situations

- Eliminating flame-retardants would cause a safety concern, as foam is highly flammable
- Using a natural fire-resistant textile such as wool can raise animal rights concerns if the supply chain is not entirely transparent, and might not be suitable for every use
- Replacing the foam with a novel material such as 3D polyester is a new method shrouded in uncertainty

Why do we care about these situations?

- Because we feel an obligation/responsibility to do the right thing?
- Because there are values we consider important and want to ensure/protect?
- Because it's the morally right thing to do?

All matters of ethics

Design ethics

- Ethics are always implied in design:
  - Choices in the design process greatly influence the social consequences of a product
  - Industrial design is inherently normative – it says something about the way the world should (or shouldn’t) be
  - Circular design even more so

Value Sensitive Design (and Design for Values)

- An approach that aims to integrate values in a systematic way into design
- The idea that a design that doesn't have values in mind will do the opposite and infringe on values
- Designing *for* sustainability, safety (or other values like justice, human well-being, autonomy, etc.) means always having values in the back of our mind and facing decisions thinking 'is this a safe choice? Is this a sustainable choice?' etc.
- Value Sensitive Design is a way to solve ethical dilemmas *through design itself*, not just through pure philosophy (making it more applied)

Value Sensitive Design (and Design for Values)

applied to circular product design

- The gap we're filling within VSD is then the design of everyday products, which hasn't been talked about much, especially in a circular economy context
- Circular products are especially interesting because of substances of concern (SoC) being reintroduced into the cycle, and hazardous chemicals accumulating over time in a closed production loop

Safe (and Sustainable) by Design

- Safe-and-Sustainable-by-Design (SSbD) builds on the pre-existing concept of Safe-by-Design (SbD), an approach to design that aims to minimize risk by encouraging designers to make safety-motivated choices early in the design process
- However, there is very little agreement about what this means, or what it looks like in practice
- Translating values into design interventions is only made more difficult by the fact values often conflict

Value conflicts

- When trade-offs happen between moral values, we call them value conflicts
- A value conflict is a situation in which:
  1. A choice has to be made between at least two options for which at least two values are relevant as choice criteria
  2. At least two different values select at least two different options as best, and
  3. The values do not trump each other
- Example of a value conflict in engineering: seat belts (safety vs autonomy/freedom)

- How to operationalize values in circular product design?
- First we need to know what values we're talking about, when and why it's a problem to design with these values in mind (taxonomy), and what can be done about that (strategies)

What are the ethical dilemmas designers face in SSbD?

Strategies for dealing with value conflict in design (with an ethical motivation)

- These can, but don't have to be, intertwined with VSD
  - Multi-criteria analysis
  - Precautionary principle (especially when it comes to uncertainties)
  - Moral satisficing
  - Maximin
  - Participatory design and other forms of ethics-motivated design (speculative design, critical design, adversarial design…)

Ethical motivation

Utilitarianism

The morally best action is the one that brings the most happiness/pleasure to the greatest amount of people

Judgement based on consequences

Multi-criteria analysis

Assessment of consequences (impact, performance, etc.)

Deontology

An action is morally right if it is in agreement with a certain moral rule (law, norm, or principle)

Judgement based on actions

Precautionary principle

As a rule, precautionary measures should be taken even if we don't know what the consequences are

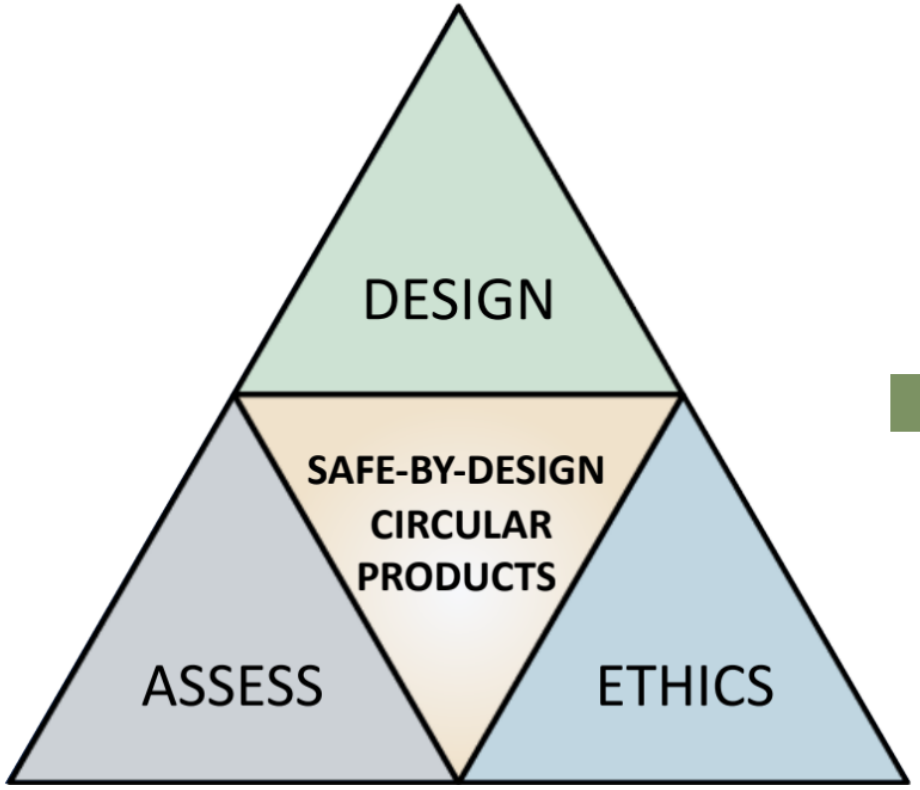
What is a good (enough) strategy?

- There is no one universal strategy, and more often than not, more than one will be used simultaneously
- What **criteria** do these strategies need to fulfill?
  any strategy a designer uses needs to be **robust** (adaptable to changing circumstances), **repeatable** (needs to have the same results when applied again), needs to work in **multi-agent settings**, be able to handle **uncertainties**…

Final disclaimers

- While my research doesn't go into it, there is also the important question of **responsibility** (for actual changes to be made at an institutional level, collaboration is needed from all stakeholders involved, but allocating responsibility is still important) and related to that, the **power of the designe**r (as in, there is only so much a designer can do, we need systematic changes)

Overaching project



next step

IMPLEMENT

TU Delft | IDE

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DESIGN

PRODUCTION

USE

DISPOSAL

RECOVERY

npk | design

VANBERLO
Part of Accenture

spark

PHILIPS
Healthcare

PHILIPS
Domestic Appliances

Erasmus MC
University Medical Center Rotterdam

Planbureau voor de Leefomgeving

Rijksinstituut voor Volksgezondheid en Milieu
Ministerie van Volksgezondheid, Welzijn en Sport

CIRCO
creating business through circular design

REFERENCES

Friedman, B., 1996. *Value-sensitive design*. interactions 3, 16–23. https://doi.org/10.1145/242485.242493

Van de Poel, I. R., & Royakkers, L. M. M. (2011*). Ethics, technology, and engineering: an introduction*. Wiley-Blackwell

Van Den Hoven, J., Vermaas, P.E., Van De Poel, I. (Eds.), 2015. *Handbook of Ethics, Values, and Technological Design: Sources, Theory, Values and Application Domains*. Springer Netherlands, Dordrecht. https://doi.org/10.1007/978-94-007-6970-0

Quantitative sustainability and risk assessment for safe-by-design circular products

NWO project Safe-by-Design Circular Products

Nina van Dulmen – 29-08-2024 – Circular Design Forum

Universiteit Leiden
The Netherlands

CONTENTS

01 INTRO TO MY WORK

02 SSbD ASSESSMENT

03 SOCIAL ASSESSMENT METHODS

04 CASE STUDY AND LEARNINGS

(Quantitative) assessment on SbD Circular Products

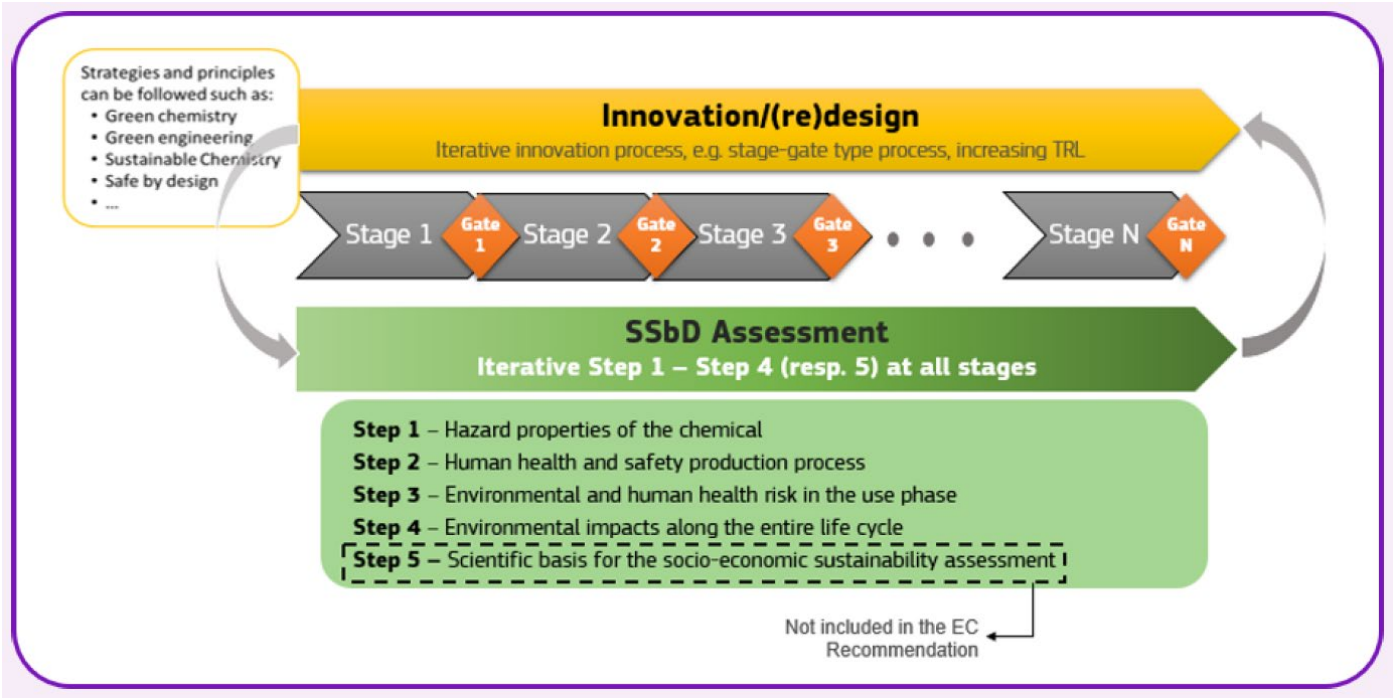
Main research question:

"How can **ex-ante risk assessment**, **ex-ante life cycle assessment (LCA)**, and ***social assessment*** Guidelines be developed for **practical application in a designer's context**, particularly for the initial stages of product design and how can these be best made **accessible to designers**?"

→ How to best integrate social assessment in SSbD frameworks?

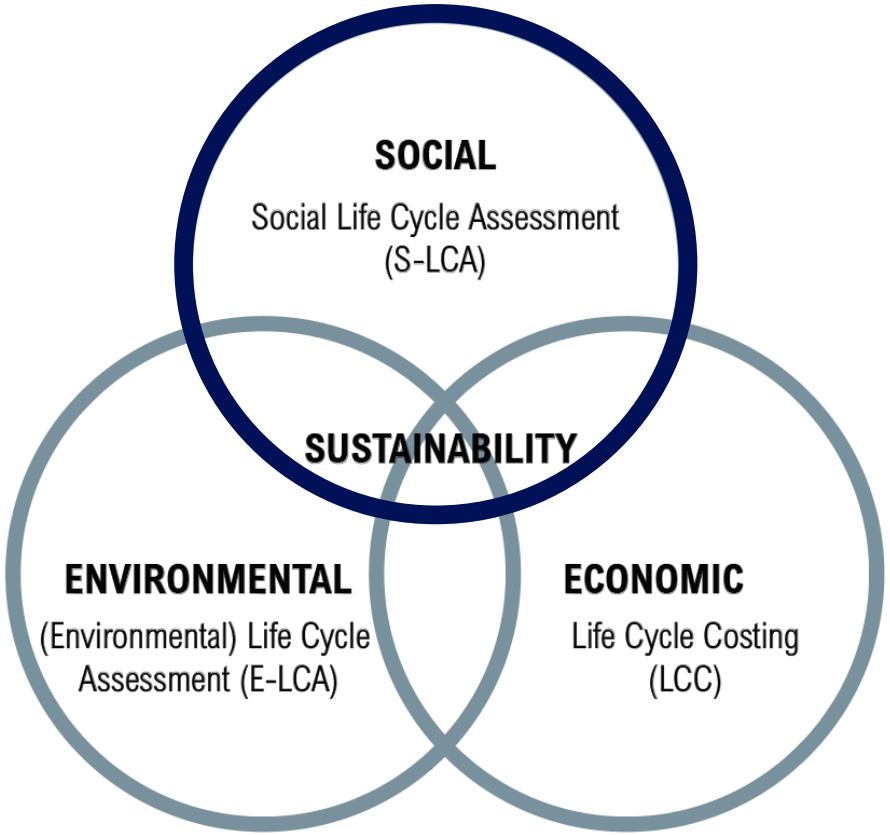
SSbD ASSESSMENT STEPS

- JRC SSbD framework is the furthest developed SSbD assessment framework in a product context;
- JRC framework presents steps on Risk Assessment (RA) and Environmental Life Cycle Assessment (E-LCA);
- Optional to include socio-economic assessment.



Source: JRC Safe and Sustainable by Design chemicals and materials - Methodological Guidance, 2024

LCSA & SSbD



S-LCA

- Less mature compared to E-LCA and LCC;
- Data available to lesser extent;
- Increasing application of S-LCA in LCSA context, e.g., in upsurging frameworks like SSbD.

→ Calls for evaluation of S-LCA's:

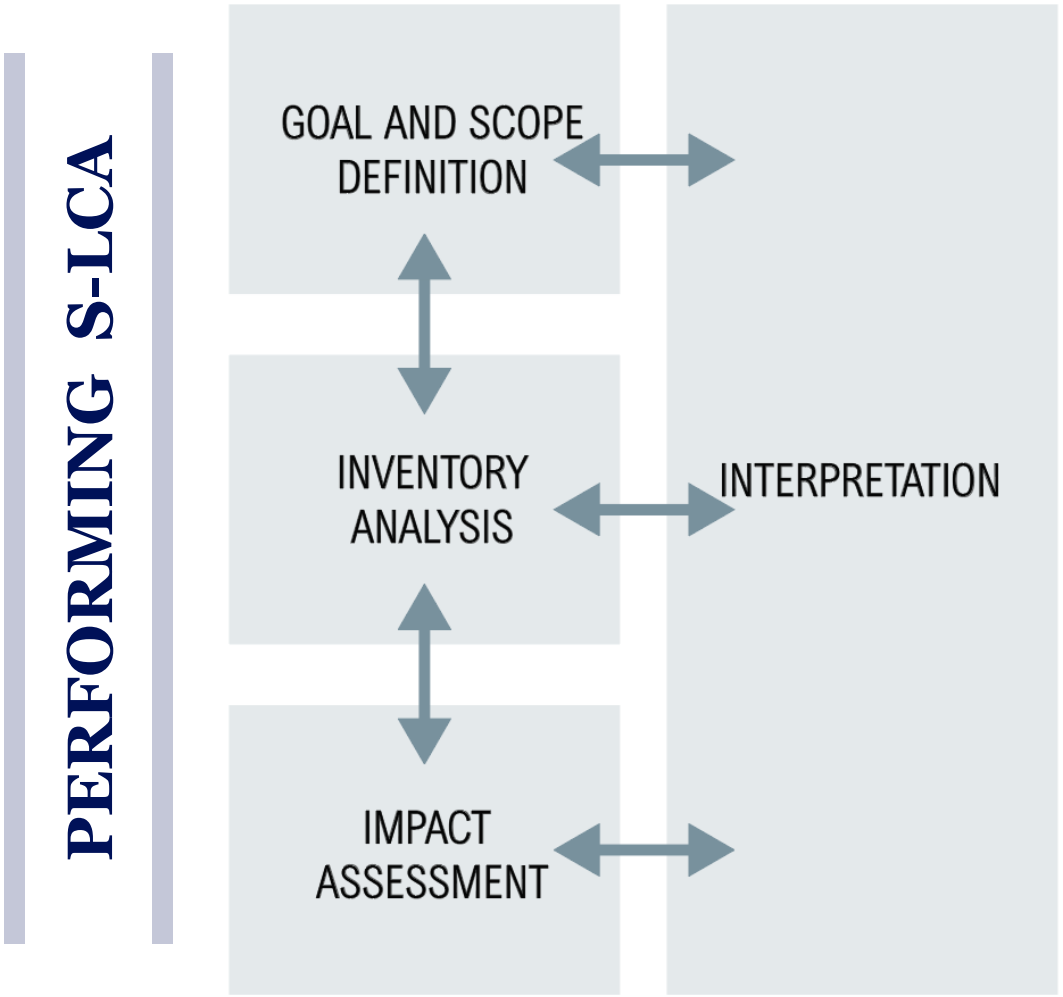
- compatibility on integration in such frameworks;
- added value compared to more qualitative social assessment methods;
- best way of integration in SSbD frameworks.

WHAT IS SOCIAL LCA

UNEP (2020) S-LCA Guidelines

- Evaluation of social impacts of products and services along their life cycle (UNEP 2020);
- Stakeholder perspective;
- Social impacts to people (i.e., stakeholder categories), originating from organizational behavior (UNEP 2020);
- 6 stakeholder categories, 40 subcategories with underlying social indicators.

Stakeholder categories	Workers	Local community	Value chain actors	Consumers	Society	Children
Subcategories	1. Freedom of association and collective barganing 2. Child labor 3. Fair salary 4. Working hours 5. Forced labor 6. Equal opportunities / discrimination 7. Health and safety 8. Social benefits / social security 9. Employment relationship 10. Sexual harassment 11. Smallholders including farmers	1. Access to material resources 2. Access to immaterial resources 3. Delocalization and migration 4. Cultural heritage 5. Safe and healthy living conditions 6. Respect of indigenous rights 7. Community engagement 8. Local employment 9. Secure living conditions	1. Fair competition 2. Promoting social responsibility 3. Supplier relationships 4. Respect of intellectual property rights 5. Wealth distribution	1. Health and safety 2. Feedback mechanism 3. Consumer privacy 4. Transparency 5. End-of-life responsibility	1. Public commitments to sustainability issues 2. Contribution to economic development 3. Prevention and mitigation of armed conflicts 4. Technology development 5. Corruption 6. Ethical treatment of animals 7. Poverty alleviation	1. Education provided in the local community 2. Health issues for children as consumers 3. Children concerns regarding marketing practices



PRODUCT S-LCA

GSD: define function and functional unit

Inventory: product system modelling using mostly generic (e.g., ***PSILCA** database*) data

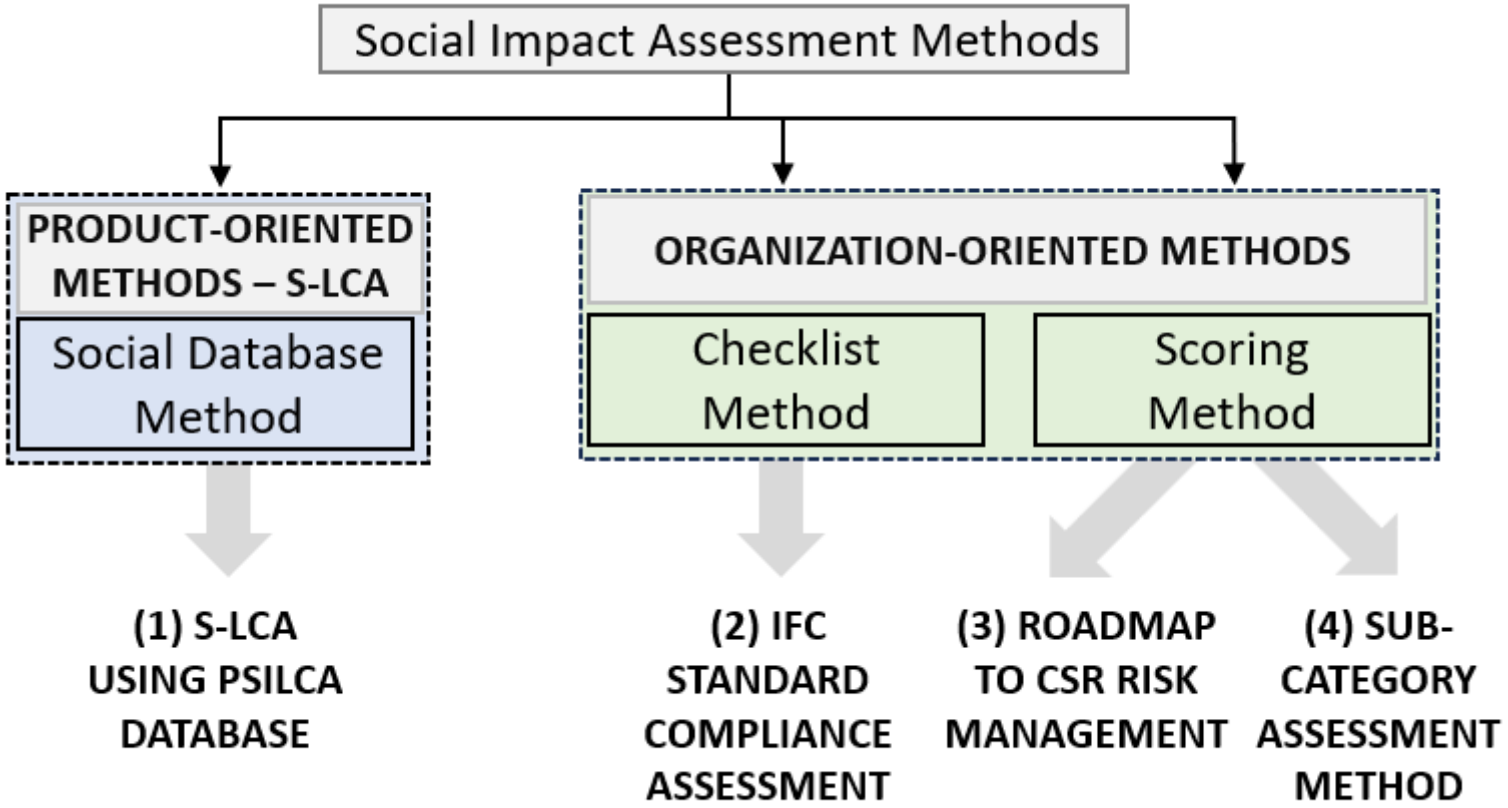
IA: life cycle calculations

Interpretation: interpretation of results

Barriers

- Quantification/scaling to FU less straightforward;
- Discrepancy between S-LCA's risk language and positive impacts;
- Limited interpretation of results, difficult to communicate;
- Problematic variety of methods (qualitative – quantitative) developed and utilized.

ASSESSING SOCIAL IMPACTS

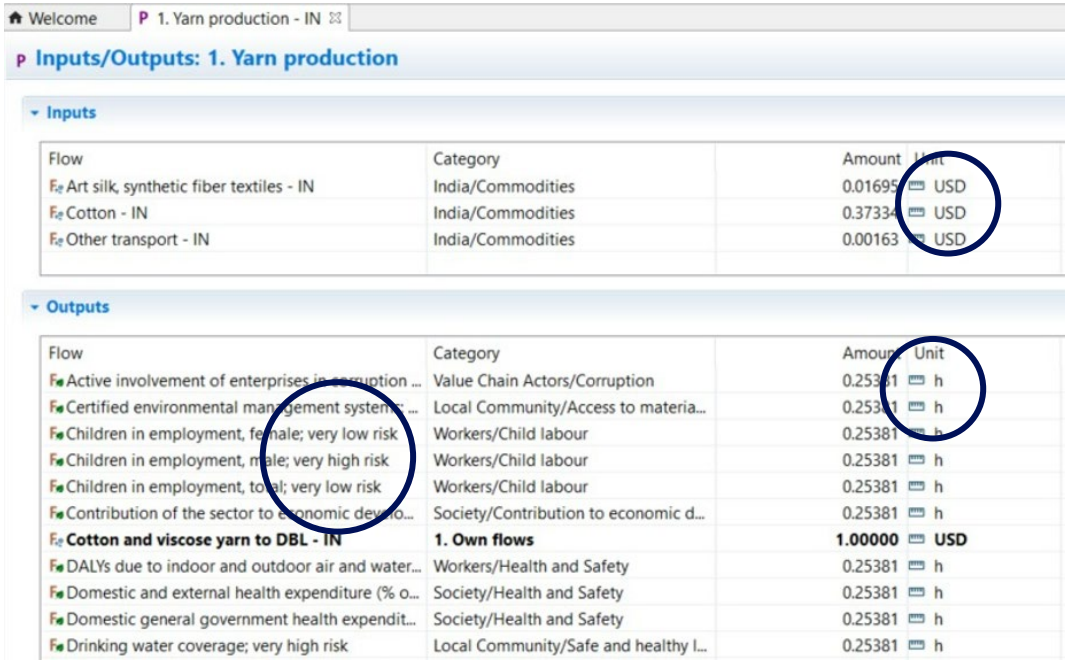


Method categories adapted from Chhipi-Shrestha et al. (2015) and Pollok et al. (2021)

EXAMPLARY CASE

SOCIAL LCA

INVENTORY MODELLING


Welcome | P 1. Yarn production - IN

P Inputs/Outputs: 1. Yarn production

Inputs

Flow	Category	Amount	Unit
Art silk, synthetic fiber textiles - IN	India/Commodities	0.01695	USD
Cotton - IN	India/Commodities	0.37334	USD
Other transport - IN	India/Commodities	0.00163	USD

Outputs

Flow	Category	Amount	Unit
Active involvement of enterprises in corruption ...	Value Chain Actors/Corruption	0.25381	h
Certified environmental management system ...	Local Community/Access to materia...	0.25381	h
Children in employment, female; very low risk	Workers/Child labour	0.25381	h
Children in employment, male; very high risk	Workers/Child labour	0.25381	h
Children in employment, total; very low risk	Workers/Child labour	0.25381	h
Contribution of the sector to economic develo...	Society/Contribution to economic d...	0.25381	h
Cotton and viscose yarn to DBL - IN	**1. Own flows**	**1.00000**	**USD**
DALYs due to indoor and outdoor air and water...	Workers/Health and Safety	0.25381	h
Domestic and external health expenditure (% o...	Society/Health and Safety	0.25381	h
Domestic general government health expendit...	Society/Health and Safety	0.25381	h
Drinking water coverage; very high risk	Local Community/Safe and healthy l...	0.25381	h

IMPACT ASSESSMENT RESULTS

Impact category	Reference unit	Result
Active involvement of enterprises in corruption and bribery	AI med risk hours	0.496069922
Anti-competitive behavior or violation of anti-trust and monopoly legislation	AC med risk hours	0.409669498
Association and bargaining rights	ACB med risk hours	**0.349002146**
Biomass consumption	BM med risk hours	503.5495661
Certified environmental management system	CMS med risk hours	11.8754982
Child Labor, female	CL med risk hours	0.144357491
Child Labor, male	CL med risk hours	106.7200055
Child Labor, total	CL med risk hours	0.973409962
Contribution of the sector to economic development	CE med risk hours	1.285180713
DALYs due to indoor and outdoor air and water pollution	DALY med risk hours	1.066931713
Drinking water coverage	DW med risk hours	106.668919
Embodied agricultural area footprints	EAF med risk hours	0.004240961
Embodied biodiversity footprints	EBF med risk hours	0.158446915
Embodied forest area footprints	EFA med risk hours	0
Embodied water footprints	EWF med risk hours	0.018059113
Expenditures on education	EE med risk hours	9.781506997
Fair Salary	FS med risk hours	234.7472672
Fatal accidents	FA med risk hours	0.109086553
Fossil fuel consumption	FF med risk hours	0.050504658
Frequency of forced labor	FL med risk hours	0.025140176
Gender wage gap	GW med risk hours	11.00776245

OTHER ASSESSMENT METHODS

CHECKLIST METHODS (2)

✓ - Full compliance	? - Unknown due to data unavailability
✓ - Medium compliance	N/A – Requirement not applicable
✕ - No compliance	

Category	Subject	Requirements	Fashion company	Tier 1	Tier 2
Direct Workers					
Working conditions and management of worker relationship	HR policies and procedures	(8) Adaptation and implementation of HR policies, consistent with national law.	?	✓	?
		(9) Provision of clearly documented information on worker rights to employees. These rights are under national labor and employment law.	✓	✓	✓
	Working conditions and terms of employment	(10) Collective bargaining agreements with workers' organizations are respected, when applicable. Or, the company provides reasonable working conditions and employment terms to its employees.	✓	✓	?
		(11) Migrant workers are identified and it is ensured they are engaged on substantially equivalent terms and conditions to non-migrant workers.	✓	✓	✓
		(12) When in place, quality and management policies regarding accommodation services are put in place. These services are provided consistent with non-discrimination principles and not be restricting workers' freedom of association.	N/A	N/A	✓

IFC Compliance Assessment (IFC, 2012)

SCORING METHODS (3 + 4)

Category	Module	Specified risk	Ranking category
Fair business practices	Market distortion & competition	Poor forecasting, poor payment terms and unfair penalties to workers, due to buyers providing low purchasing prices	Monitor
Human rights & ethics	Consumer interests & product safety	Personal data is not always used in a secure way.	N/A
Labor rights	Freedom of association	Violation of the right of freedom of association	Action
		Dissuasion or unfair punishment of workers participating in strikes	Action
		Firing of a worker part of a trade union	Monitor
		No guarantee of workers' rights for workers	Monitor
		High violation against human rights defenders	Monitor
	Labor conditions	Workers are forced to make long working days under bad conditions	Monitor
		Workers are unaware of their rights	Monitor
		Subcontracting leading to little oversight on working conditions	Monitor
		Work weeks of over 60 hours a week	Urgent action
	Child labor	Occurrence of child labor, possibly in worst forms of forced labor.	Monitor
	Discrimination & gender	Women are discriminated based on their gender, where men occupy technical and managerial positions, and women work low-skilled and low-paid.	Stop
		Women experiencing sexual intimidation, violence, and discrimination	Monitor

Roadmap to CSR Risk Management (MVO, 2020)

Stakeholder category	Subcategory	Tier 2 yarn supplier	Tier 1 T-shirt manufacturer	Fashion brand
Workers	Freedom of association and collective bargaining	D	D**	No data
	Child labor	B or D*	A	A
	Fair salary	D	D	A
	Working hours	B	D	A
	Equal opportunities/ discrimination	No data	A	A
	Health and safety	No data	A	A
	Social benefits/ social security	B	A	B
Local community	Access to material resources	No data	B	N/A
	Safe and healthy living conditions	No data	B	N/A
	Local employment	No data	B	N/A
Value chain actors	Fair competition	No data	C	No data
	Supplier relationships	No data	A	A
Consumers	Transparency	No data	N/A	B
	End-of-life responsibility	No data	N/A	A
Society	Public commitments to sustainability issues	No data	A	A
	Contribution to economic development	No data	B	No data

* No information is available if the Tier 2 supplier has a child labor policy in place.
** Contradicting answers were provided by the Tier 1 manufacturer, leaving this scoring as under high uncertainty levels.
A: complying to the Basic Requirement (BR), plus showing proactive behavior by promoting CSR on this aspect amongst suppliers.
B: complying to the BR, but not showing any additional proactive behavior.
C: not complying to the BR and the organization being immersed in a context described in C (e.g., 'a country with low risk on child labor').
D: lowest scoring. Not complying to BR and immersed in a negative context.

Subcategory Assessment Method (Ramirez et al., 2014)

CONCLUDING REMARKS

DISCUSSION POINTS

- Added value S-LCA: *potential* for compatibility with LCSA;
- S-LCA falls short in adequately capturing qualitative nature of social impacts + their connection to value chain actor behavior;
- It really differs per social assessment method performed what insights results can give;

OUTLOOK

- S-LCA should be limited to only few correctly quantifiable indicators, linkable to the specific Functional Unit;
- Apply limited S-LCA together with qualitative and organization-oriented methods;

QUESTION TO YOU

- SSbD assessments: what is being done in practice, and what could a (product) designer or (product) design team do?
- Importance in taking a holistic LC and sustainability perspective in developing SbD Circular Products. SSbD as proposed by JRC is too complex to perform as a designer. What to do as a designer?

- Chhipi-Shrestha, G. K., Hewage, K., & Sadiq, R. (2015). 'Socializing' sustainability: a critical review on current development status of social life cycle impact assessment method. Clean Technol Environ Policy, 17(3), 579-596. https://doi.org/10.1007/s10098-014-0841-5
- IFC. (2012). Performance Standards on Environmental and Social Sustainability.
- Maister, K., Di Noi, C., Ciroth, A., & Srocka, M. (2020). PSILCA database v.3 documentation.
- MVO. (2020). Roadmap to CSR Risk Managment. https://www.mvorisicochecker.nl/en/roadmap-csr-risk-management
- Pollok, L., Spierling, S., Endres, H.-J., & Grote, U. (2021). Social Life Cycle Assessments: A Review on Past Development, Advances and Methodological Challenges. Sustainability, 13(18), 10286. https://doi.org/10.3390/su131810286
- Ramirez, P. K. S., Petti, L., Haberland, N. T., & Ugaya, C. M. L. (2014). Subcategory assessment method for social life cycle assessment. Part 1: methodological framework. Int J Life Cycle Assess, 19(8), 1515-1523. https://doi.org/10.1007/s11367-014-0761-y
- UNEP. (2020). Guidelines for Social Life Cycle Assessment of Products and Organizations 2020.

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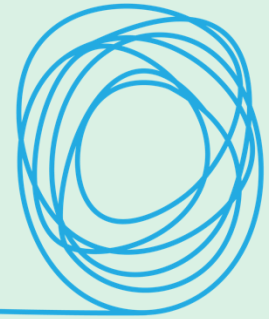
SAFE AND SUSTAINABLE BY DESIGN *IN DESIGN*

Circular Design Forum 24: Sharing Session Substances of Concern

By Maaike Weber, PhD candidate at TU Delft



HOW ARE DESIGNERS AND ENGINEERS **DEALING** WITH SOC?

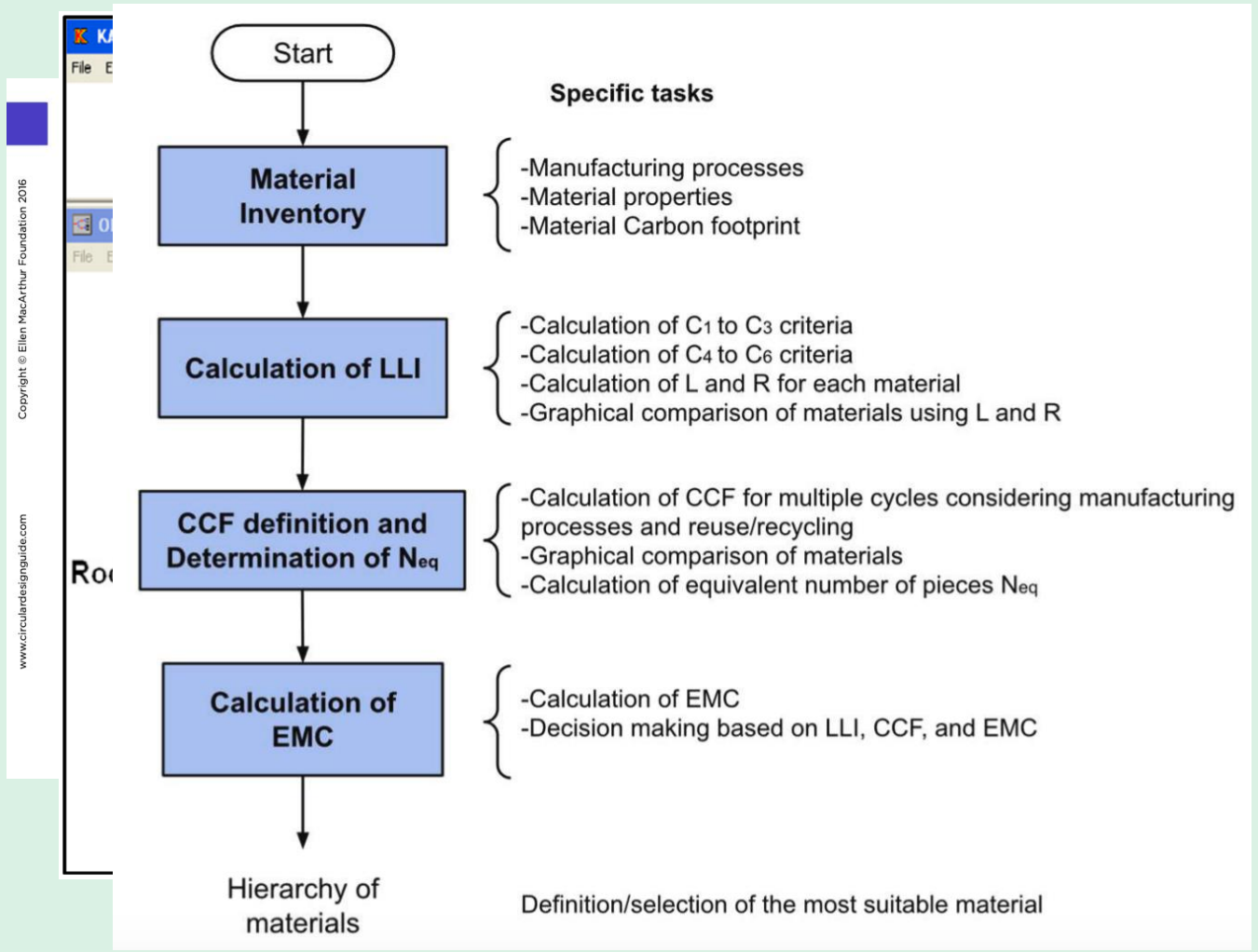
&

HOW CAN THEY BE **SUPPORTED**?

A case in practice

Method analysis

How are designers supported by existing methods?



Mesa, 2023

Safety dimensions & guidelines

Guidelines

- ✓ Reduce substance toxicity
- ✓ Favor cleaner processes
- ✓ Define substitution criteria to avoid regrettable substitutions
- ✓ Do not go for acceptable limits (but use less)

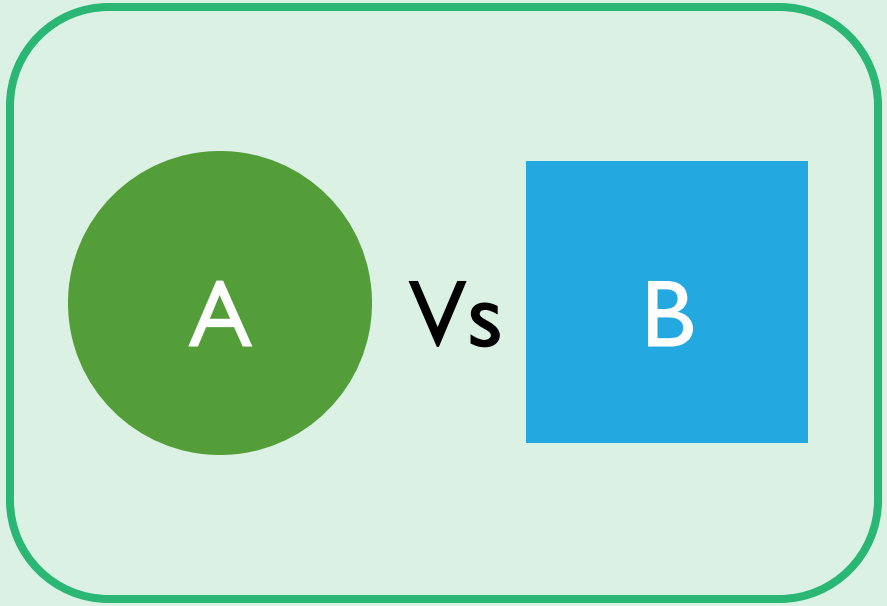
Assess and compare

- ✓ LCA to predict impacts to in e.g. DALYs or POCP
- ✓ LCC to assess potential costs of hazardous waste

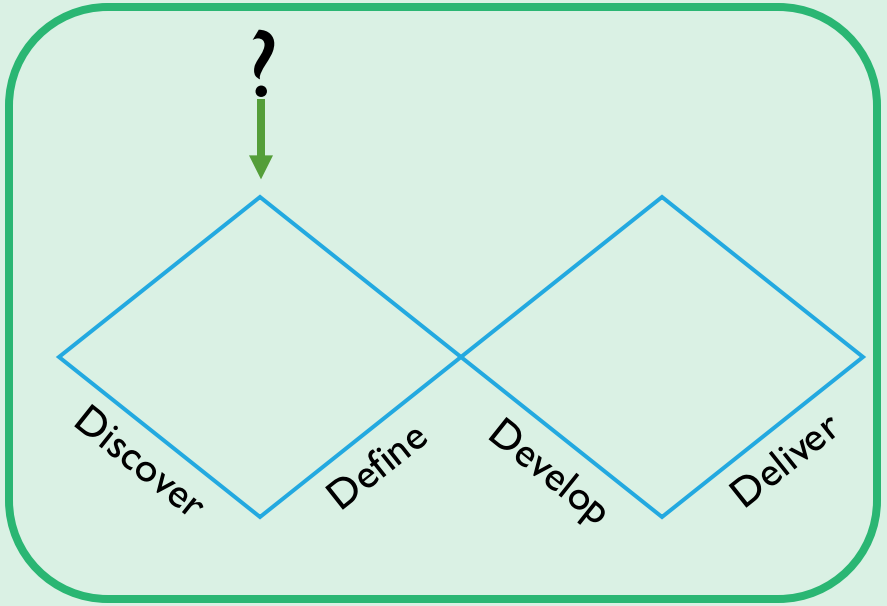
Safety parameters

- ✓ % of hazardous materials
- ✓ Amount of hazardous waste produced
- ✓ Number of traceable parts

Method content



Supported: compare design alternatives for predetermined criteria



Not supported: in determining safety requirements

Gaps in support

- Percentage of hazardous substance is not always known
  - No support in asking the right questions
- Contextual risks are not considered in LCA
  - No support in risk assessment
- Risks of consecutive lifecycles not considered
  - No support to assess and visualize systemic impacts
- Formulating substance safety requirements is hardly supported
  - No generic requirements as guidelines for project specific ones
  - No good & bad examples
  - No support during the discover phase for SoC related information

Some possible solutions

- Percentage of hazardous substance is not always known
  - Substitute gaps with impacts of similar materials
  - Commission an assessment by chemists and toxicologists
  - Propose NDA if suppliers are hesitant to share
  - Relative scoring of alternatives to avoid absolute input
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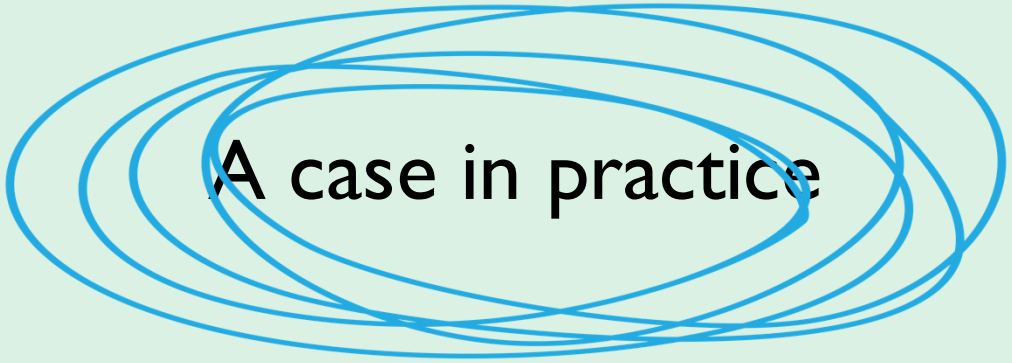
- Formulating substance safety requirements is hardly supported
  - Refer to previous projects
  - Involve experts

HOW ARE DESIGNERS AND ENGINEERS **DEALING** WITH SOC?

&

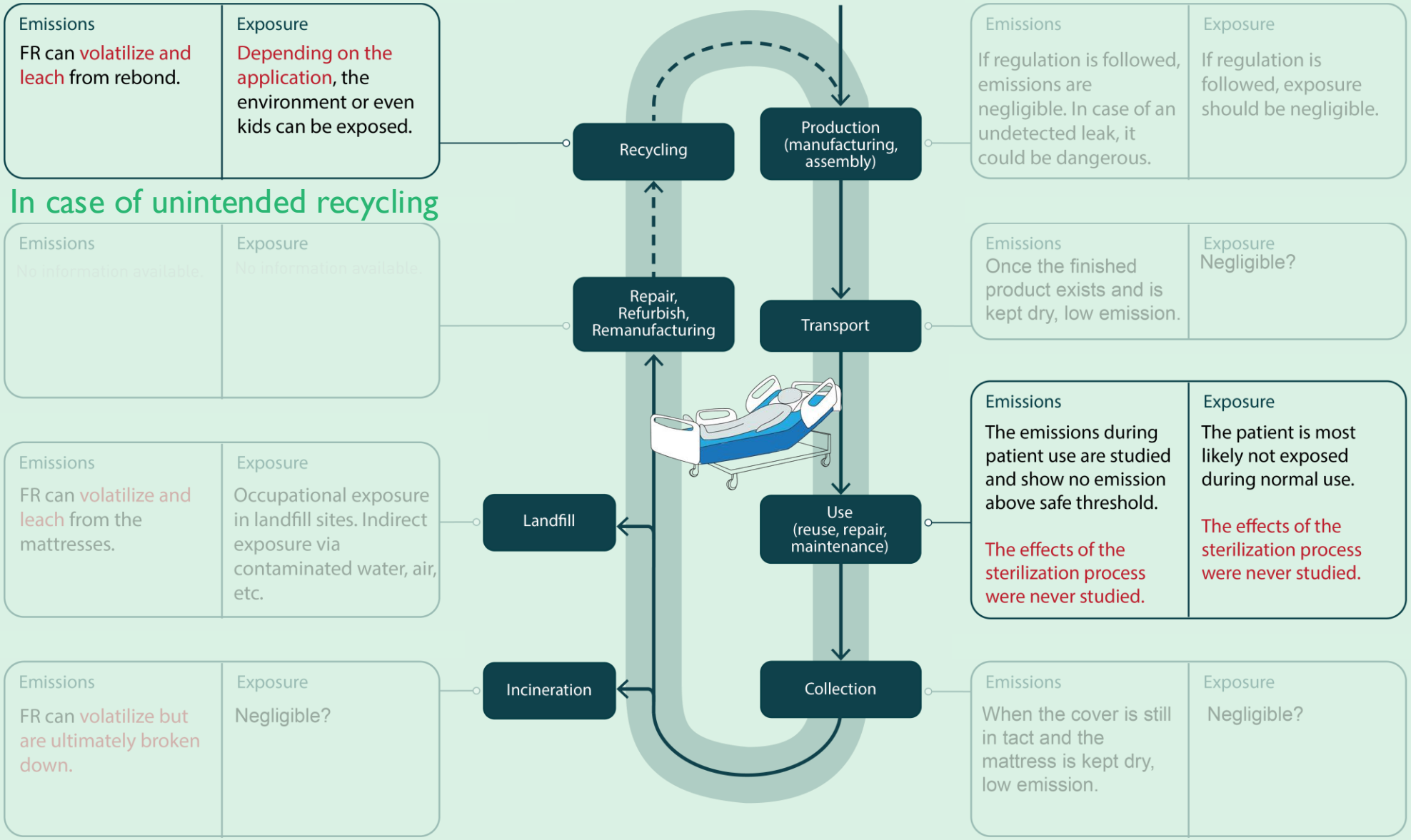
HOW CAN THEY BE **SUPPORTED**?

Theory in methods



Mattress with hazardous flame retardants

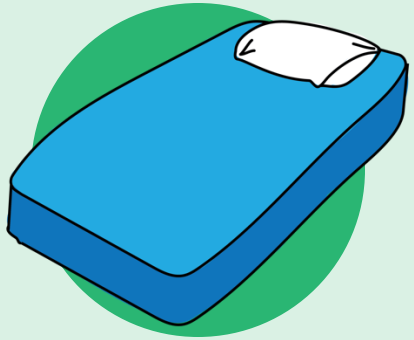
- Foam mattresses are extremely flammable
- No regulation exists for suitable flame retardants
- Current flame retardants are hazardous and hamper recycling



Template by Julieta Bolaños Arriola

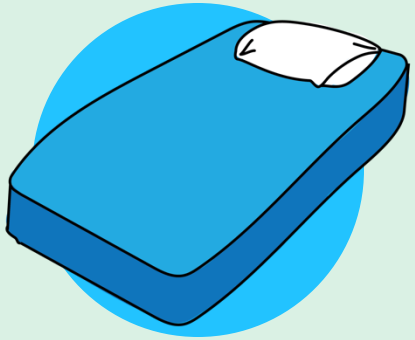
4 SSbD solutions

1– Novel materials



- Substitute foam with safe(r) thermoplastic
- Steel springs for comfort
- DfD: Reversible glue
- DfRec: Collection and recovery infrastructure part of the design

2 - Novel materials

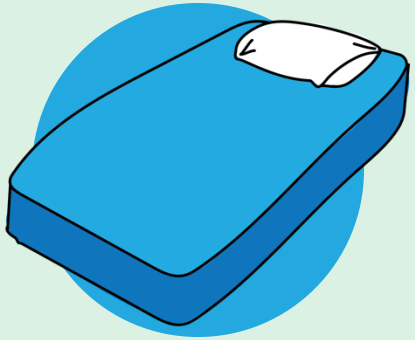


- Foam is substituted with safe(r) thermoplastic
- DfM: All parts can be cleaned by user
- DfD: Replaceable cover
- DfRec: Monomaterial

3 - Modular

- Foam is substituted with safe(r) thermoplastic
- Steel springs for comfort
- DfM: All modules are cleanable by user
- DfM: Separately replaceable modules

4 – Recyclable foam



- Foam based on repolyol
- Non-toxic, recyclable flame retardant
- DfRec: Foam mattress can be included in regular recycling streams

Dilemmas

BUT: traditional market wants foam

BUT: no production line for mattress-sized material

BUT: no recovery infrastructure in place

BUT: lack of information inherent to using novel material

BUT: mattresses last 10 years, so how to test recovery

Solution: use inherently flame-retardant thermoplastic 3D structure instead of foam

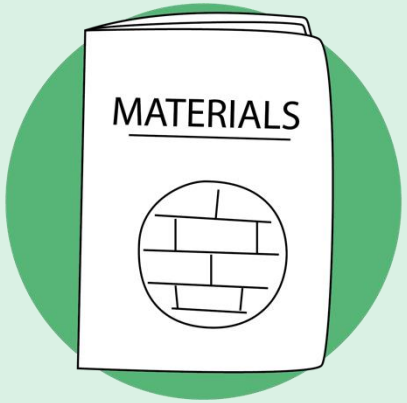
Observed SSbD strategies

Co-development

Incremental improvement

Third party

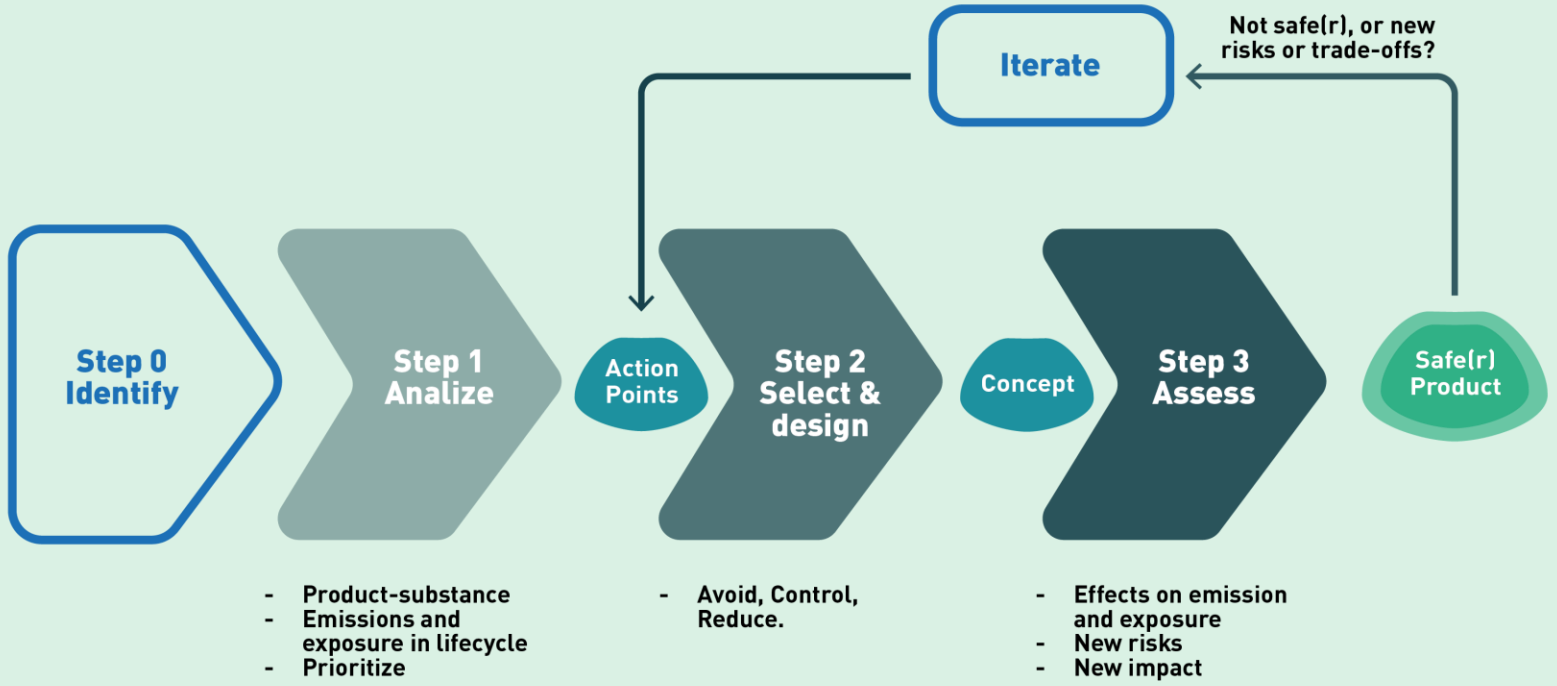
Allergy certification



Material passports

Towards an integrated approach

- SSbD as iterative assessment & development process
- Next steps:
  - Gain better understanding of how designers deal with uncertainty and dilemmas in practice
  - Investigate ways to support systemic perspective and multiple lifecycle thinking

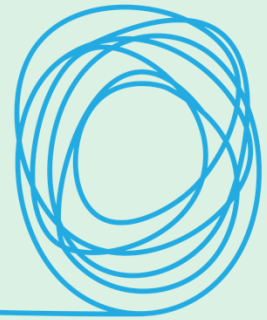


Visual representation of design process by Julieta Bolaños Arriola

SAFE AND SUSTAINABLE BY DESIGN *IN DESIGN*

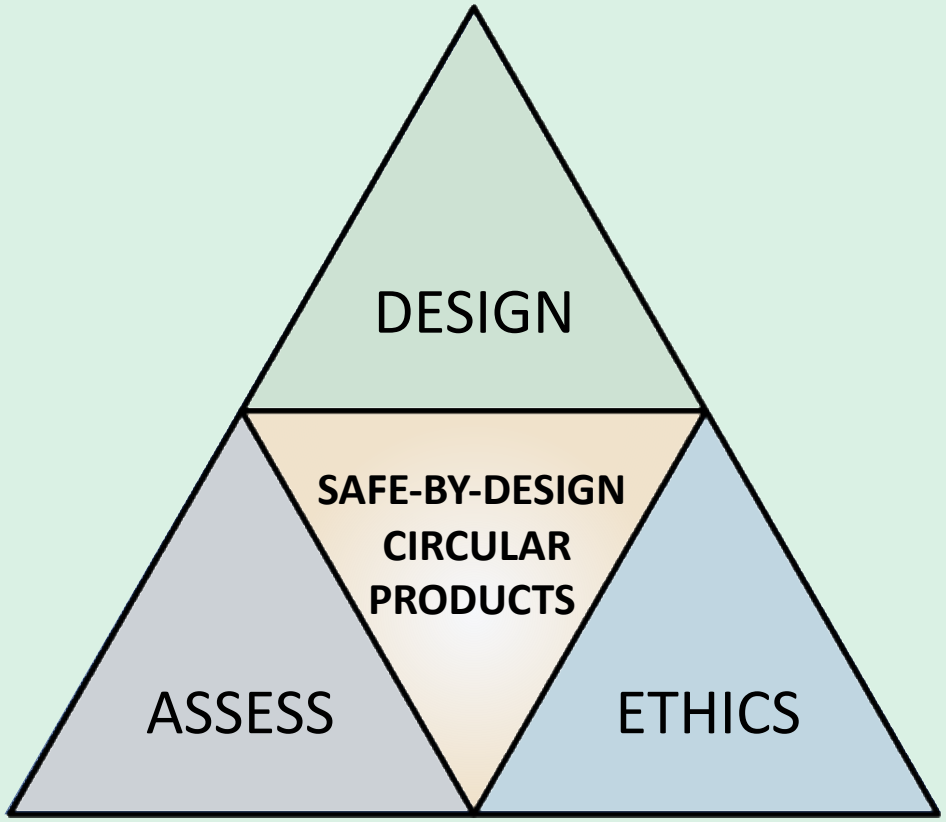
Circular Design Forum 24. Sharing Session Substances of Concern

By Maaike Weber, PhD candidate at TU Delft



Our project

- 3 perspectives
- Trade-offs and value conflicts over multiple lifecycles at the core of the problem statement
- Investigate and support role and ability of designers in practice



Questions & topics from audience

- Certification on circular products and materials
- How design can drive increased use of recycled materials from electronics
- I am interested in hearing any actions taken or future next steps into tactical use cases, small/regional, crawl, walk, run....choose diverse group of value chain stakeholders.
- Any thoughts on how to deal with substances of concern in the design of an assembly from the perspective of using a mass balance as a means to help analyze and improve the design concept?

Avoid	
Avoid	Alternative value proposition or function
Substitute	With substances or materials known to be safe
	With less harmful substances or materials
Phase out	Re-evaluate essentiality

Hazard

The SoC is no longer used in the product, making it inherently safe.

Reduce	
Reduce content (lower volumes = lower exposure)	Reduce content of the SoC in the product or limit use to certain components
Increase useful life / Keep in use longer (to avoid accumulation at end of life)	Durability
	Maintenance and repair
	Refurbish
	Remanufacture
	Alternative business models
Inform / customize	To protect vulnerable groups
	To avoid mechanisms that aggravate emissions

Control	
Contain / isolate	Prevent emissions or exposure by isolating the SoC in the product.
	Redefine production/ manufacturing processes
Control collection / recovery	Separate collection
	Monitor materials to avoid SoC
	SoC can be easily separated
Maintain control over the product	Maintain influence in case unforeseen negative effects arise.

Risk

The SoC remains in use, but emissions and exposure are reduced or controlled, minimizing risk.

Strategies by Julieta Bolaños Arriola

Untapped potential in design?

- Although designers are no LCA, chemistry or material experts
- Ability of framing and reframing throughout process problems and therefore the design space
- To potentially solve dilemmas, trade-offs, uncertainties