



UNION EUROPEENNE Fonds Européen de Développement Régional

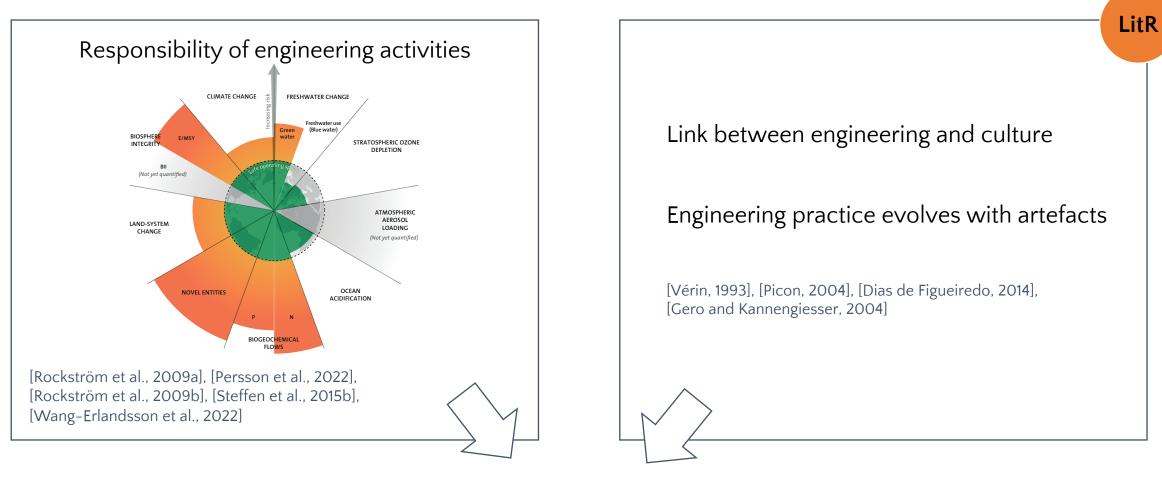
Permaengineering A theoretical framework towards a strong sustainability paradigm in design. An HCI study

Lou GRIMAL, INSYTE – LIST3N, Université de technologie de Troyes Under the supervision of Nadège TROUSSIER & Inès di LORETO

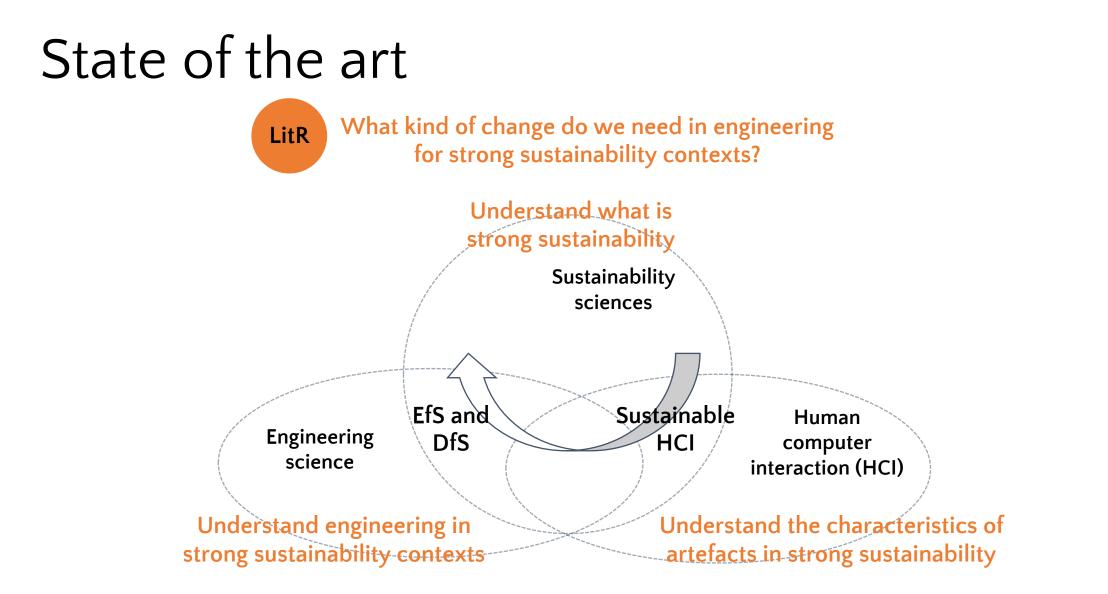
Agenda

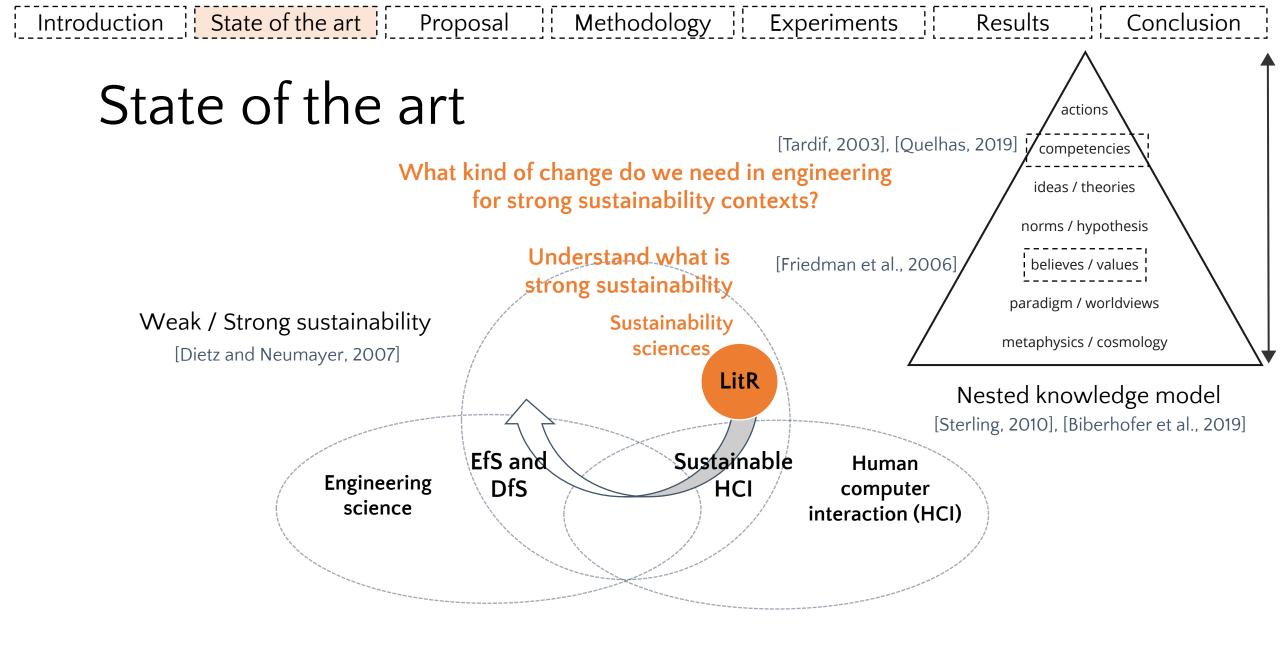
Engineering in the Anthropocene	Engineering and interactions for strong sustainability	Proposal of Permaengineering	Methodology and experiments	Results	Contributions & perspectives
Introduction	State of the art	Proposal	Experiments	Results	Conclusion

Problem



What kind of change do we need in engineering for strong sustainability contexts?



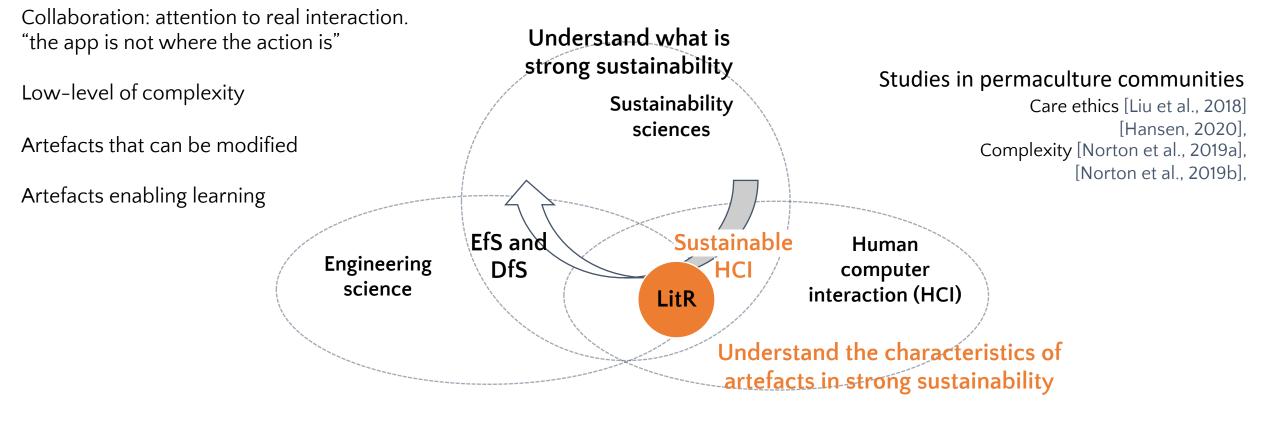


Introduction State of the art Proposal Methodology Experiments Results

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State of the art

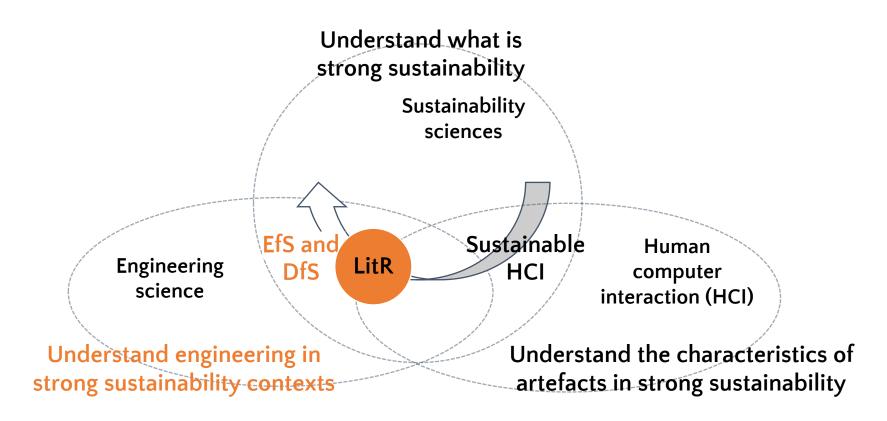
What kind of change do we need in engineering for strong sustainability contexts?



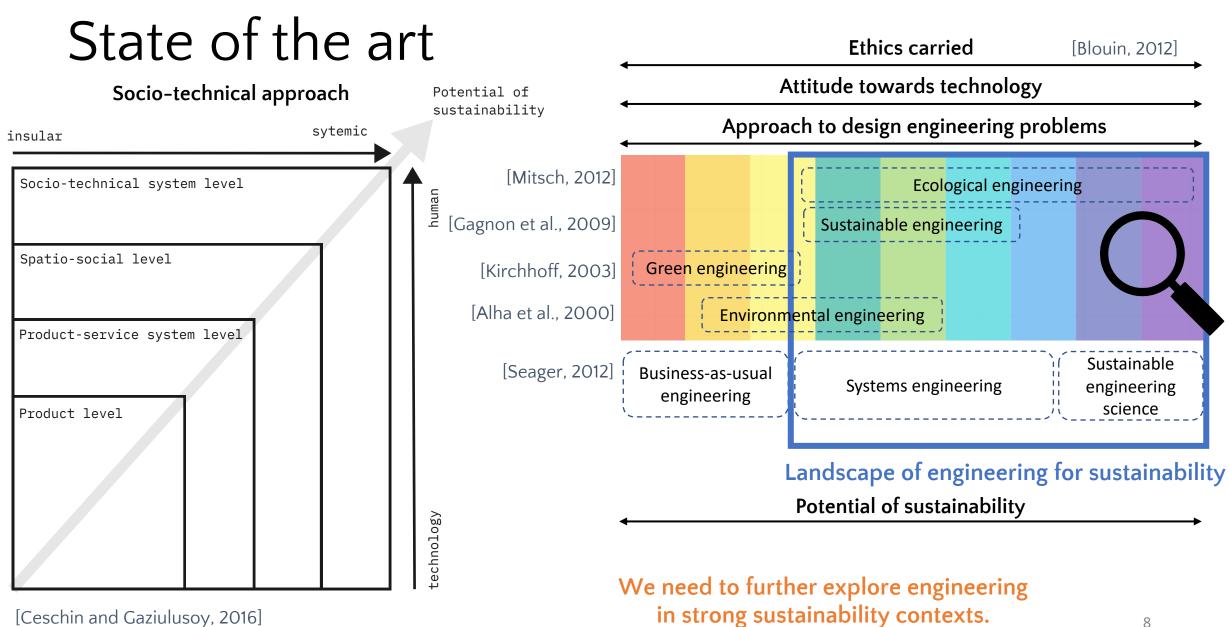
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State of the art

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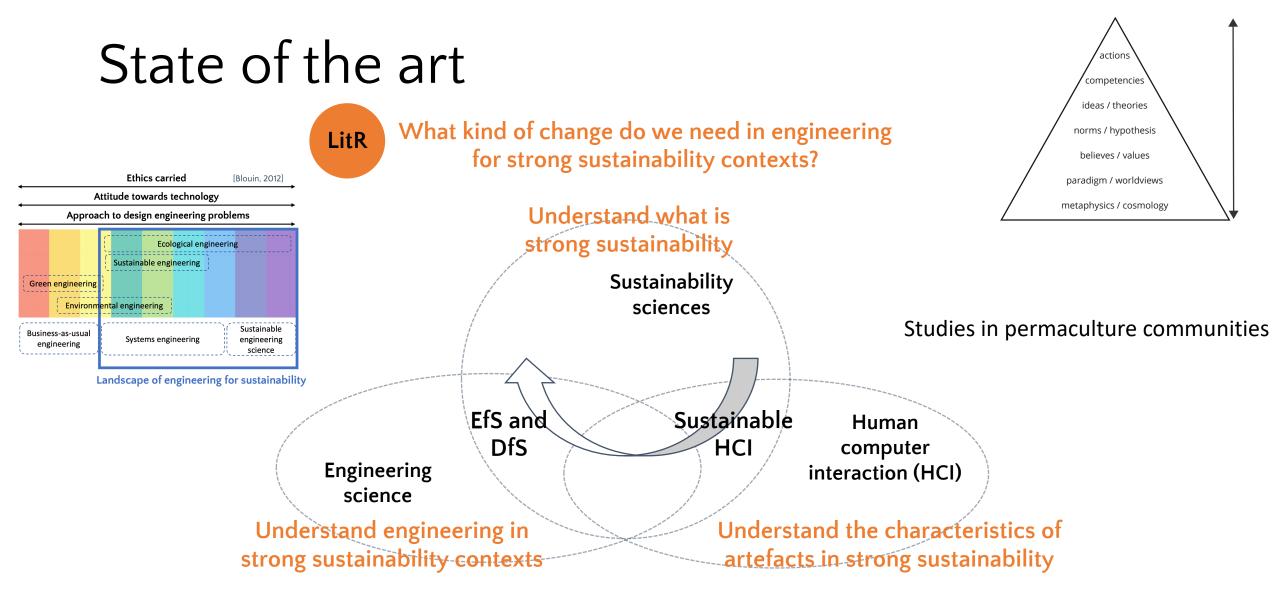


Introduction State of the art Proposal Methodology Experiments Results Conclusion



[Ceschin and Gaziulusoy, 2016]

Introduction State of the art Proposal Methodology Experiments Results Conclusion



Findings from state of the art

<u>Goal</u> of **strong sustainability**

Clarification of <u>ethics</u>: **care ethics**

Questioning the application domain Attention to relation (not blocking action)

Socio-technical <u>approach</u>: **collaboration**

Low-level of complexity

Supporting interaction among people

- Artefacts enabling learning
- Artefacts that can be modified

<u>Ability to act</u>: engineering competencies for sustainability

An artefact which supports the development of the 8 competences

Research questions (RQ)

What kind of change do we need in engineering for strong sustainability contexts?

Engineering level

<u>**Gap 1:**</u> Design engineering in strong sustainability contexts is not enough addressed

<u>RQ 1</u>: In a context of ecological transition, to what extent **<u>engineering</u>** can evolve towards other ways of being and being practiced?

Digital transition

Interactions level

<u>Gap 2:</u> Understanding HCI in engineering practices for strong sustainability <u>RQ 2:</u> What are the <u>digital tools and methods</u> to support engineering practices in line with strong sustainability contexts?

Proposal

(1) <u>Goal</u> of strong sustainability

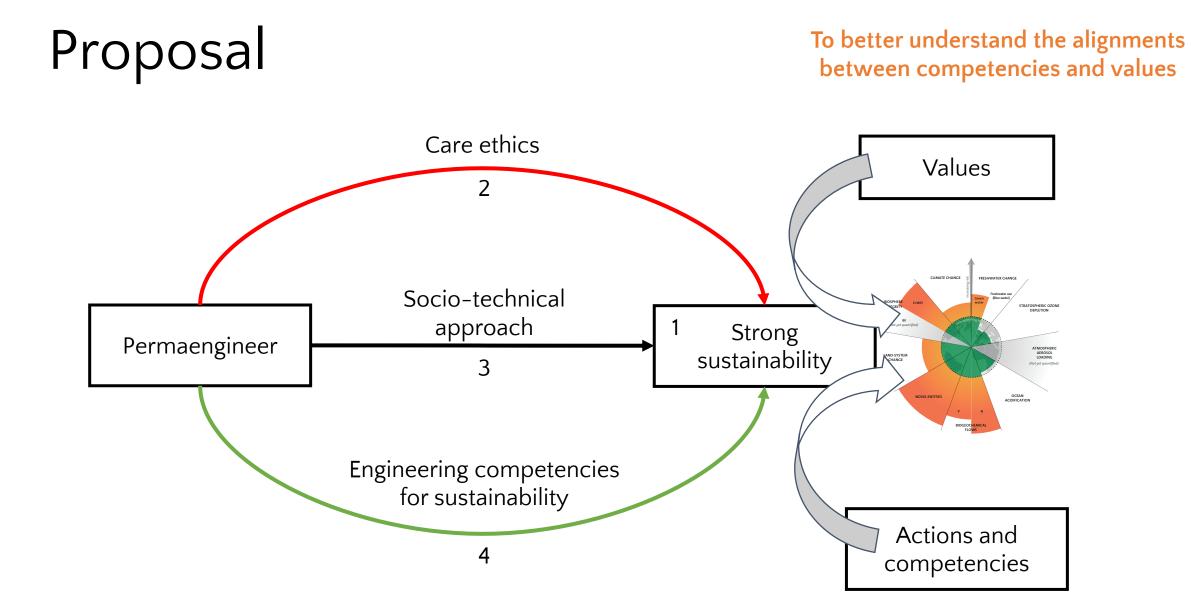
(2) Clarification of <u>ethics</u>: **care ethics** Questioning the application domain Attention to relation (not blocking action)

(3) Socio-technical <u>approach</u>: **collaboration** Low-level of complexity Supporting interaction among people Artefacts enabling learning Artefacts that can be modified

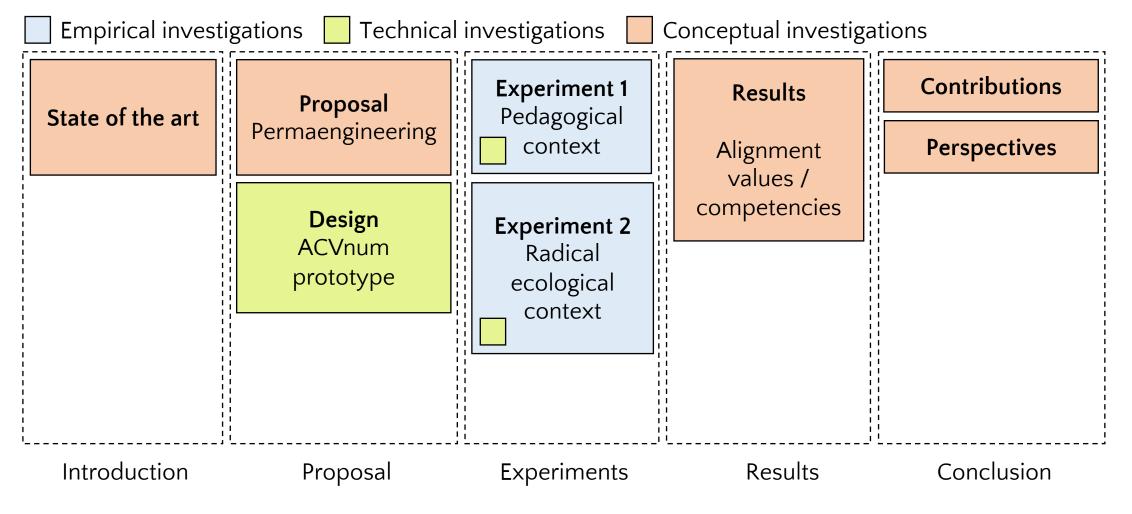
Proposal: In a (1) context of strong sustainability, (2) care ethics, (3) collaboration and
(4) engineering competencies for sustainability enable to align values and actions

(4) <u>Ability to act</u>: **engineering competencies for sustainability** An artefact which supports the development of the 8 competences





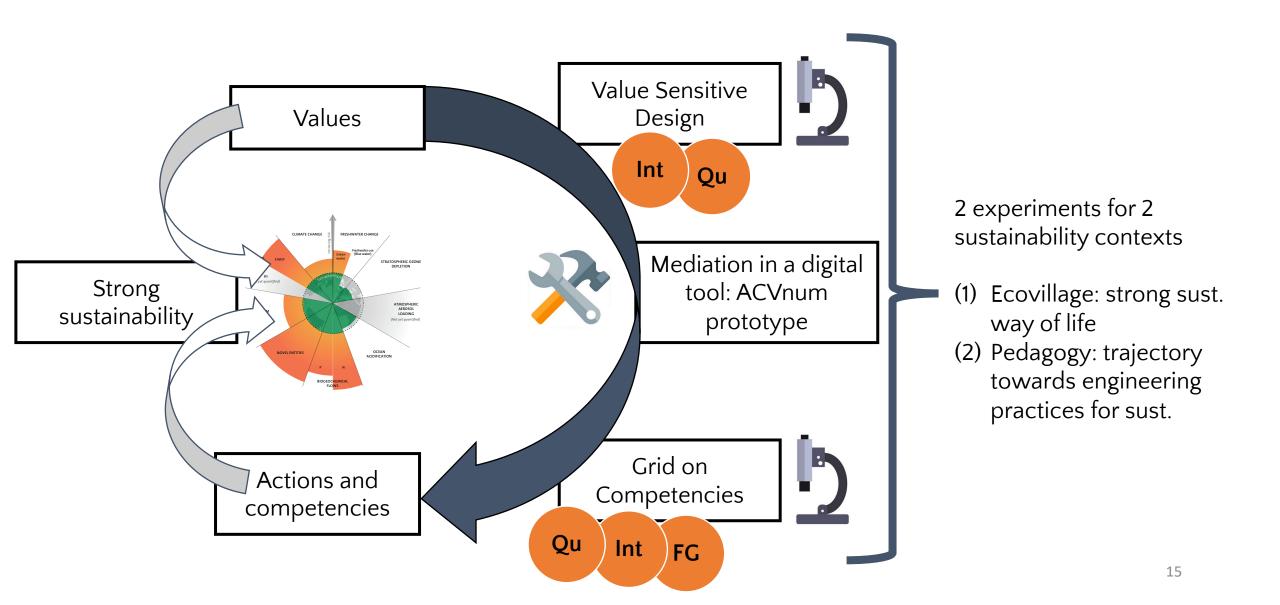
Value sensitive design



Understanding HCI in engineering practices for strong sustainability

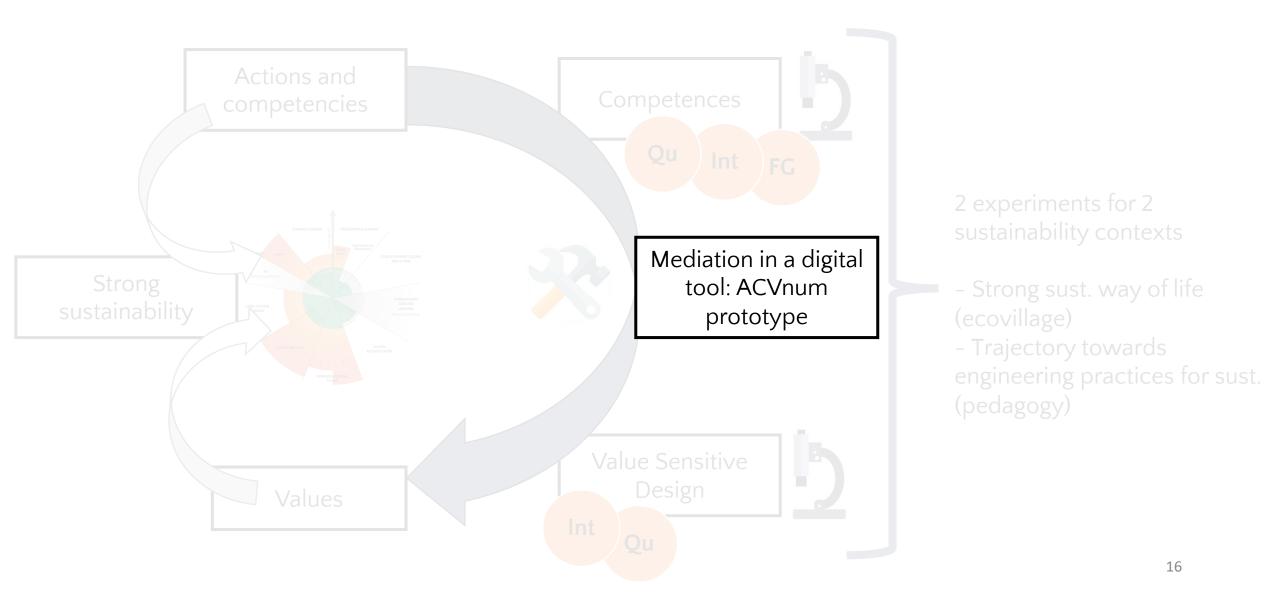
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Understanding HCI in engineering practices for strong sustainability



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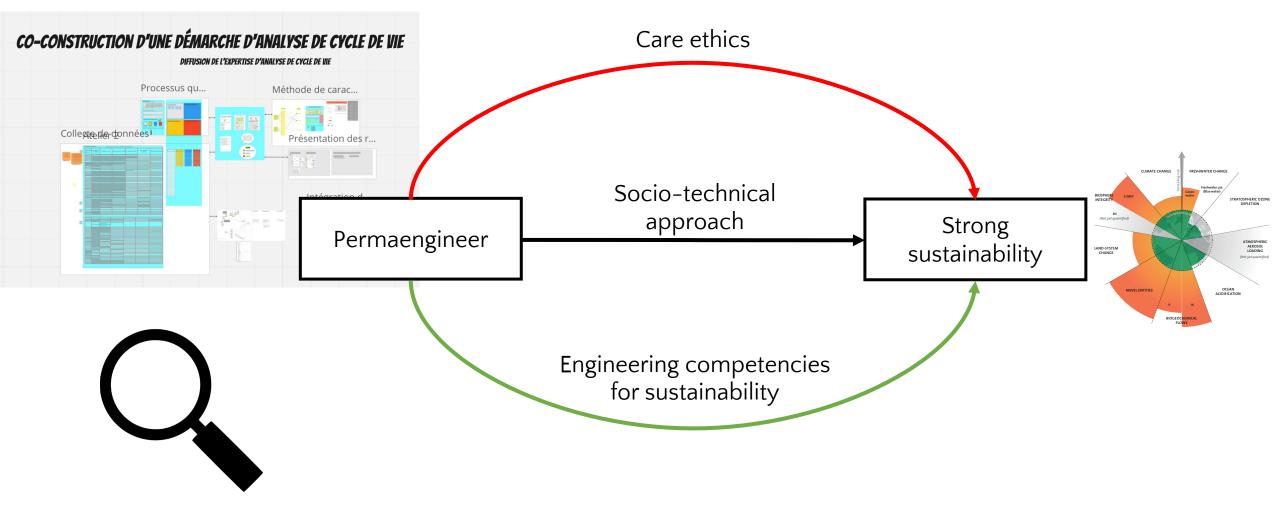
Understanding HCI in engineering practices for strong sustainability



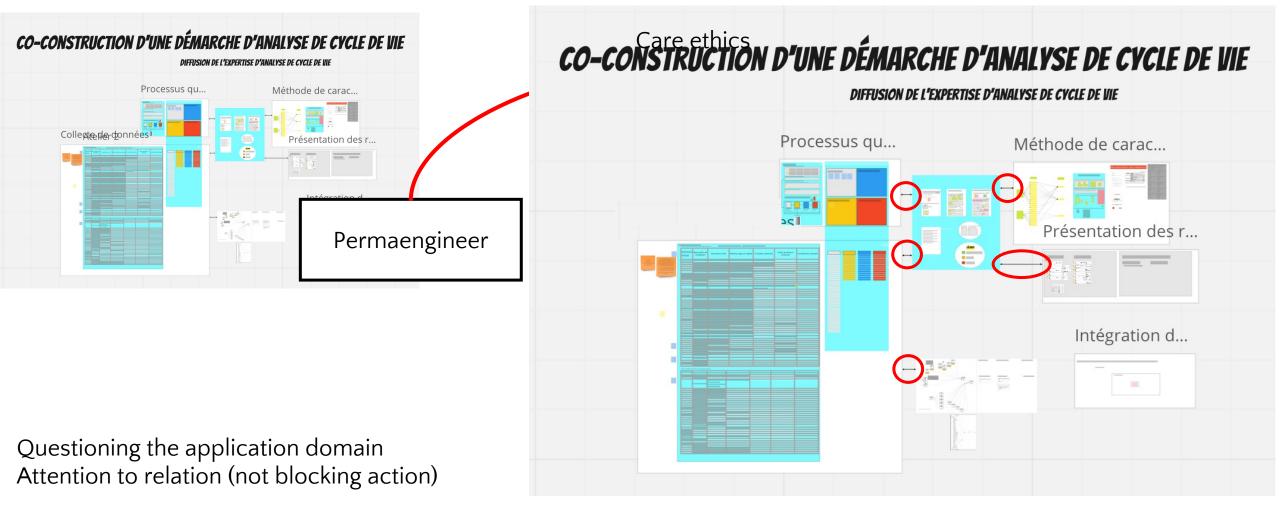
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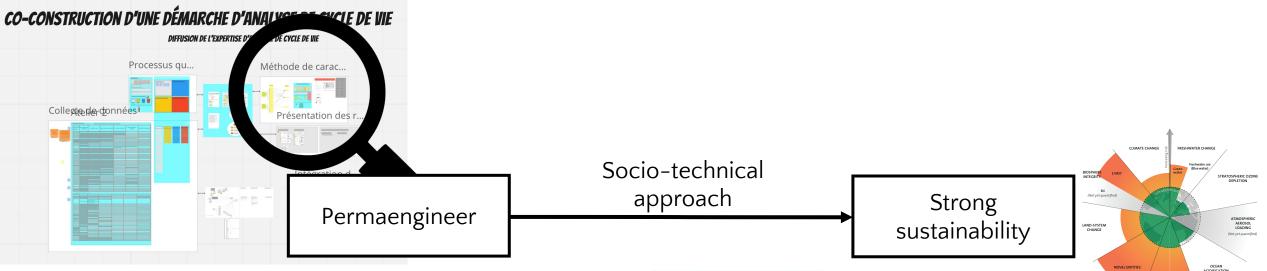




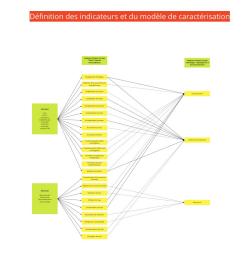






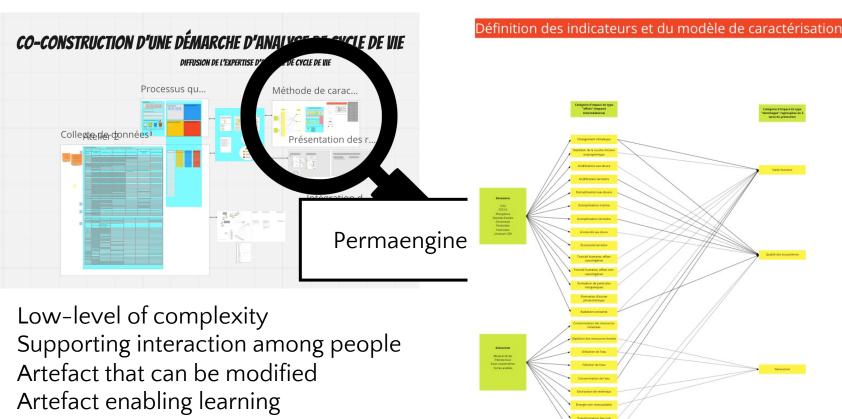


Low-level of complexity Supporting interaction among people Artefact that can be modified Artefact enabling learning



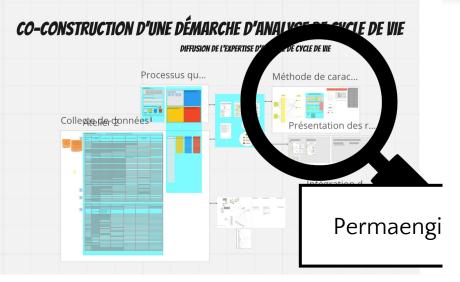


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GreenDeLTa

LCIA methods Impact assessment methods in Life Cycle Assessment and their impact categories

Version: 1.5.5 Date: 11 May 2016

Changelog		Changes	Dete
Versian 1.0	Azero, Rodríguez,	1º release	31 January 2014
	Ciroth		
Versian 1.1	Acero, Rodríguez,	Corrected normalization factors for CML 2001	3 Tebracy 2014
	Ciroth		
Version 1.2	Acero, Rodrigoez,	Added Social LCIA method, updated TRACI 2.0 to	17 February 2014
	Ciroth	TRACI 2.1, updated ILCD 2011	
	Acero, Rodrígsez,	Updated TRACI 2.1 to add some ecolewart specific flaws	
	Circh		
Versian L4	Acero, Rodríguez,	Corrected CML and ReCiPe version	28 April 2014
	Ciroth		
	Azero, Rodríguez,	Delated EDIP 2003 methods as they need further	4 September 2014
	Circh	revision. Only in EcoSpoid and openLCA 1.4 formats	
	Accro, Rodrígocz,	Added nermalization/weighting factors for intermediate	17 October 2014
	Ciroth	endpoint categories in ReCiPe. Only in EcoSpoid and	
		openLCA 1.4 fermais	
Versian 1.3	Acero, Rodríguez,	ReCiPe 8 methods apgraded to version 1.10 from May	30 October 2014
	Circh	2014. Only in TcoSpold and openLCA 1.4 formats	
	Acero, Rodríguez,	Some missing factors in ReCiPe 8 methods added. Only	11 November 201-
	Circh	in EcoSpold and operLCA 1.4 formats	
		Cumulative Energy Demand method added. Added	5 January 2015
	Circh	normalisation/weighting factors for intermediate endpoint	

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	Pollution photochimique ou smog		X
	Autres formes de la pollution de l'air (métaux,	X	X
	poussières, dioxines et furanes,)		
Pollution des eaux	Eutrophisation		X
	Rejets de composés organiques carbonés		Х
	Matières en suspension		Х
	Métaux lourds		Х
Pollution des sols	Métaux lourds		X
	Polluants organiques		Х
	Pollution par les déchets		Х

Documentation des indicateurs

Source : https://www.ademe.fr/sites/default/files/assets/documents/25165_acv_impacts.pd

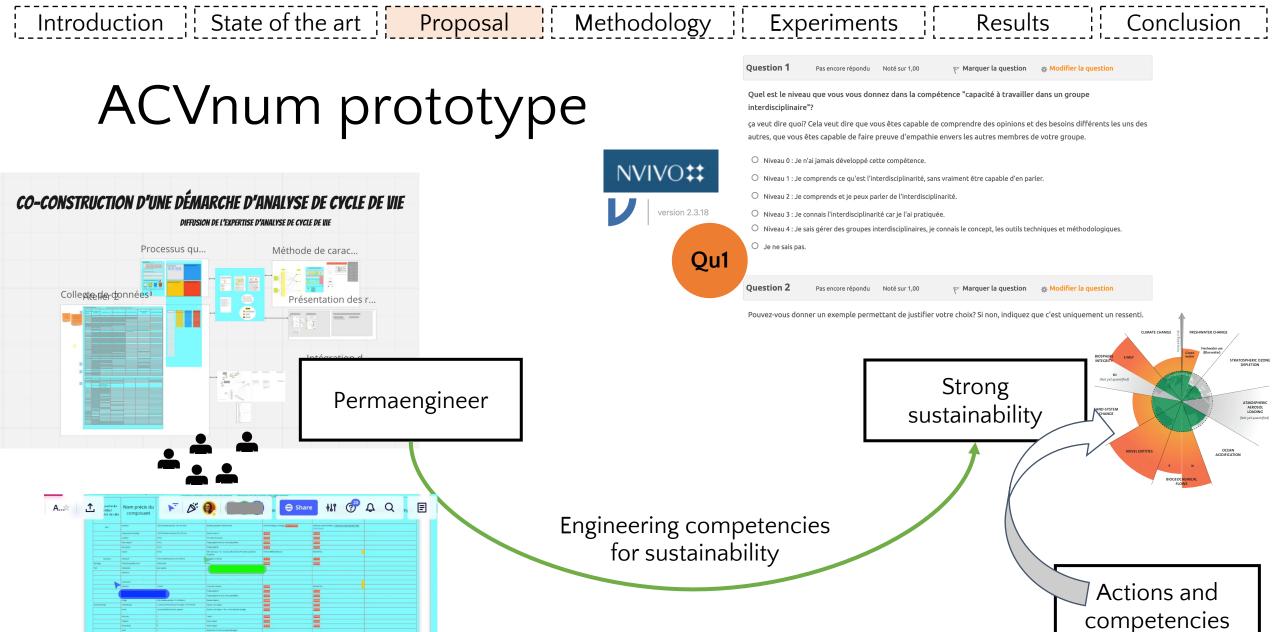
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	Factours de caractérisation				Pacieurs de caractérication			

Low-level of complexity Supporting interaction among people Artefact that can be modified Artefact enabling learning

Comment évaluer
les impacts environnementaux
au moyen de
l'analyse du cycle de vie (ACV)

OPTIMISATION DE LA GESTION DES DECHETS MUNICIPAUX



Int1

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Introduction State of the art Proposal Methodology Experiments Results Conclusion

Mediation via ACVnum

Regular LCA tools

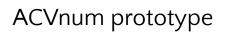
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ocial indicators	 P Grape, early production (phase), organic, variety mix 	France						0.01494	kg 1,4-dichlorobenzene eq.		
ackground data	fe Copper		soil/agricultural	0.00124	kg	14.35989	kg 1,4-di		kg 1,4-dichlorobenzene eq.		
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pet_teacher	le Cadmum		water/ground water	2,14245E-10	kg	1.41506E-20		4.21658E-30 3.03170E-30	kg 1,4-dichlorobenzene eq.		
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ica4students,August2016 ica4teacher,August2016	Fe Lead		water/ground water	3,243185-10	kg	4.77422E-22		1.54836E-31	kg 1.4-dichlorobenzene eg.		
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a v1 starter	Fe Cadmium		soil/agricultural	-1.89405E-10	kg	166,80795		-3.15942E-8	kg 1.4-dichlorobenzene eg.		
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Jeacoro	fe Nickel		soll/agricultural	-2.770975-8	kg	238,55193		-6.610206-6	kg 1,4-dichlorobenzene eg.		
	le Chromium		soll/agricultural	-4471368-7	kg	6102.86169		-0.00282	kg 1.4-dichlorobenzene eg.		
	> P Plant protection, spraving, with atomiser/spraver, 20	France			-			1.54854E-5	kg 1,4-dichlorobergene eg.		
		France						1.46559E-5	kg 1.4-dichloroberzene eg.		
		France						1.00250E-5	kg 1.4-dichlorobenzene eg.		
	P Harvesting (vine), with trailer	France						9.40278E-6	ko 1.4-dichlorobenzene eg.		
	> P Ploughing (vine), with frame plough	France						7.74272E-6	kg 1,4-dichlorobenzene eg.		
	P Hoeing, with 2 row hoe	France						6.636622-6	kg 1,4-dichlorobenzene eg.		
	> P Crushing, with shredder or chipper	France						3.56165E-6	kg 1,4-dichlorobenzene eq.		
	> P Tipping, with vine shoot tipping machine	France						2.44265E-6	kg 1,4-dichlorobenzene eg.		
	> P Fertilizing, solid manure (charging and spreading), w	France						2.30796E-6	kg 1,4-dichlorobenzene eg.		
	P Transporting to farm, with 2 axie trailer (15 t)	France						1.428455-6	kg 1.4-dichlorobenzene eg.		

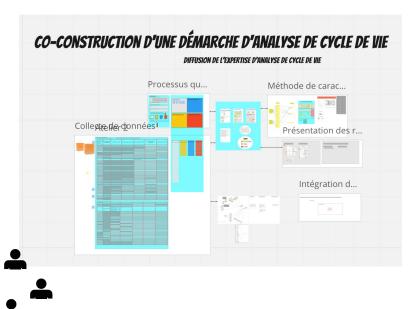
- (1) <u>Goal</u> of **strong sustainability**
- (2) Clarification of <u>ethics</u>: **care ethics** Questioning the application domain Attention to relation (not blocking action)

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- (3) Socio-technical <u>approach</u>: **collaboration** Low-level of complexity
 - Supporting interaction among people
 - System enabling learning
 - System that can be modified
- (4) <u>Ability to act</u>: engineering competencies for sustainability
 - A system supporting the development of the 8 competences





Collective intelligence tool

Individual expert tool



Experiment in an ecovillage

In a (1) context of strong sustainability, (2) care ethics, (3) collaboration and (4) engineering competencies for sustainability enable to align values and actions

Heterogenous *focus group* (<u>actions</u> and <u>competencies</u>) Individual interviews centred on <u>values</u> and <u>competencies</u> (7 months)

Group work sessions

Analysis with 3 main types of codes

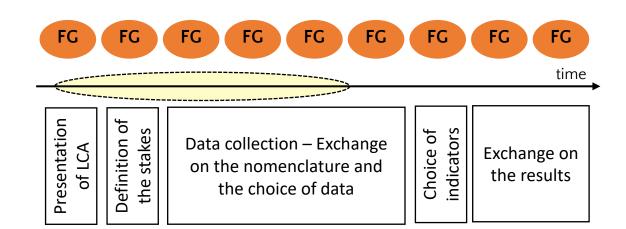
(1) Difficulties encountered by inhabitants

(2) Elements easy to manage for inhabitants

(3) Competencies developed along the process

Individual interviews

- 1) Motivational interviews [Pollak, 2011] & links with **values** [Friedman et al., 2006]
- 2) Interviews about the **competencies** developed [Quelhas, 2019], [de l'enseignement, 2011]



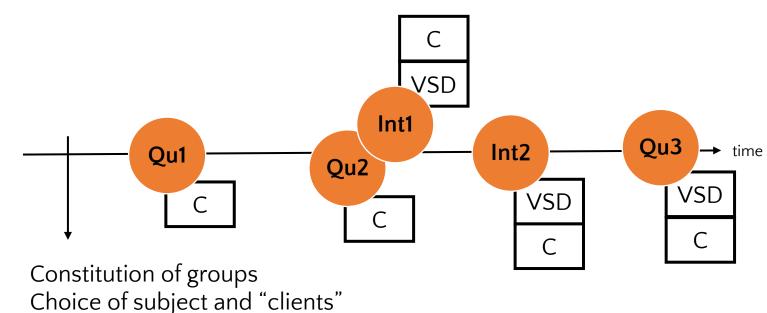
Conclusion

Experiment in a pedagogical context

In a (1) context of strong sustainability, (2) care ethics, (3) collaboration and (4) engineering competencies for sustainability enable to align values and actions

Goal: comparison of groups using ACVnum prototype and groups without the prototype

Groups: ACVnum groups (4) and control groups (4)

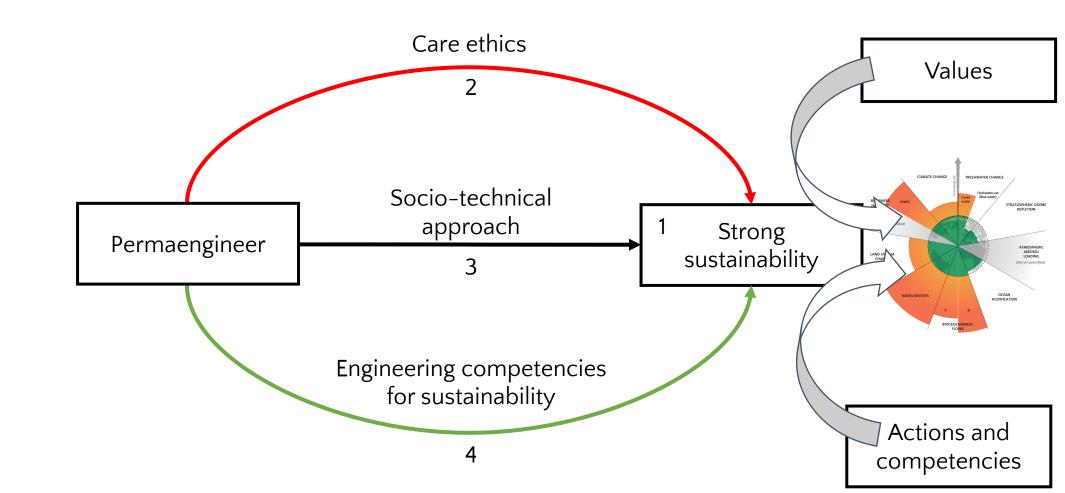


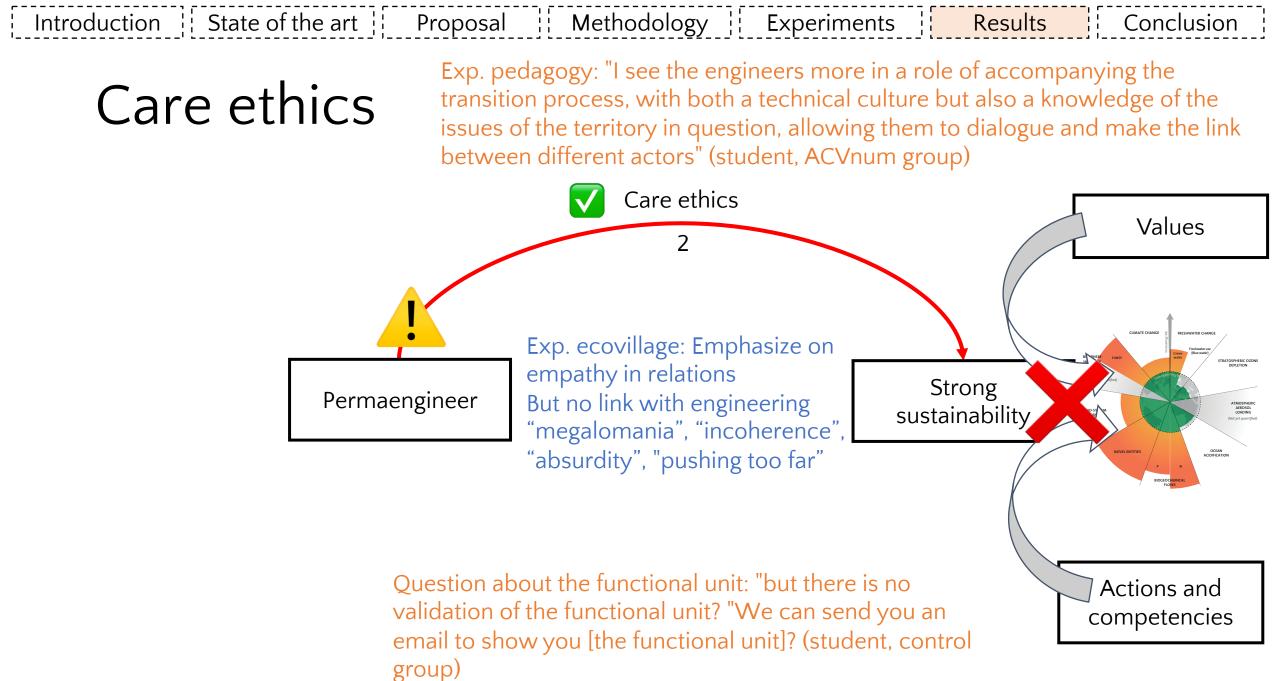
Question 1 Pas encore répondu Noté sur 1.00 Marguer la guestion Ouel est le niveau que vous vous donnez dans la compétence "capacité à travailler dans un groupe interdisciplinaire"? ca veut dire quoi? Cela veut dire que vous êtes capable de comprendre des opinions et des besoins différents les uns des autres, que vous êtes capable de faire preuve d'empathie envers les autres membres de votre groupe O Niveau 0 : Je n'ai jamais développé cette compétence O Niveau 1 : Je comprends ce qu'est l'interdisciplinarité, sans vraiment être capable d'en parler O Niveau 2 : Je comprends et je peux parler de l'interdisciplinarité O Niveau 3 : Je connais l'interdisciplinarité car je l'ai pratiquée O Niveau 4 : Je sais gérer des groupes interdisciplinaires, je connais le concept, les outils techniques et méthodologiques O Je ne sais pas Ouestion 2 Marquer la question Modifier la question Noté sur 1.00 Pouvez-vous donner un exemple permettant de justifier votre choix? Si non, indiguez que c'est uniquement un ressent

Conclusion

i Introduction i! State of the art	Proposal !! Methodology :! Experiments :!	Results !! (onclusion !!
Introduction : State of the art	1 $10003a$ 1 $1000000gg : LAPETITIETIS : 1$	
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Results





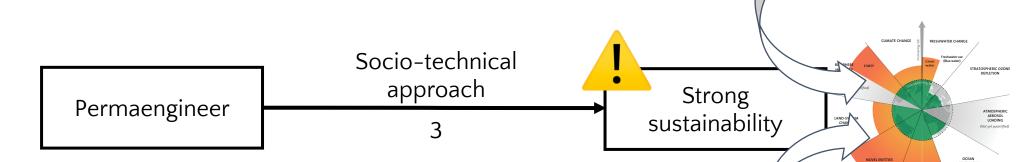
Socio-technical approach

Exp. ecovillage

Implementation difficulties

No collaboration with stakeholders external to the focus group

Whereas willingness to impact society at a local level



Exp. pedagogy

Reluctance to collaborate (ACVnum groups > control groups)

- 1. The client was already an expert: « No because we had only 1 meeting with him. And he was already very engaged so he already knew all environmental actions possible to conduct »
- 2. Lack of interest from the client: « I don't think they had expectations from our work »

Fear to have gaps between their work and clients expectations

 « I was afraid that we would end up being a bit silly with an LCA that would not meet their expectations »

Actions and

competencies

Values

Engineering competencies for sustainability

[Quelhas, 2019] Exp. ecovillage CO-CONSTRUCTION D'UNE DÉMARCHE D'ANALYSE DE CYCLE D Already high level Interdisciplinary group Values Self-knowledge Formulation difficult to understand Normative competence Systemic thinking Low impact of ACVnum prototype on inhabitants Ability to solve problems Contextualisation and vision of the future Critical thinking Strategic competence Strong Permaengineer ATMOSPHERI AEROSOL LOADING sustainability Exp. pedagogy Engineering competencies No significative difference (p>0.05) for sustainability between control groups and ACVnum D-CONSTRUCTION D'UNE DÉMARCHE D'ANALYSE DE CYCLE DE Actions and groups competencies Difficulty with **normative competence** 31

Introduction State of the art Proposal Methodology Experiments Results Concl	ion
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What kind of change do we need in engineering for strong sustainability contexts?

Engineering level

Gap 1: Design engineering in strong sustainability contexts is not enough addressed

RQ 1: In a context of ecological transition, to what extend **<u>engineering</u>** can evolve towards other ways of being and being practices?

Findings:



Better understanding the link between values and actions Lack of normative competence is an hindrance to evolve towards strong sust.

Interactions level

<u>Gap 2:</u> Lack of understanding of the role of HCI in strong sustainable

RQ 2: What are the **digital tools and methods** to support engineering practices in line with strong sustainability contexts?

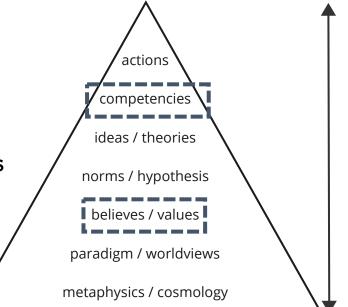
<u>Findings:</u>



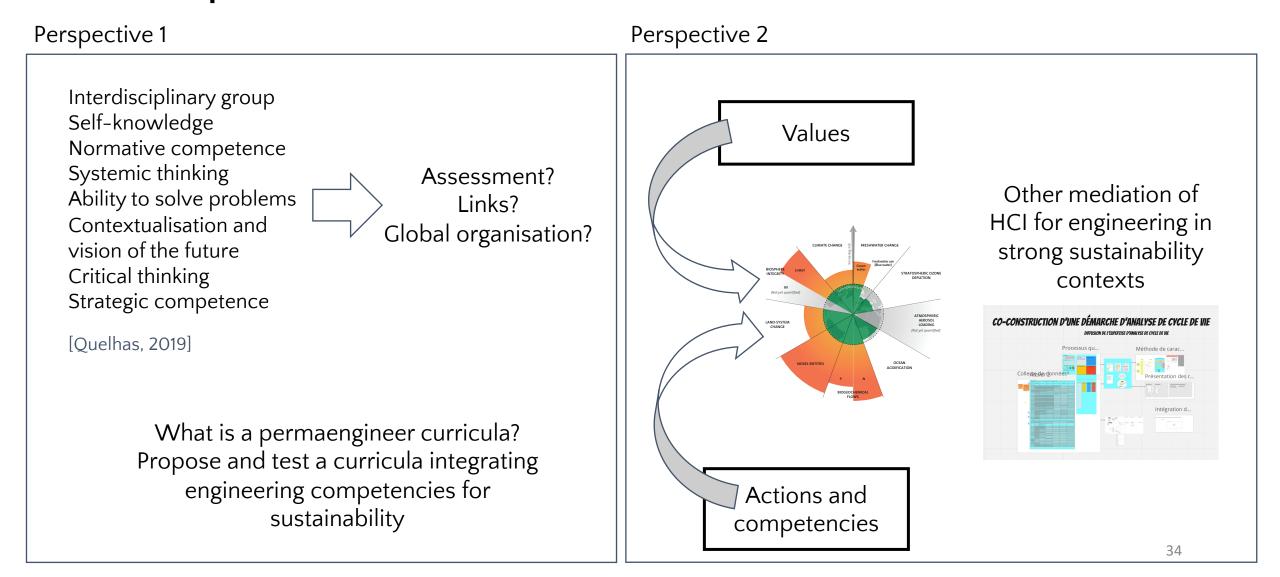
Artefacts can highlight the difficulty of collaboration Difficult to change an already existing interactive tool into a strong sustainability one

Discussion and limits

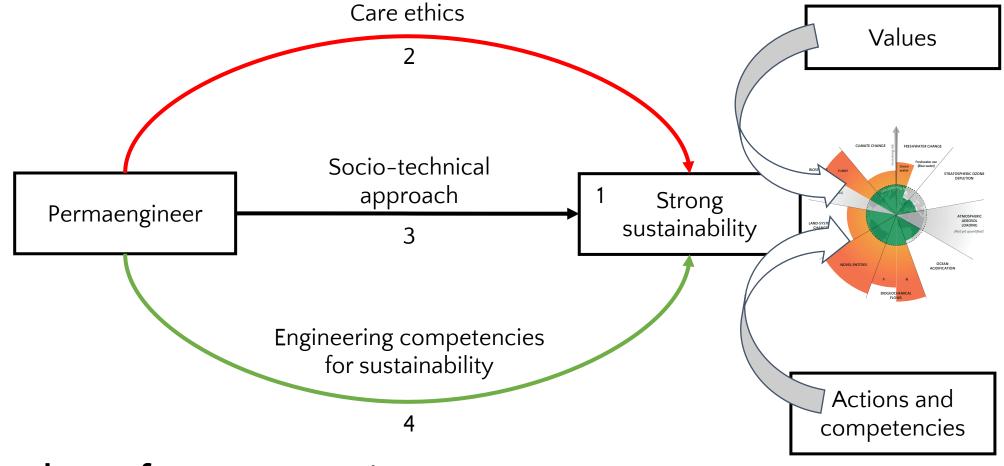
- Evaluation and role of competencies
 - Difficulty to assess the competencies [Wiek et al., 2011],
 - Scope of answers [Redman et al., 2021]
 - > Methods to better collect and analysis data
- Collaboration
 - Interpretation of my results: why such a fear of collaboration?
 - LCA method and LCA software? ACVnum prototype?
 - Pedagogical situation?
 - Cultural difference between students and clients?
- Still no good understanding of alignment process between values and actions
 - Observations of gaps
 - Analysis of their origins



Perspectives



Permaengineering: a theoretical framework towards a strong sustainability paradigm in design. An HCI study



Thank you for your attention

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