STRONG SUSTAINABILITY ASPECTS IN THE IDEATION PROCESS: A PEDAGOGICAL EXPERIMENT

Melissa Escobar, Valérie Laforest, Nadège Troussier, Jenny Faucheu

STRONG SUSTAINABILITY ASPECTS IN THE IDEATION PROCESS: A PEDAGOGICAL EXPERIMENT

Escobar, Melissa (1,2,3);
Laforest, Valérie (1);
Troussier, Nadège (3);
Faucheu, Jenny (2)

1: Mines Saint-Etienne, Univ Lyon, CNRS, Univ Jean Monnet, Univ Lumière Lyon 2, Univ Lyon 3 Jean Moulin, ENS Lyon, ENTPE, ENSA Lyon, UMR 5600 EVS, F-42023 Saint-Etienne, France;
2: Mines Saint-Etienne, Univ Lyon, CNRS, UMR 5307 LGF, F-42023 Saint-Etienne, France;
3: ICD, CREIDD, Université de Technologie de Troyes, 12 rue Marie Curie, 10 0 04 Troyes, France

ABSTRACT

The progress of science and technology has considerably increased the quality of life - especially the material standard of living - (e.g. disappearance of famines, increase in life expectancy) On the other hand, climate change, reduction of biodiversity, decrease of natural resources, and increase of environmental risks are some of the consequences of this human activities. Addressing these new challenges will require holistic comprehension and actionable approaches. The mitigation of these consequences requires effective responses in terms of transition. In this context, engineering and design students need time but also adapted curricula focused on sustainability and eco design concepts to support evolution of their skills, their knowledge and their culture. This article discusses the integration of a strong sustainability knowledge within the ideation process through a pedagogical experience, in order to develop new knowledge-based approaches, methodologies and tools

Keywords: Strong Sustainability, Creativity, Design education, Sustainability

Contact:
Escobar, Melissa
Ecole de Mines de Saint Etienne France
melissa.escobar.c@emse.fr

Cite this article: Escobar, M., Laforest, V., Troussier, N., Faucheu, J. (2023) 'Strong Sustainability Aspects in the Ideation Process: A Pedagogical Experiment', in *Proceedings of the International Conference on Engineering Design (ICED23),* Bordeaux, France, 24-28 July 2023. DOI:10.1017/pds.2023.321

1 INTRODUCTION

Engineering and design tools and methods are influenced by societal constraints, such as the ecological crisis, including associated social crises (sanitary crises, for instance) as they enhance creativity and innovation (Brown & Katz, 2011; Bocken et al., 2014).

Young people are already aware of some aspects of sustainability related to sustainable development (SD) and eco-design and therefore to the weak sustainability paradigm (Perpignan et al. 2018). SD is considered to be “development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (Brundtland, 1987). Eco-design is a design approach with a technical focus on reducing impact, which “puts emphasis on the whole life cycle of the product” (Ceschin & Gaziulusoy, 2020). These aforementioned aspects lay down the strategies of the weak sustainability approach, establishing that technical progress provides a set of solutions allowing substitution between the different forms of capital; "human-made capital" (productive equipment, education, research, etc.) must be able to take over from lesser degrees of “natural capital” (ecosystem services and natural resources) (Solow, 1992). Nevertheless, strong sustainability is not yet welldefined in the existing literature. Moreover, the existing literature shows that “awareness” might be a key to professional commitment, as pertains to the “meaning of work” (Mao et al. 2020; Dimitrova et al.2021), so it is a mission of higher education to link "awareness" and "skills" to promote the use of "skills" in the service of SoSy.

First formulated by Daly and Costanza in 1992, “strong sustainability” is a paradigm that is still being explored, described and defined through the lens of complementary disciplines (Daly, 1999a; Ott, 2009; Chaminade, 2020). Considering this multidisciplinary literature review, three aspects tend to characterise Strong Sustainability (SoSy):

- Ecocentrism, explored in philosophical and ethical discussions that represent a full integration of human beings and human activities (social and economic) within the ecosphere (living ecosystems, water, land and atmosphere) (Daly, 1999a; Ott 2003; Ott, 2009; Ott & Dôring, 2008; Wu, 2013).
- Regeneration, that takes into account the different temporalities (short-term, medium term and longterm) of living organisms (Robert K-H, 2000) and the biogeochemical cycles of the planet (Turner et al. 1993), and that highlight the interrelationships of living systems (Reed, 2007).
- Safe and just operating space, that is related to planetary boundaries (Steffen et al, 2015; Rockström, 2009). Finding a safe operating space allows social well-being for the entire population (Raworth, 2012) while safeguarding the capacity for the planet to continue providing for future generations (Steffen et al 2009).

From an educational point of view, this paper focuses only on the ability to influence students’ awareness of SoSy during the ideation phase of a design process. Thus, the aim of our paper is to evaluate the adequacy of the current framework of formalisation for strong sustainability, inspired by diverse disciplines. The aim is not to evaluate its innovation; the proposals could be creative or even existing. This positioning will allow us to propose new perspectives on the pedagogical methods used to learn, teach and practice a new design methodology that takes into consideration the requirements of a strong sustainability paradigm. Furthermore, we believe that the factors observed in this experiment will allow us to visualise the criteria that must be considered to create a new design process for a strong sustainability paradigm.

2 EXPERIMENT

The experiment was conducted in April 2022 during a “Design and Sustainability” workshop with twenty students enrolled in three different curricula (design, management and engineering). The main purpose was the study of the influence of students’ awareness of the SoSy paradigm on the characteristics of the concepts proposed by the students during a design process. This experiment is part of a first initiative in building a longer learning program with other activities: "long project with tutor", "6h course on SoSy" and one week workshop.

2.1 Methodology

For the experiment, the students were divided into 2 subgroups of 12 students in 2 different classrooms and were asked to work in pairs/teams of two (teams A-F and teams G-L). In room 1, the
“preservation” brief was proposed as “Preserving food is an essential need for humans. This need is revealed in a wide variety of food preservation solutions across time and cultures. Can you imagine your food preservation scenario?” In room 2, the “cooking” brief is proposed, as “Cooking food is an essential need for humans. This need is revealed in a wide variety of solutions for cooking food, across time and cultures. Can you imagine your cooking scenario?”

During the first sequence (1 hour), considered as the reference situation, teams A-F were placed in room 1 and teams G-L in room 2. They had one hour to consider the brief, with no constraints, and deliver their concept through a sheet. They were required to present their proposals with five descriptive sentences (who, where, why, what, when) and a graphical representation (image, diagram, collage, etc.) (See figure 3).

The second sequence (1 hour) consisted of a plenary lecture on the SoSy paradigm with the totality of the students gathered together in a third classroom. In the lecture, a historical view of Design for Environment, Design for Sustainability and the emergence of SoSy was presented through the lens of different disciplines. In particular, a comparison between weak or strong sustainability was presented (F. Hedenus, M. Persson & F. Sprei, 2015 p.26). At the end of this plenary lecture, students were asked to self-assess their concepts following 3 questions related to SoSy paradigm:

How is your concept related to the aspect of "Ecocentrism"?

How is your concept related to the aspect of "Regeneration"?

How is your concept related to the aspect of "Safe and Just operating Space"? The students were given a 4-level Likert-scale to answer:

1- Not related at all
2- A little bit related
3- Correctly related
4- In total correlation

The average values calculated for teams A-F for sequence 1 are considered as the self-assessed SoSy values for "preservation" concepts "without SoSy awareness". The average values calculated for teams G-L for sequence 1 are considered as the self-assessed SoSy values for "cooking" concepts "without SoSy awareness".

During the third sequence (1 hour), teams A-F were assigned the "cooking" task and the teams G-L were assigned the "preservation" task. As in the first design sequence, they were asked to consider the brief and deliver their concept through a sheet with a sentence that describes the products and a graphical representation. This time they were asked to take into account the three key aspects of SoSy. Then, they were asked to perform the same self-assessment of their concepts. The average values calculated for teams A-F for sequence 3 are considered as the self-assessed SoSy values for "cooking" concepts "with SoSy awareness". The average values calculated for teams G-L for sequence 3 are considered as the self-assessed SoSy values for "preservation" concepts "with SoSy awareness". All the student proposals were then assessed by 3 experts on Sustainability using the same assessment questionnaire. For self and expert assessments, a focus on the ability to integrate strong sustainability aspects into the student proposals and not on the feasibility or viability was requested. For "preservation" concepts, the average values calculated for teams A-F for sequence 1 are considered as the expertassessed SoSy values "without SoSy awareness" and the average values calculated for teams G-L for sequence 3 are considered as the expert-assessed SoSy values "with SoSy awareness". Similarly, for the "cooking" concepts, the average values calculated for teams G-L for sequence 1 are considered as the expert-assessed SoSy values "without SoSy awareness" and the average values calculated for teams A-F for sequence 3 are considered as the expert-assessed SoSy values "with SoSy awareness".

3 RESULTS AND ANALYSIS

3.1 Assessment related to the "SoSy" awareness

The results of the self and expert SoSy assessments between sequence 1 and 3 are analysed. Overall, the self-assessment results of all three concepts of strong sustainability significantly increased from sequence 1 to 3 (see fig. 1). More particularly, however, the self-assessment of teams A-F on the specific aspect "eco-centrism" showed no significant change over the course of the study. On the other hand, for teams G-L, their self-assessments significantly increased. Some students from the G-L group expressed that they perceived the "preservation" brief as easier to apprehend than the "cooking" brief, so it was advantageous to apply the SoSy concepts on the "preservation" brief. The self-assessment of the "regeneration" aspect also increased over the sequences for both groups. Some of the teams saw their ratings increase by 2 units (teams A, B, G, K, L and I). Concerning the concept of "safe and just operating space" for teams A-F, four out of six groups increased their ratings during the selfassessment. Similarly, in teams G-L, half of the teams (G, K, and L) increased their self-assessment whilst the others maintained high values (ratings between 4 and 3).

The experts' assessments show no significant variation between sequences 1 and 3 with respect to the three SoSy concepts. In addition, the results reveal that the last concept "safe and just operating space" decreased from one

sequence to another for teams A-F that had the “cooking” brief during the third sequence. This is consistent with the students’ feedback mentioned previously expressing that the
“cooking” brief is more difficult to apprehend than the “preservation” brief.

The results of the self and expert SoSy assessments between sequence 1 and 3 are analysed. Overall, the self-assessment results of all three concepts of strong sustainability significantly increased from sequence 1 to 3 (see fig. 1). More particularly, however, the self-assessment of teams A-F on the specific aspect “eco-centrism” showed no significant change over the course of the study. On the other hand, for teams G-L, their self-assessments significantly increased. Some students from the G-L group expressed that they perceived the “preservation” brief as easier to apprehend than the “cooking” brief, so it was advantageous to apply the SoSy concepts on the “preservation” brief. The self-assessment of the “regeneration” aspect also increased over the sequences for both groups. Some of the teams saw their ratings increase by 2 units (teams A, B, G, K, L and I). Concerning the concept of “safe and just operating space” for teams A-F, four out of six groups increased their ratings during the selfassessment. Similarly, in teams G-L, half of the teams (G, K, and L) increased their self-assessment whilst the others maintained high values (ratings between 4 and 3).

The experts’ assessments show no significant variation between sequences 1 and 3 with respect to the three SoSy concepts. In addition, the results reveal that the last concept "safe and just operating space" decreased from one sequence to another for teams A-F that had the “cooking” brief during the third sequence. This is consistent with the students’ feedback mentioned previously expressing that the “cooking” brief is more difficult to apprehend than the “preservation” brief.

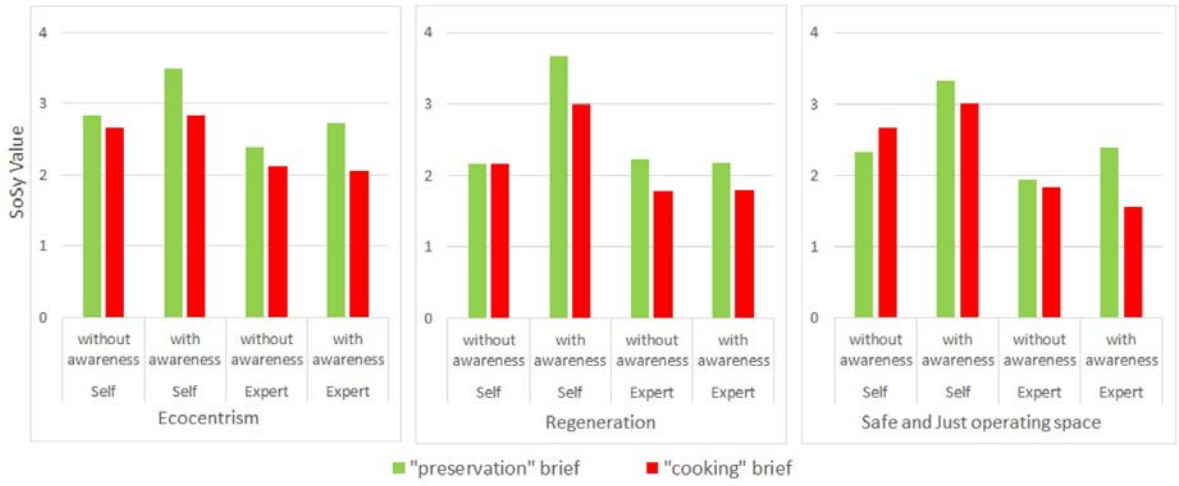

Figure 1: Average evaluation of SoSy aspects (eco-centrism, regeneration, safe and just operating space) for concepts proposed for “preservation” and “cooking briefs”.

The global self-assessment analysis (fig. 2) highlights a significant increase between sequence 1 and sequence 3. Eleven (A, B, D, E, F, G, H, I, J, K, L) out of twelve teams estimated that the second proposals take into consideration the requirements of all three concepts of strong sustainability (meaning values ranging from 3 to 4). On the other hand, the experts’ assessments indicate a slower increase. Only four teams (H, K, L, I) out of twelve were better evaluated from sequence 1 to 3 and only three teams reached values between 3 and 4 during sequence 3. Note that these teams had the
“cooking brief” during the first sequence.

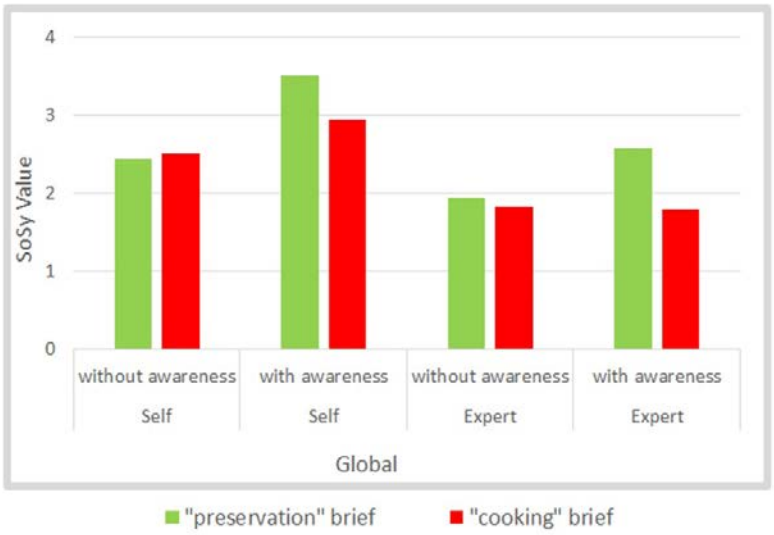

Figure 2: Global average evaluation of SoSy aspects for concepts proposed for "preservation" and "cooking" briefs.

Figure 3 shows the evolution of the ratings between sequence 1 and sequence 3. A positive value means an increase between sequence 1 and sequence 3. For both self and expert assessment, the "regeneration" concept exhibits the largest increase (fig.3). In addition, note that the "regeneration" concept exhibits the lowest ratings for the self-assessment "without awareness". This tends to indicate that students did not consider that aspect prior to the SoSy course and found it understandable and operational enough to be applied in their projects after the SoSy course. From the expert point of view, the average evaluation also shows a positive impact, yet at a lower extent.

Note that team C were negatively evaluated (-0.6), to include the concepts of strong sustainability in their proposal. No progression was noted between the sequences 1 to 3, one student declared, "Not having any concern or interest in the environmental issues".

When students were asked about this educational experience, and their feedback for the ideation sequence 1 and 3, 15 students declared that they had a mental block during sequence 2. This is characterised by group E, in saying "The second sequence was more difficult. We concentrated a lot during the first instruction, and we were tired for the second one".

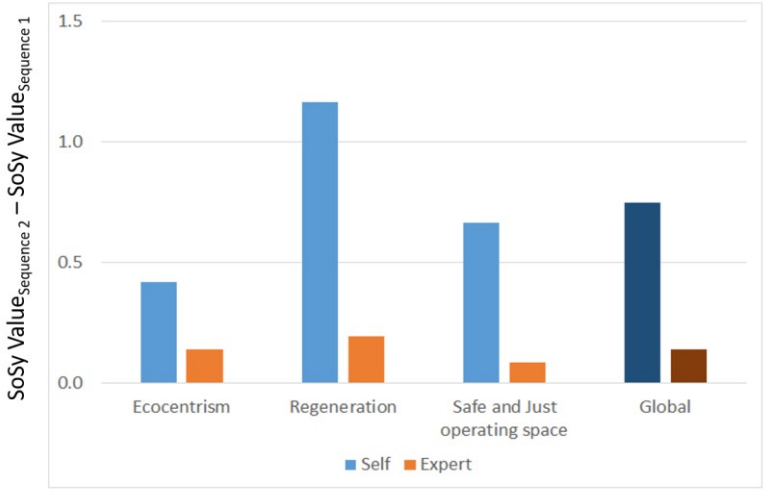

Figure 3: Evolution of the average evaluation of SoSy aspects for all concepts (positive value means a value increase between sequence 1 and sequence 3).

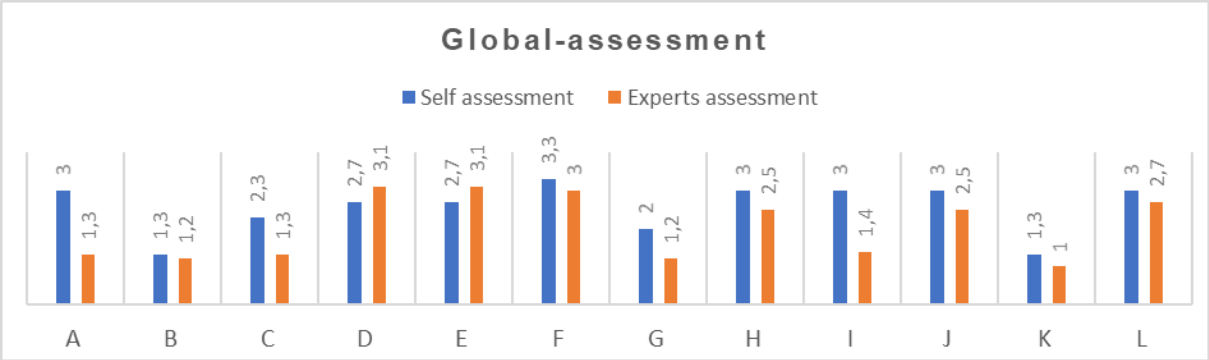

Figure 4: Evaluation of students' proposals for the first sequence

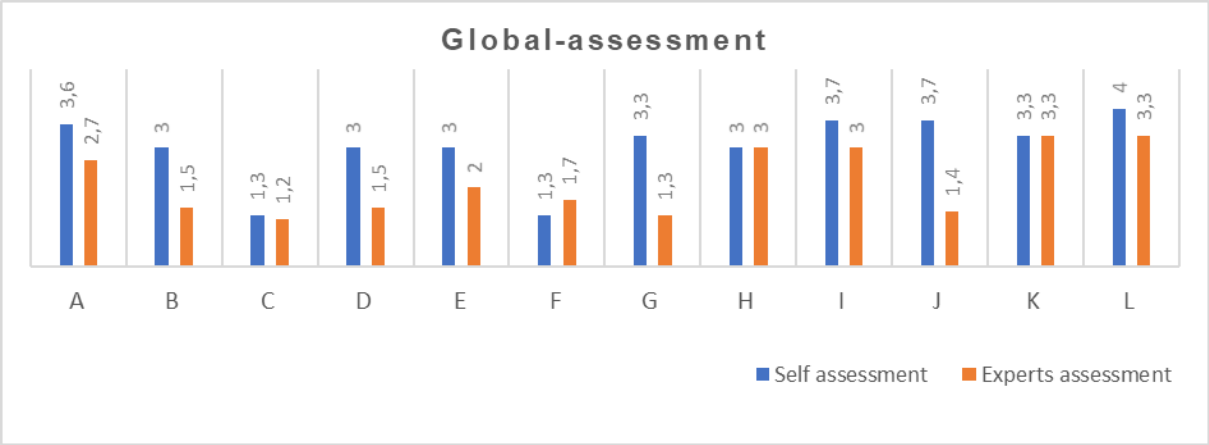

Figure 5: Evaluation of students' proposals for the second sequence

3.2 Qualitative discussion of the concepts proposed by students

Table 1. Description of the 24 concepts (orange: "cooking brief", green: "preservation brief")

Team	Without SoSy awareness	With SoSy awareness
A	Connected plastic box for children enabling the preservation of fruits	Modular bag that conserves heat to reduce electricity or gas consumption
B	Vacuum fridge in the shape of a gorilla that can be used as a decoration	A common oven recharged by the batteries of cities' bike-sharing systems, which recharge during the usage stage
C	Machine with drawers to preserve food by excluding air to kill bacteria	Saucepan for cooking food with steam
D	Modern and ecological underground refrigerator using the thermal capacity of the ground to preserve food	Underground cooking kit using organic waste from gardening and bricks constructed in accordance with ancestral techniques
E	Reusable and compostable bread packaging, made with 100% vegetable fibre (cellulose)	Cover that allows reuse of heat/steam from pots/pans for cooking/heating
F	Truck that buys the unsold goods from the markets in order to dry them for resale	Process of cooking with the heat produced by balls made of refractory material. These are heated by a car engine, and are recovered to deposit them at the bottom of the container to be heated.
G	Automatic cooking box that identifies food and makes personalized recipes	Intelligent conservation box, which identifies products and alerts the consumer to avoid waste

H	Foldable solar barbecue for camping, which avoids the emission of greenhouse gases	Buried natural refrigerator in the form of a tube. This is composed of three compartments; a vacuum system for fruits and vegetables, a system of preservation using bacteria for dairy products; and a system of preservation by salting for meat
I	Heated daypack to cook food without the use of electricity, made for travellers	Portable dehydrator equipped with a water recovery system to water the plants, favouring local food networks.
J	Cooking by the heat released by the compostable/biomass waste with nitrogen regulation	Food drying system, using a lens and a solar panel
k	A destructive cooking process, with the use of single-use ovens and intensive farming systems	System of commons for short-term conservation. An urban island made up of gardens to eat local products, and a built structure containing the kitchen equipped with low-tech furniture (pantry, dessert fridge) and a dwelling for educational activities.
L	Cooking process using a reflecting parabola for collective use, the light ray will heat the oven and the cooking plates by reflection.	Conservation of food products in the form of a spiral, made of humidified sand with the help of a recovery system for rainwater, in the form of a dessert fridge

In the first sequence “without SoSy awareness” (figure 4), among the 12 concepts, six concepts (A, B, C, G, I, K) exhibited universal expert ratings lower than 2, related to a rather weak sustainability position. The products proposed are primarily on single issue and aesthetically pleasing, not providing significant environmental benefits nor favouring “green” consumption. On the other hand, all 3 SoSy aspects were well-balanced in the concepts proposed by teams D, E, F, H, J and L with ratings higher than 2 on the experts’ evaluation, which is close to fulfilling a strong sustainability framework as defined in this paper. Focusing on energy and environmental transition, these projects use passive energy methods fromsolar, geothermic, and biomass sources and take into account reuse or circular material flow.

In sequence 3 “with SoSy awareness” (figure 5), there are seven concepts classified, by the experts, as having a limited incorporation (teams B, C, D, E, F, G and J). These teams had difficulties in the ideation process; they incorporated high battery use (B), emissions of greenhouse gases (D), already existing products (G) or even products which pose dangers to health (F) within their proposals. Five proposals (teams A, H, I, K and L) were analysed as having a strong sustainability position (meaning values from 2, 1 to 4 on the global expert’s evaluation). They had a systemic approach, seeing the proposals as a system, a set of interacting elements in interaction with each other, as ecological boundaries (e.g. closing the loops, team I), having a low-tech approach (constraint of materials/resources), and considering how to associate the systems with collective uses to incentivise lifestyle changes (K). This increase in the level of criteria can be seen as a broadening for the design scope, from technical to social aspects.

Additionally, the concepts associated with strong sustainability are characterised by energy efficiency (preservation of food without energy input, as for team H), refocusing on the essentials and tending towards a more technologically-favourable development (given the problem). The main feature is the low energy consumption and use of simple technologies to ensure needs are met with a high level of accessibility and with locally-available materials.

Another criteria shared by some groups was the consideration of a self-sufficiency aspect technical, functional, and ecological. For example, team L evolved from an advanced technology in the first sequence to taking inspiration from ancient techniques or traditional knowledge - cooling through the sand - (figure 6), which was not only relevant for energy consumption, but revisited all the component parts of these systems. The students were pleased with their proposal, and they said that they would patent their project. Currently, one of the students has transformed his proposal into a personal entrepreneurial project, and we believe that the experiment gave them a sense of legitimacy and confirmed a “meaning of work”.

At the same time, we notice that the proposals remain at a rhetorical level. Despite inspiring visions, in some cases the design is not technically well justified. For instance, some concepts (A, B, C and G for the first sequence and only G for the sequence 2) incorporate sensors or screens in the artefacts for them to become “intelligent”, but this

decision is not well justified. However, this shift from 4 teams to only 1 in the sequence 2, shows us that students consider less use of technology when they are ideated with the SoSy requirements.

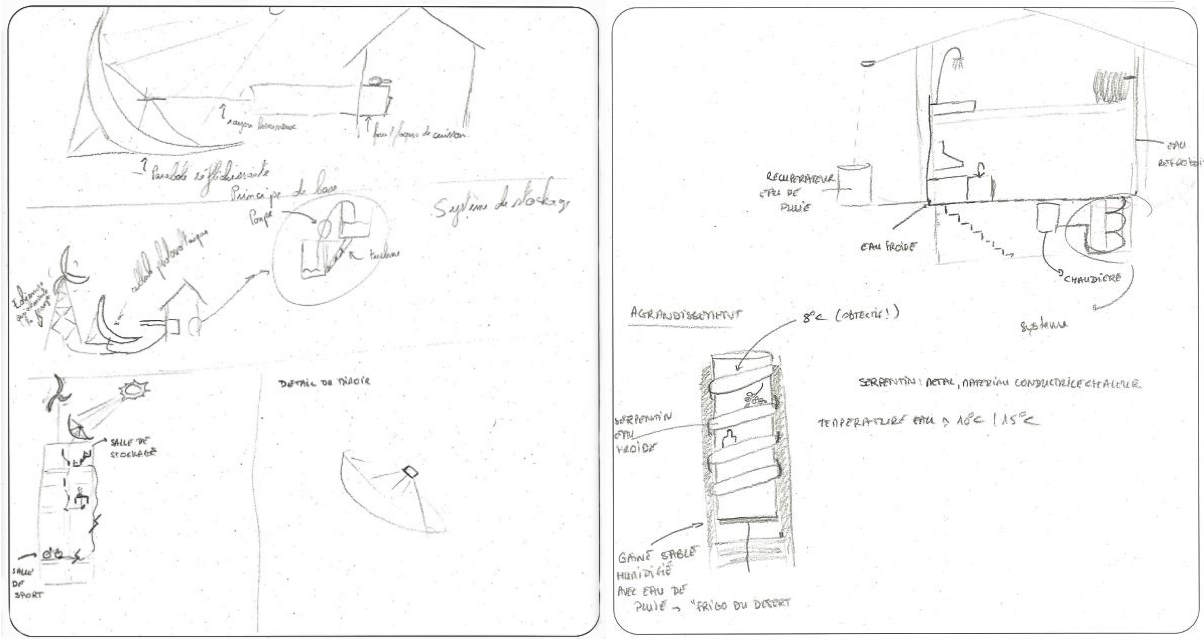

Figure 6: Example of a student's proposals (team L) evolving from a high-tech approach in the first sequence to a low-tech approach in the second one.

3.2.1 Discussion of the ecocentrism aspects in the concept typologies of "eco-centrism" aspects in the different projects:

Concerning the three concepts of SoSy and their impact on the ideation process, the "eco-centrism" concept translates into the ability to think about the three domains (environment, economic and social aspects) at the same time, without favouring the economic or the social over the environmental. This implies reflection at the local level, with located (situated) solutions.

As we could see in the results, there were insignificant changes between the reference situation and the awareness solutions. We believe that there is a need to link this concept to a new way of thinking for the students to acquire. For instance, the incorporation of interdependencies with other living beings by integrating the perspective of environmental ecosystems.

Students need to analyse the interactions between their technical propositions and ecological issues that forces them to question their initial version of a system. Although there were insignificant evolutions in the solutions, this experience helps us to clarify the constraints that this concept represents.

3.2.2 Discussion of the regeneration aspects in the concepts

Concerning the regeneration concept, the solutions positively evaluated included; material flow, interactions between different actors, and consideration of the different time perspectives (seasonal vegetables). This means that, to put this concept into practice, it is also necessary to take into account the different periods of nature, considering the time and the rates of regeneration (e.g. production ceilings). A way to do this can be by integrating within the systems the perspectives of the human societies and non-human societies of a given geographical area.

3.2.3 Discussion of the "safe and just operating space" aspects in the concepts

Regarding the concept of "safe and just operating space", the solutions were considered on a large scale. This means that they favoured the development of surrounding ecosystems, and the choice and quantities of materials considered allowed a contribution to the community, favouring collective use. Nevertheless, with the very little evolution witnessed from the reference situation to the third sequence, we believe that the three concepts need to have a clearer application, such as the development of tools to simplify the process. In addition, during the feedback the students expressed experiencing a mental block between the two ideation sessions. This was reflected especially in the fatigue experienced by the group that was instructed in the second phase to consider the cooking subject; a drop in the quality of reflection was noted.

Concerning the evolution of the proposals, there were transformations in food conservation enabling access to fresh food, in the process changing farming systems and moving away from input-intensive polluting industrial farming towards more diverse sustainable systems, resembling permaculture.

4 CONCLUSION

The global self-assessment analysis points out a significant progression between sequence 1 and sequence 3; from the students' perspective they acquired the new knowledge and were able to put it into practice. Their self-assessment of the three specific aspects demonstrated that "regeneration" was the most easily understood and operationalised concept.

The analysis of the experts evaluation indicates a more gradual improvement, showing the need to recreate the experiment with clearer guidelines for the development of a design tool, where it's necessary not only to ask them to describe the 5 W's but also explain the "how" and "for what reason". The results provide some guidance to create a prescriptive framework to be used for a design for strong sustainability (DfSoSy). Therefore, a second test with steps after the ideation and focusing on the development of a complete project will be carried out.

We consider that an operationalisation of strong sustainability in design can be done through giving guides or principles to be treated as constraints for a design for strong sustainability (DfSS). The aspects need to be seen as constraints in a design process, to be progressively incorporated in an iterative ideation phase. Therefore, a new design methodology for strong sustainability needs to raise awareness on the impacts of anthropogenic activity, generating self-reflectiveness in order to question the relationship with our utilisation of technology, changing the mind-set.

In the student proposals we identify the need to locate (situate) our context, and therefore our user and their territory's needs analysis (user/product interactions, consumptions habits, community practices), to define requirements. This includes the development of a guide to encompass the different scope of the design interventions from human/individual to community and ultimately planetary interventions. Guidelines to progressively treat the scope of the design intervention, level by level in one design process, are needed. This means beginning from a focus on components/product and evolving to a socio-technical ecological system.

In summary, the experiment allowed the analysis and improvement of students' awareness of sustainability. However, several changes are needed to increase its pedagogical efficaciousness. This activity does not necessarily boost creativity or innovation but it does influence engagement, which can influence the different stages of the design.

ACKNOWLEDGMENTS

This research is part of the collaborative project D-TechnoSS, funded by French National Research Agency (ANR-20-CE10-0006). We would also like to thank the students that participated in our experiments and supported our activities. Special thanks are extended to Romain Guillerm, PhD candidate in low technology for territorial resilience and Charlène Bouchot, research engineer in circular economy.

This research contributes to the Sustainable Development Goal (SDG) 12: Responsible consumption and production.

REFERENCES

Ahlborg, H., Ruiz-Mercado, I., Molander, S., Masera, O. (2019). "Bringing Technology into Social-Ecological Systems Research—Motivations for a Socio-Technical-Ecological Systems Approach". Sustainability. https://doi.org/10.3390/su11072009

Bocken, Nancy M.P., Short, S.W., Rana, P., & Evans, S. (2014). "A literature and practice review to develop sustainable business model archetypes". Journal of Cleaner Production 65, 42-56.

Brown, T., & Katz, B. (2011). "Change by Design. The Journal of Product Innovation Management" 28(3), 381383.

Ceschin, F., Gaziulusoy, I., (2019) "Design for sustainability. A Multi-level framework from products to sociotechnical systems". Routledge. London. https://doi.org/10.4324/9780429456510

Chaminade, (2020) "Innovation for What? Unpacking the Role of Innovation for Weak and Strong Sustainability". (2020). Journal of Sustainability Research, 2(1). https://dx.doi.org/10.20900/jsr20200007.

Costanza, R., & Daly, H. E. (1992). "Natural Capital and Sustainable Development". Conservation Biology, 6(1), 37–46. http://www.jstor.org/stable/2385849

Daly HE (1999a) Wirtschaft jenseits von Wachstum: die Volkswirtschaftslehre nachhaltiger. Entwicklung. Pustet, Salzburg

Dimitrova, A.; Vaishar, A.; Šťastná, M. Preparedness of Young People for a Sustainable Lifestyle: Awareness and Willingness. Sustainability 2021, 13, 7204. https://doi.org/10.3390/su13137204

Hedenus, F., Persson, M., & Sprei, F. (2015) History, Definition & The Role of the Engineer. Gothenburg

Leach M, et al.: "Equity and sustainability in the anthropocene: a social–ecological systems perspective on their intertwined futures". Glob Sustain 2018, 1

Mao, C.; Koide, R.; Akenji, L. Applying Foresight to Policy Design for a Long-Term Transition to Sustainable Lifestyles. Sustainability 2020, 12, 6200.

Raworth K: "A Safe and Just Space for Humanity: Can We Live Within the Doughnut?" Available (November 2019) at: Oxford: Oxfam; 2012-https://www-cdn.oxfam.org/s3fs-public/file_attachments/ dp-a-safe-andjust-space-for-humanity-130212-en_5.pdf.

Ott, K. (2003). “The case for strong sustainability”. Greifswald’s environmental ethics, 59-64.

Ott K (2009) “On substantiating the conception of strong sustainability”. In: Döring R (ed) Sustainability, natural capital and nature conservation. Metropolis, Marburg, pp 49–72

Ott K, Döring R (2008) “Theorie und Praxis starker Nachhaltigkeit” 2nd edition, Metropolis, Marburg.

Perpignan, C. , Robin, V. , Eynard, B. , 2018. From Ecodesign to dfs in engineering Education. In: In DS 93: Proceedings of the 20th International Conference on Engineering and Product Design Education (E&PDE 2018), pp. 622–627. Raworth, K. (2012). “A safe and just space for humanity: Can we live within the doughnut?” Oxfam Discussion Paper.

Reed, B. (2007). Shifting from ‘sustainability’ to regeneration. Building Research & Information, 35(6), 674680.Robert K-H, 2000

Rockström, J., Steffen, W., Noone, K., Persson, Å., Chapin, F. S., Lambin, E. F., ... & Foley, J. A. (2009). A safe operating space for humanity. Nature, 461(7263), 472-475. Steffen et al 2009

Steffen, W., Richardson, K., Rockström, J., Cornell, S. E., Fetzer, I., Bennett, E. M., … Sörlin, S. (2015). Planetary boundaries: Guiding human development on a changing planet. Science, 347(6223), 1259855.

Solow R.M. (1992), ≪ An almost practical step toward sustainability ≫, in Oates W.E. (ed.), The RFF reader in environmental and resource management, Washington DC, RFF, 1999, p. 263-272.

Turner, R. K., & Pearce, D. W. (1993). Sustainable economic development: economic and ethical principles. In Economics and ecology (pp. 177-194). Springer, Dordrecht.

Wu, J. (2013). Landscape sustainability science: ecosystem services and human well-being in changing landscapes. Landscape ecology, 28(6), 999-1023