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Published in:
Designing Sustainability for All

DOI:
[10.1007/978-3-030-66300-1_5](https://doi.org/10.1007/978-3-030-66300-1_5)

Published: 22/04/2021

Document Version
Publisher's PDF, also known as Version of record

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Please cite the original version:
García Parra, B., Kohtala, C., Marttila, T., dos Santos, A., Molina Mata, S., Zhong, F., Xia, N., Xin, L., Zhang, J., Banerjee, S., Upadhyay, P., & Punekar, R. M. (2021). S.PSS and DE in Practice. In C. Vezzoli, B. García Parra, & C. Kohtala (Eds.), *Designing Sustainability for All: The Design of Sustainable Product-Service Systems Applied to Distributed Economies* (pp. 123-142). Springer. https://doi.org/10.1007/978-3-030-66300-1_5

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S.PSS and DE in Practice



Brenda Garcia Parra, Cindy Kohtala, Tatu Marttila, Aguinaldo dos Santos, Sandra Molina Mata, Fang Zhong, Nan Xia, Xin Liu, Jun Zhang, Sharmistha Banerjee, Pankaj Upadhyay, and Ravi Mokashi Punekar

1 Introduction: Teaching and Learning Contemporary Design for Sustainability

Contemporary challenges related to sustainability are shared across the globe. Their materializations, prioritizations and emphases, however, vary from one region and context to another. As we have seen in the previous chapters, Sustainable Product-Service Systems (S.PSS) and Distributed Economies (DE) as concepts are still in the making, and tools to assess and implement them in design are still developing. Their interpretations can also take various forms when they become introduced into different contexts. Alongside these shared challenges, there are also specific regional or historical tensions, which connect not only with education, design and the histories and trajectories of industrialization, but also arise in international projects and collaboration. Such tensions become even more evident if new concepts and contents come into play. It can also lead to differing interpretations on how to approach them.

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The international LeNS network was created in an EU-funded project between 2007-2010, and it has continued to expand and interact in the LeNSes project (2011-2015, with a focus on renewable energy for all) and in the LeNSin project (2015-2019). With its ‘ethos’ on ‘multi-polar’ collaboration and several strong regional networks, the international LeNS network has accommodated an atmosphere that has been sufficiently open and sensitive to elaborate these concepts further, and to critically assess their potential in developing new, more sustainable solutions.

This chapter shares the experiences from the LeNSin seminars and pilot courses from various perspectives. In this chapter, we also briefly discuss the potential of design education as a transdisciplinary matchmaker between various actors and networks.

2 Introducing S.PSS and DE into Higher Education in Design

Despite its recent origins in the mid- to late twentieth century, discourses around professional design, its identity and expectations, are relatively consistent across the globe, particularly with regard to industrial design. Various methods for sustainable design, including product-service system design, have also evolved, increasingly acknowledged in public discourse, such as in EU and UNEP publications. However, the very concept of PSS still allows for various interpretations depending on the socio-economic context. For example, in some pedagogical contexts, the concept of a ‘sharing economy’ may be seen as more engaging or understandable for design students than ‘user-oriented PSS’. Moreover, when relatively broad concepts such as Distributed Economies are introduced into sustainable design teaching, interpretations can vary significantly with regard to focus and expectations.

Design activities have gradually extended further from the studio and the factory line. Currently, design connects with various domains of interest, with products and services, but also systems innovation; with organizations and business, but also societal change-making. Designers work with diverse professionals and experts, as well as laypeople and public media. This diversity extends the area where such interpretations can be trialled.

In this section, we reflect on how S.PSS and DE as concepts can be introduced into different geographical, socio-cultural and educational contexts, and we examine some of the choices and emphases in developing two rounds of pilot courses during the project. We also address the variety in which the DE focus can be adjusted and look into the role of the university in contemporary knowledge building for transdisciplinary sustainability.

One integral aspect in the LeNSin project has been in sharing experiences on teaching and in developing new educational content. The main strength has been the strong network, which has helped to overcome practical difficulties, and to balance course expectations and institutional constraints in developing new teaching contents.

2.1 Experiences from Regional Pilot Courses: An Overview

Sustainable design has gradually become a highly promoted strategy linking industrial developments, consumer domain actions and policymaking. In sustainable design, as often in complex problem-solving processes, several actors from different fields need to work towards a shared goal, and a more detailed discussion on the driving values and goals pursued is needed. The challenge of sustainability lies in connecting not only scientific research and politics, but also the perceptions and actions of professionals and laypeople. In this sense, design for sustainability can be understood by its very nature also as transdisciplinary, drawing together considerations from ecological, societal and economic domains into a shared process of mediation and making.

Contemporary design activities in various regions are in many ways still based on the educational programme of the Bauhaus school, where architects, painters, and sculptors combined multiple perspectives with an emphasis on workshop or studio work [4]. In the last few decades, however, the role of design has gradually shifted towards higher levels of focus, from the crafts studio and factory line towards society at large and towards broader socio-technical systems [6]. Today, design has been noted as a possible catalyst for social innovation [10] and sustainability transitions [9]. Consequently, the potential of design has been increasingly noted also in relation to transdisciplinary activities in education and in sustainability at large ([5, 8, 14]).

Design schools around the world share similarities in both the challenges they face, as well as the potential that the discipline itself allows. As a discipline in higher education, design often connects with engineering and business, but also media and art. Earlier, it has acted as a bridge between the producer and consumer world. Particularly now, with new phenomena heralding new agency and competencies for users and consumers—as seen in the spread and promotion of social innovation, the influence of the internet and peer networks, and the DIY, amateur design ‘maker movement’—these roles have also become increasingly mixed [11].

2.1.1 Developing Teaching in Two LeNSin Pilot Rounds

The LeNSin project focused on developing new teaching contents on S.PSS and DE, but also on expanding the network of partners, to gather an understanding of various DE related actors in different contexts and countries. This was taken forward in the form of case studies, new tools and methods, local seminars to gather insight, and in consecutive pilot courses in which various DE topics were taken under study with students (DE topics are discussed in Chap. 2). The seminars gathered local actors that shared an interest in the topics, but also linked to already existing networks and projects. The consecutive pilot collaborations took place with design students from various fields, ranging from media and graphic design to industrial and service design, and to engineering and architecture.

To understand what impact the project has had, we look into the interactions in developing these collaborations and reflect on the preparation process, the emphases taken in the actual pilot courses, as well as their outcomes. Our reflections are grounded on the course materials (syllabuses, teachers' course reports), our own experiences and insights from interviews with the teachers involved.

Overall, five seminars and ten pilot courses were organized in five countries, with two main partners from each country and additional associate partners around the region. This interaction also constituted one main part of the whole project, where theoretical contents, design methods practice and real case studies came together. Initially, in each country the two partners came together to host a seminar, in which the main topics of S.PSS and DE were discussed from the regional perspective. Later the pilot courses were conducted, which aimed at examining and designing for DE in the various contexts in student case work. Teachers refined their understanding of the connection between S.PSS and DE during the courses, as well as tested and refined design tools. In China, the focus in the first pilot course was on lighting and 3D printing, in both commercial contexts and marginalized communities, and in the second pilot on regional food culture. In India, the focus of the first pilot was to help a local NGO actor boosting regional health, well-being and resilience and the second was on developing the local silk weaving industry. In South Africa, the focus was first on developing distributed health solutions and information and then on developing a supporting app for deaf people. In Brazil, the case work in the first pilot focused on the local fashion cluster and the second one on local mobility. And lastly, in Mexico, the first pilot focused on a local book club programme and then the second pilot on the university payment service system for students. Finally, besides access to a gradually extending case study library and improved revisions of toolsets, student teams also had an opportunity to submit their solution to the LeNSin student competition, and eventually six national winners were selected (including Europe), and four honourable mentions were given [12].

Overall, the themes in the regional educational activities progressed in different directions. However, the predefined structure of interaction and thematic content helped to keep a relatively coherent whole. Regional seminars and the following pilot courses called for a cumulative amount of preparation, but also ensured that the network of actors was gradually formalizing and roles became clear. In the end, the teaching activities involved an extended number of educators, both from the local region as well as internationally, and they attracted local attention.

During the teaching collaborations, in many locations, there were also unexpected local events—natural or societal—that led to additional challenges in preparations (for example, employee union strikes, student strikes, political instability and natural disasters such as earthquakes). The strong network allowed the necessary reflexivity that helped to overcome these obstacles.

Although each pilot comprised introduction to S.PSS theory and tools and an introduction to DE topics, the structure of the pilots varied. As the participating teachers visited several locations, and experiences were shared across, the teaching as a whole nevertheless remained rather coherent in relation to its main topics. Additionally, various experiences with tools and methods for teaching were exchanged

during the pilots, but also informally across the network via email conversations or face-to-face meetings.

The structure of the seminars and two consecutive pilot courses held in each region provided the possibility to have ‘rounds of iteration’. Each pilot also had visiting teaching partners from another university, as well as observers from a third one. Experiences were then gathered in reports and exchanged in project meetings. This material also allows for subsequent academic communications and reflections in various forms.

Although it was challenging to insert an intensive, short course within most of the institutions involved (see Sect. 6), many of the teachers later reported that the very intensity was beneficial to the students’ learning. Many things about the pilot course were ‘new’ for both students and teachers: the diversity of didactic approaches (from theoretical lectures to active teamwork and fieldwork); the diversity of the student body (e.g. coming from all over the country, see Sect. 5, or from different departments, see Sects. 3 and 4); and the diversity of perspectives represented (teachers from other countries, stakeholders from companies or NGOs, and so on). Teachers quickly learned to improvise and take advantage of each other’s expertise, while needing to create a learning structure that did not lose students through the gaps. Teachers later appreciated how these opportunities and challenges helped create courses that managed to avoid “superficial sustainability” or “sustainability-as-usual”, as a kind of green paint splashed onto design education. Students were rather pushed to improve their abilities in systems thinking and to imagine and aim for new paradigms beyond business-as-usual: the territory of Distributed Economies where locally relevant solutions with greater sustainability potential are identified and fostered or designed anew and gradually embedded within the existing culture. S.PSS and DE were unquestionably often problematic concepts, but both teachers and students worked on translating the terms literally and culturally: reframing, re-coding and re-interpreting them. In some cases, the internationality of the work helped to raise the profile of sustainable design education in the institution and lend it further legitimacy, in a global context of tight budgets and instrumentalist learning objectives.

2.2 Reflections: Teaching S.PSS and DE Design

The concept of S.PSS is rather established in both design teaching and industry in many regions, and as a concept, it also acts as a suitable basis to develop a new understanding on DE. DE as a thematic area of focus, however, introduces very different interpretations in different contexts, regarding expectations, mode of work and developed outcomes. One important outcome is, in this sense, also in being able to discuss these views and to spread it forward to new actors. Getting to grips with what Distributed Economies actually means and why it is a beneficial umbrella concept requires much discussion among teachers and students on what kind of industrialized or post-industrial context they exist within and how it compares to others. It is pedagogically useful to make the concept familiar, to bring it ‘home’, by identifying

local case studies that can be classified as various DE cases, whether distributed manufacturing or distributed renewable energy. This, in turn, helps identify the case's sustainability benefits and threats, as a locally relevant system with cultural, social, technical and economic aspects. Teaching and learning DE is therefore not a case of importing a European concept into a non-European socio-technical environment, nor is the intent to design a solution that imitates solutions from the global North. Instead, what is important is to define 'sustainability' in dialogue and according to what is locally appropriate.

Adams et al. [1] promote developing education based on a "sustainability culture conceptual framework", which connects people, teachers to other staff to students to external stakeholders, and that entails organizational transformation: building systems that support dialogues on both visible artefacts and activities and invisible values. Consequently, when we introduce design collaboration into the context of sustainability, its driving values are challenged, and responsibility and ethics come into play. To overcome these obstacles, collaboration is needed across continents and disciplinary sectors. In this process, projects as arenas to facilitate these discussions have high impact—and an open and supportive network helps.

Sustainability and 'sustainable development', in the end, are wedded to (global) equality, equity and justice, roles, access to participation and transparency. To this end, if design practitioners have a role in promoting collaborative mediation for sustainability or even further—to promote democratic assessment of heterogeneous perspectives for sustainable innovation [13]—this also calls for fundamental changes in how to approach design education and its processes of teaching and learning.

And yet, design activities around the world are fundamentally grounded on iterative development. Design thinking acts in bridging problem and solution spaces [7], and its activities proceed by default through trial and error. Design as a discipline remains a developing field, continually producing new methods and collaborations in various contexts, in between and in connection to multiple domains and discourses. And finally, at best, teaching design involves an open and expansive process. Contemporary design activities involve several emphases on inducing and promoting collaboration and shared mediation. Collaborative, participatory design processes can support shared knowledge building and development of practice. Such interaction can also connect with local and tacit understanding, to be adapted and better applied in new contexts.

2.2.1 Discussion: The Changing Role of (Design) Academia

When design educators are networking globally and bringing local actors into dialogues to promote sustainability in various contexts, conventional industrial collaborations can expand further into new networks (see Sect. 3). S.PSS and DE as concepts allow such expansion and extend these networks further.

In developing new international collaboration on teaching and making, interaction needs to be embedded in a shared and reflexive process. In support of this, design remains an open field for education and action, linking various local and global

inquiries across several professional domains. And as a result, design for sustainability as an aim and agenda can support a transformation in contemporary practices of making and learning; design acts as one key focus for developing policies and action, attracting interest in developing new ideas for societal sense-making.

Today, universities are adopting a new role, to establish their position in the political and economic structures of an increasingly knowledge-driven society. This new role emphasizes knowledge production for society and societal benefit, calling for stronger connections between research, education and everyday practices to expand participation to the outside world. For contemporary universities, this call moves the emphasis on how students and other stakeholders in the processes of learning are taken into account when joining up the fundamental orientations for any action.

As a mode of interaction and collaboration—and shared development of learning content—the LeNSin pilot course interactions provided a valuable opportunity to develop new tools and methods to implement sustainable design, and to share and connect the topics further. In parallel with the pilot courses, other curricular courses and collaborations with stakeholders (NGOs, municipal authorities, companies and so on) furthered the lessons learned. In the following sections, we will describe further how collaboration particularly with external stakeholders in the courses is carried out, from fieldwork involving regional industry clusters to small NGO partners in a long-term partnership in education.

3 Working with a Regional Industry Cluster in Education in Brazil

In the north-eastern part of Brazilian territory, nearly 23.5 million people have faced harsh living conditions due to severe weather for decades. This so-called Semi-Arid region is characterized by high temperatures and low rainfall, generating water shortages. Poverty and social injustice have emerged as problems associated with the scarcity of water, but policy and top-down solutions have failed to democratize access to the water supply, hindering local development and putting individuals under economic, political and cultural domination. However, in recent years, with the implementation of social innovation initiatives, local communities of the Semi-Arid region have begun to change their dependence on centralized public policies and to develop bottom-up alternatives to mitigate the conditions associated with water scarcity.

Based on innovative interactions between stakeholders, the Agreste's fashion cluster was created. The cluster specializes in the manufacturing of jeans, cotton and polyester clothing. A total of 18 000 SMEs employ 8% of the workforce in the state of Pernambuco and generate 5% of the state's GDP. Despite all the economic benefits brought to the Semi-Arid area by the fashion cluster, the region's environmental and social degradation has worsened. It was impacted by the intense use of

already scarce resources, such as wood and water, which are used in the manufacturing process, mainly for the washing and finishing of jeans. From 60 to 100 litres of water are necessary to wash one pair of jeans. Toritama, the city where jeans are produced, manufactures 800 000 pairs of jeans per month. The waste from this process is not correctly processed. It is disposed of in the river that crosses the city, changing the colour of water from pink to blue to a coloured mix.

3.1 The LeNSin Pilot Course Brazil

In June 2017, the first LeNSin Pilot Course Brazil took place in the city of Recife, at the Federal University of Pernambuco. Thirty-five students from the business administration and design courses from UFPE were challenged to develop S.PSS proposals for the fashion cluster of Pernambuco. The students were expected to develop an understanding of current environmental issues; demonstrate understanding of the tools used to develop S.PSS concepts; discover design strategies and to design an S.PSS for Distributed Design and Distributed Manufacturing with a particular focus on the Brazilian context; and to explore and test out-of-the-box concepts and ideas for S.PSS concepts. A field trip was organized to the fashion district to collect data and to give participants the opportunity to ‘experience’ some of the issues described in the challenge. Students also presented and validated initial ideas with representatives of the fashion cluster. Their final design concepts ranged from ways to transform waste from manufacturing processes to solutions to promote the empowerment of women in the region.

From the point of view of learning objectives, the mixture of students from different disciplines was beneficial: it proved to be quite effective for the learning process to have business and design students together in mixed groups. Having the participation of lecturers from other universities and presenting local and international case studies brought together the local and the global perspectives on S.PSS, fostering a better understanding of the concepts and enriching the discussions. That said, sustainability is complex and much information was presented, needing systematic and constant reviews throughout the course.

The collaboration with the regional industry cluster was important for several reasons. First, there is an urgent need to put our students in contact with the context in which they live. For instance, many of the students did not know the possible negative environmental impacts of the clothing they were wearing. Coming into direct contact with the problem through a site visit enhanced the creative process and resulted in a more empathic process, even if such visits are time-consuming within short courses. Furthermore, the field study sped up the bonding among team members, resulting in a pleasant atmosphere for the practical part of the course. The second reason the collaboration with industry was essential is because it shows potential partners outside the university, the role academia can play in practice, with concrete tools and innovative ways for understanding their problems.

3.2 Reflecting on Industry-Academic Collaborations in Brazil

There are at least three key challenges for setting up a direct collaboration with industry, based on the Brazilian experience. The first relates to information scarcity. Achieving a robust (meta) concept on PSS and DE requires a wide set of data, information and intelligence that is not usually ready to be used by students. The inherent nature of Distributed Economies often implies the consideration of stakeholders that conventional companies have not integrated into their business process and, therefore, have little knowledge as to how to support the creative process. In other cases, the business partner cannot disclose information as it often deals with strategic and sensitive issues, such as the long-term vision and objectives regarding the service and product portfolio. In order to enable a meaningful experience, the approach adopted in the pilot courses in Brazil was to present a compact set of information about the problem, leaving some room for the students to collect additional information as needed. Although students can opt to adopt more empathic approaches with the stakeholders (such as focus groups) or more quantitative approaches (such as Business Analytics), short courses have shown that it is more viable to dedicate time to the analytical process than the data collection. Awareness of the scope and depth of the information required by S.PSS applied to DE Design is, therefore, one of the expected learning outcomes of these courses.

The second challenge relates to expectations regarding innovation insights. Expectation management is quite important when developing courses on S.PSS applied to DE. When the business partner is not fully aware of the meaning of PSS and DE, the expectations may be overoptimistic regarding what would be delivered at the end of the course. While on a regular product design course a student may be able to produce a usable prototype, tested in a real-world setting, the complexity of an S.PSS applied to DE problem usually allows the students to only get to the (meta) concept stage. When the business partner is knowledgeable about S.PSS and DE the expectations are naturally more realistic. In such situations, the (meta) concept produced by the students results in insights for the business partner, which is the most relevant benefit of the cooperation. No ethical issues have been raised in any of the pilot courses in Brazil in this academia-industry collaboration, since none of the student groups have reached a stage where an idea could effectively result in e.g. a patent. Indeed, most of the projects developed by the students have achieved more innovation at the system and service level than at the product level, making it difficult to reach a stage where copyrights would be an issue to be raised.

The third key challenge in industry-academia collaboration is being part of the learning process and not just a client. Comparing the experiences in Brazil, it is quite clear that a full involvement of the business partner contributes to a better result with regard to the learning process. Such involvement might require a wide set of contributions: giving technical and managerial feedback on the evolving concepts; reassuring the students regarding the attractiveness (or not) of their concepts; pointing out barriers and strategic advantages of their ideas in topics that have been overlooked

by the students; bringing onto the table insights from past experiences; information about the dynamics of the stakeholders in the industry, and so on.

When the industry is already involved and interested in PSS projects, the motivation to take part in the learning process of the students is two-fold: to have direct contact with methods and tools developed in academia, and to contribute to the training of possible future employees. In Brazil, there is a growing demand for design professionals with competencies in PSS and Service Design. Actively developing new young professionals, observing them in action, offers the partner companies the opportunity to identify new talents that might be recruited to join their staff.

4 Working with a Regional Industry Cluster in Education in India

This section presents the experience of the team at IIT Guwahati in teaching Design undergraduate, postgraduate and Ph.D. students the principles of Design for Sustainability (DfS) for Socio-Economic Ecosystems (SEE) of India [2, 3]. According to Banerjee et al. [2], “A SEE is a context where the economic activities of the community are deeply ingrained in the socio-cultural ways of living.” In these contexts, the major challenge for DfS is how, through design, one can bring about:

- *first, the sustainability orientation to the socio-ethical dimension in a manner that it is in the economic interest of the system stakeholders to be so, and;*
- *then, the sustainability orientation to the environmental dimension in a manner that it is in the economic interest of the system stakeholders.*

Another characteristic is that it is difficult to identify one company or stakeholder who is the promoter or provider of the offerings of the SEE. Instead, these are multi-stakeholder ecosystems. The inherent nature of the economic activities in these contexts is distributed (Distributed Economies) in nature. SEE might be distributed in terms of design, manufacturing and knowledge generation. These ecosystems might also have a long history of existence and, as a result, have evolved their system to be sustainable on many accounts. In order to initiate any design intervention, a designer must therefore deeply study these traditional ecological and social knowledge systems and their integration with the local cultures.

4.1 Case Study Location: Sualkuchi Silk Handloom Industry as a SEE

Sualkuchi in the Kamrup district of Assam, India is a census town and is made up of a cluster of 16 villages. It is on the banks of the river Brahmaputra, 35 km from Guwahati, the largest city in the northeast of India. The population is more

than 100 000. It is also famously referred to as the ‘Manchester of Assam’ due to its large silk handloom weaving industry which now also has a trademark—Sualkuchi’s. The handloom industry here is even mentioned in the works of Kautilya, an Indian royal advisor and economist who lived during 371–283 BC. The current form of the industry is a result of the encouragement it received during the Ahom Dynasty from 1228–1828 AD [15].

A typical household in Sualkuchi owns at least one loom and contributes to the silk weaving industry here. Post-independence of India, the industry began to flourish and reached its peak during 1981–2001 when looms per household increased from 2 to 6, on average [17]. During this time, many households shifted their operations towards entrepreneurship, owning 50 or more looms, employing weavers rather than using the family members as weavers. There are four major categories of actors in the ecosystem: owners, weavers, reelers and helpers. The owners might be small (<5 looms) or large (>50 looms) and own the instrument of production, the Jacquard loom. The small owners mostly weave and reel themselves with their family while others hire weavers, reelers and helpers. The contracted weavers are paid based on the length of garment woven and the number of design elements. They learn to weave on the job and come from all over Assam. Some of them stay back in Sualkuchi while others go back to their native place to start their handloom setup. The reelers are also contractual and perform pre-loom activities like reeling and spinning of yarn while the helpers are paid monthly for helping the other three actors. Other standalone actors support the ecosystem: designers, loom makers, and servicers, intermediaries, distributors, shopkeepers (selling raw materials, selling finished products), government support units for low-cost raw material for small owners, silk testing lab, and Sualkuchi Tat Silpa Unnayan Samity. The biggest strength of the existing system is its distributed nature in terms of design and manufacturing (it has very few large units). Attention to technology, design and business model upgrading has lacked due to unorganized production systems, leading to stagnation. There are also rising costs of raw materials and lack of a financial support system, meaning the small owners are slowly disappearing leading to possible centralized economic models kicking in.

The primary learning objectives for the course were “Developing competencies”, “Creating and changing values, attitudes, and awareness”, “Transferring knowledge and understanding”, “Promoting sustainable behaviour and responsible action” and “More just and sustainable society”. Students were introduced to the history, development, approaches and various tools for DfS in a global context, as well as how to tackle DfS for SEE in the Indian context. Through field study methods, they were encouraged to identify how indigenous systems have evolved to live in harmony and a mutually symbiotic relationship. This also entailed identifying what new challenges were entering the system and how they are challenging the sustainability (social, environmental and economic) of the system. Given this background, the students would then design for the emerging context using the fundamentals of DfS, SEE and Distributed Economies. Lectures were organized by local stakeholders, visionaries and administrators, along with faculty and researchers from Design, Engineering and Social Sciences. The students also came from diverse backgrounds, design, architecture and fashion.

In the first process, the ‘Project Socio-Economic Ecosystem Analysis’, the group of actors from the ecosystem were identified who will together own the new S.PSS and their critical activities, by interviewing the local administrators and visionaries. They can quickly provide the designer with the main value proposition of the local ecosystem, its problems and an understanding of all the actors and their activities. The interviews also provided valuable information to help identify the challenges, potential barriers and support for the S.PSS to be designed in terms of infrastructure (knowledge, economic, physical or social) and changes required. Using mapping tools, the students could then identify the needs of the actual actors.

In the second process, ‘Defining Intervention Context’, the context for intervention was identified using a participatory approach, involving as many actors of the SEE as possible. This resulted in the identification of an S.PSS problem statement, design brief and unit of satisfaction. In the light of the selected problem statement, the students could then conduct a competitive analysis on two ecosystem parameters: the local ecosystem’s main value proposition and the design intervention goal.

4.2 The Outcomes of the Course

The main outcome of the course was a shared Living Lab in the SEE for constant design upgrading and archiving in collaboration with the local NGOs, Government, entrepreneurs, educational institutes, designers, machinery and software manufacturers. This configuration thus reduces the cost of design and keeps design up-to-date with current fashion trends. A design concept for a co-working space was also developed, as well as a central online platform for global customers’ orders and customization offers.

The collaboration with local stakeholders was fruitful, as it emphasized to the students that we should not teach and learn sustainability as a criterion in the process of design, but design in the context of sustainability. Validation of ideas with stakeholders is vital to keep students grounded in the context and for the solutions to be useful. However, students find systems thinking complex and intimidating in the context of sustainability when the cascading impact of one decision can lie in multiple aspects of the system. Repeated one-to-one discussions with the instructors were needed to ensure final design solutions were oriented to the context the students had analysed. Moreover, having a range of faculty members to support was beneficial, as we need integration of multiple knowledge domains. This range can help with the constant tension in teaching between breadth versus depth of analysis and ideation in courses of limited duration.

5 Country-Wide Teaching Networks on Sustainability: LeNS China

In China, two pilot courses (Tsinghua University and Hunan University) were organized involving about 30 teachers from home and abroad, and around 150 students from more than 20 universities across the country (including almost all LeNS China member institutions and other universities offering sustainable design-related courses), as well as practitioners in the field of sustainable design.

5.1 Pilot Courses in China

The courses provided an international communication platform for people to promote and spread sustainable design in China. The teachers systematically combined the relevant knowledge of sustainable design for the students—history, basic concepts, methods and tools—as it is important for all students to discuss and think according to a common understanding and a unified paradigm. In the courses, the teacher teams not only encouraged students to think comprehensively about sustainable design from the environmental, social and economic levels, but also guided students to integrate ‘culture’ as an element into the design. In addition, students were encouraged to build their own understanding of sustainability and explore innovative and sustainable solutions. To address the concepts of S.PSS applied to DE (Distributed Manufacturing and Distributed Renewable Energy, see Chap. 3) the students were taken on field visits to relevant cooperating companies, on the one hand, to understand the most cutting-edge technology development and applications, and on the other hand to encourage students to consider sustainable solutions in the future from a commercial perspective. Sustainable solutions should not only exist at the concept stage, as they require effective technical support and reasonable commercial promotion to realize fully.

Organizing such a large pilot course was both compelling and challenging. It was compelling that students showed a strong interest in the background: the international cooperation of the teaching team and the subject. With different cultural backgrounds, academic backgrounds, novel ideas and a vision for a sustainable future, these future designers were coming together to communicate sustainable design ideas and share sustainable design practices, experiences and insights, which was not only beneficial to students, it was also for teachers and all participants. The difficulty was due to a large number of students: the degree of sustainable design knowledge and understanding was uneven, and it was, therefore, challenging to conduct more in-depth discussions during the course and for students to come up with more reflective opinions and ideas. The time pressure of the short, intensive courses nevertheless stimulated students and pushed them to their full potential. Behind each final presentation was the discussion, debate, disagreement and compromise of the students,

which represents the meaning of teamwork. Despite this, it was an extraordinary experience and learning opportunity for the teachers and students who participated.

Tsinghua University Academy of Arts & Design and Hunan University School of Design & Art are among China's top design schools. As the organizer of the LeNSin pilot courses, both have great appeal and influence on other design schools in China. On the one hand, teachers in colleges and universities want to learn about the resources, teaching methods and curriculum materials of sustainable design teaching, and have more exchanges with domestic and foreign counterparts. On the other hand, students hope to master the cutting-edge knowledge of the design field and learn design thinking through the curriculum training.

5.2 Having Impact Nation-Wide

In China, teachers and students are increasingly interested in and becoming more involved in sustainable design, research and discussion. With the push of government policies in the field of sustainable development, many institutions are gradually opening courses related to sustainable design, and students are increasingly willing to reflect sustainable thinking through their projects. Therefore, there is a great need for the study of theories, methods and tools for sustainable design.

Sustainable design is empowered by its cross-disciplinary nature, by inviting not only international teachers, but also provide a global vision, broaden the horizons of students and promote cultural exchanges. Sustainable design is an area of continuous development and evolution, and it is also a process in which teachers and students learn and explore together. Designers must be conscious and responsible for their decisions to ensure that the design is positive for people, as the products and services we create will influence and change people's lives to a large extent. Sustainable design means that we must go beyond traditional design thinking to look at design innovation in a more systematic and integrated perspective. The ultimate goal of sustainable design is to achieve a win-win situation for social benefits, environmental protection and economic development. This course is part of this effort.

LeNS China is China's most active sustainable design teaching alliance. The two pilot courses organized by this project not only effectively promote the communication of sustainable design concepts and the exchange of teaching experience in design institutes, but also have impact more widely. The related course information has been widely disseminated on the WeChat platform and the courseware and lecture materials have been downloaded nearly a thousand times on the LeNS-China network platform.

Sustainable Product-Service Systems (S.PSS) as a design strategy, aimed at exploring how to understand and intervene in these new, emerging economic and social forms, generates opportunities for sustainable business model innovation and industrial value creation. In this process, new tools and design methodologies need to be included to continuously meet the requirements of economic, environmental and social sustainable development. Through curricula, teaching and learning of

S.PSS ideas, and the participants' use of methods and tools, more applications will be generated and new practices conceptualized to adapt to China's conditions.

6 Integrating Experimental Pilots into Long Curricular Courses

This section highlights the importance, challenges and opportunities of executing a pilot course during the complete term of an existing curricular course, which has previously established course objectives, credits and enrolled students in a full-time programme, and sometimes pre-assigned teachers who may (or may not) be familiarized with a Sustainable Design paradigm.

Incorporating a pilot course within a curricular course according to its full-time scheme sets a significant challenge, but also offers the opportunity to have a wider perspective regarding the trajectory of an enrolled student at an undergraduate design programme. It allows teachers to be able to identify what kinds of preliminary knowledge would be needed and when, to recognize what specific topics should be previously introduced or reinforced in strategic courses along the complete undergraduate programme, to promote interrelations with other curricular courses, and to understand how S.PSS and DE knowledge contributes to shaping the overall graduate profile of the students.

6.1 LeNSin Pilot Courses at UAM Universities

The Autonomous Metropolitan University (UAM) participated in the LeNSin Project involving two campuses, Azcapotzalco Campus and Cuajimalpa Campus, both in Mexico City. Though both precincts have different undergraduate programmes (Industrial Design and Design, respectively) they both share a general structure, in which courses are scheduled by Trimesters and envision a Three-Trimester-long course at the end of the undergraduate programme called "Final Project", in which students are to immerse in a complex problem, propose, evaluate and communicate a design solution through a thesis. The Final Project is thereby part of the UAM design programme's strategy to provide students with the time and academic space to have all previously acquired knowledge during the Bachelor's programme put into practice. It also denotes the ideal course in which to undertake the whole design process in a project, in which a real-life implementation and contribution to society are encouraged. In order to plan and realize the LeNSin Pilot Course as a Final Project course, there were thus three levels of objectives to be considered: the LeNSin Pilot Course particular objectives of designing for S.PSS applied to DE; the particular Final Project course objectives, and the objectives of the Undergraduate Design Programme.

Once the Pilot Course was defined to be integrated and planned as a one-year-long course, with a two-week “observation window”, specific problems or thematic cases were established, as well as specific scheduling to accommodate the two campuses, calendar stages and topics related with the LeNSin Project. The thematic cases are briefly described in the following section.

6.2 Book Club and Desierto de Los Leones Park Projects

Libro Club (Book Club) is a government programme initially launched by the Cultural Ministry of Mexico City in 1998, whose main objective was to promote reading habits through the creation of open libraries (book clubs) managed by citizens throughout Mexico City. At the beginning of the programme, more than 1,019 book clubs were installed inside cultural and communitarian centres, hospitals, among others, having each one a basic bibliographic collection of around 500 books. The overall intention of book clubs was to offer a reading space, run by autonomous citizens, who could give unlimited access to their book collection through ‘spoken agreement’, based on trust. Due to an administrative change in the political agenda of Mexico City, much of the budget related to the Cultural Ministry was reduced and thereafter the Book Club programme became fragile and unstructured and more than 1200 clubs folded. The Book Club project on the UAM Cuajimalpa campus was thus an implementation opportunity for the Final Project and LeNSin Pilot Course, as a design intervention would provide an integrated strategy to strengthen and reformulate book club structures from a systemic view, in a way that the resulting network would be authentically autonomous and resilient to all political changes through the redefinition of all its components as a socially relevant network.

The course structure consisted of three principal stages: contextual research and immersion through field study methods, development of design proposals, and proposal refinement and evaluation, in collaboration with the stakeholders, i.e. Book Club owners and users and representatives from the Cultural Ministry [16]. Synchronized with the general curricular course objectives, additional objectives were interwoven in order to incorporate a methodological base that would allow students to:

- acquire an awareness related to the promotion of sustainable principles in emerging contexts;
- identify the social, economic and environmental spheres of a complex problem/system;
- understand the importance of the configuration process of stakeholders, interactions and scenarios throughout an interdisciplinary design process; and
- identify the theoretical and methodological basis of S.PSS and Distributed Economies.

Starting from the identification of the overall Book Club macro-system and its principal problems, stakeholders and sustainability challenges, students defined and

structured their intervention through the articulation of sub-systems. This way, each team of students proposed specific S.PSS design strategies through autonomous, yet articulated, proposals. According to the specific identified problems, the overall proposed system included products and services that would allow Book Club owners and users to start, continue and self-manage an autonomous reading space.

On the UAM Azcapotzalco campus, the pilot course aimed to implement concepts and tools of social innovation to design, as well as a research process where the academic work of students was tied with those of research. Social innovation has been shown to be an important focus in sustainable design projects because it allows addressing the social variable from a novel perspective in the discipline: the user as a generator of their own solutions, where the designer reconsiders disciplinary as a key part of the process. However, this poses new challenges for design education, since it implies a multidisciplinary practice that is not always affordable in the classroom. The objective of this project was to propose a product-service system that generates a significant change in social relations to improve the quality of life and employment of the community of vendors of the Desert of the Lions Park in the State of Mexico. The stakeholders involved in teaching and tutoring the students came from other disciplines, also from outside academia.

6.3 Summary

The LeNS pilot course, implemented for one year on both UAM campuses, provided a series of advantages at different levels. At one level, it was possible to bring students closer to the theories involved, related to both sustainability and the particular problems of each project, at a higher level of depth than what is possible in a two-week course. Students could be completely immersed in the problems, reaching important levels of empathy with the users and actors involved in the projects. Secondly, even though a general introduction was given to the different tools and principles of S.PSS Design and Distributed Economies during the two-week workshop [18], during the entire project they were introduced again during the appropriate phases of research, development and/or evaluation. These reviews of tools and principles were done in such a way that students had the time and opportunity to understand, analyse, test and execute them, not only at a conceptual level, but also in a real way once the prototypes and final proposals were developed.

Moreover, having the pilot course directly integrated into the curricula of the design programmes allowed the identification of the knowledge and skills necessary to cover in previous courses related to a deep reflection of sustainability, S.PSS design and economic paradigms (in the case of UAM Cuajimalpa), as well as the place and moment in which this knowledge could be distributed throughout the design programme, suitable teachers, contents, and so on. The implementation of a pilot course through the development of a real design project, in which the different stages of analysis, development and evaluation were transparent as evidence to the stakeholders, not only allowed a total commitment on the part of the students, but

also reached a deep level of empathy and conviction of the methodological scope used.

7 Lessons Learned, Challenges and Opportunities

Besides the development of S.PSS design methods, the main success in the LeNSin project has been in the development of the network of educators that share an interest in developing teaching for sustainable design. During the project, several educators and students have collaborated in seminars and pilot courses, but also in thesis guiding, organizing seminars and events and faculty exchange. This development continues strongly from a shared history in design teaching and is well oriented to the shared challenges of today.

The project has allowed partners to study DE as a concept in various settings. Through the project, several design schools have connected to share experiences on the concept, and various actors and networks have been invited into collaboration. Within each pilot course, having lecturers from other universities acted as an alternative training process for future replications of the learning content. Since each professor has to deal with different local contexts, the result was a prolific field of discussions on how to implement S.PSS and DE methods and tools into design curricula. Another valuable outcome from the seminar and pilot interactions was the collection of several case studies from around the world on various DE interpretations. This work has continued through collaboration with selected local actors in pilot courses and in developing ideas for local DE solutions in various contexts of action in student case work.

During the project, it also became evident that S.PSS and DE as concepts are portrayed differently in different historical, geographical and political contexts. Discussing the emerging tensions can be of help in developing new content, forging collaboration and ensuring funding for future action. Understanding these dynamics is also of assistance in developing new interaction across the globe.

Sustainability is the grand challenge for the century and answers to its call are needed across professional fields. The design profession, as a potential matchmaker between different disciplines that are involved in the processes of planning and development, also calls for new methods and tools to create new interpretations of more sustainable solutions. S.PSS and DE as approaches to design can also provide new perspectives on social sustainability, extending the considerations in conventional eco-design.

In solving the challenges of the twenty-first century, future designers need to become change agents and help to expand sustainability considerations further. In this process, projects such as LeNSin—and the networks that can be developed through them—are crucial mechanisms to take work further, to legitimize action across various settings and actors.

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