LERNFABRIK ECODESIGN

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Promotion of sustainable product development in the Baltic Sea region:

Development of a transnational Learning Factory for Ecodesign

by

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BACKGROUND

Ecologically aware product design will play a key role in the evolution of consumer habits and a commercial environment that is more sustainable for both our limited resources and our world's climate. Product developers and designers can determine the ecological fate of their output from their original designs across the entire lifecycle of the resulting products and services. The use of secondary materials, the working life expectancy of products, and the ability to maintain, repair, and recycle products are all crucial criteria to be considered when a new product is developed (Umweltbundesamt 2015a, 2015b).

In spite of the proliferation of research projects and initiatives in the field of ecodesign and the circular economy, the concepts and methods that have indeed arrived in corporate practice remain far and few between. One of the steepest challenges seems to lie in the simple lack of applied knowhow in businesses (Maurer 2018; Graulich et al. 2017). This has motivated the German Environment Agency (UBA) to commission the "Development of a Transnational Ecodesign Learning Factory".

The Ecodesign Learning Factory was part of the EU-Interreg project in the Baltic Sea Region "EcoDesign Circle". The German Environment Agency took over as the lead partner of the "EcoDesign Circle" consortium, with responsibility for commissioning the development and implementation of a Learning Factory. Fraunhofer IZM applied for this project, joining other partner design centers of the "EcoDesign Circle" in Poland, Lithuania, Estonia, Sweden, Finland, and Germany. From the beginning, one of the core tasks was therefore the inclusion of the "EcoDesign Circle" partners both in the original development of the Learning Factory and, more conceptually, in terms of the potential replication of the Learning Factory in the participating countries.

The following requirements were defined in the UBA's call for tenders for a "Development of a transnational learning factory for ecological product design" (Umweltbundesamt 2015a, 2015b):

1. Matters of ecological product design and the circular economy are demonstrated in a real-life design and production environment, and the effects of design decisions on the entire lifecycle of the product are made tangible.
2. The target group includes teaching professionals in the fields of design and product development (train the trainer) and other active practitioners (on-the-job training) in Germany and the Baltic Sea states.
3. The UBA defined additional didactic and conceptual standards:
    - The choice of sample products should give the participants an insight into how ecodesign requirements can be fulfilled.
    - Theoretical input should be balanced with practical "exercises".
    - A general procedural model should be taught, with attention to typical problems.
    - A specific case study of a product's development should be explored for generalizable take-aways for the participants.
    - The principles of ecodesign, the relevant environmental scope, and the potential reach and effects of design decisions should be introduced.
    - The reuse of products and materials and product-service systems (PSS) should be addressed.

The project was expected to deliver the following output:

- A concept for a Ecodesign Learning Factory

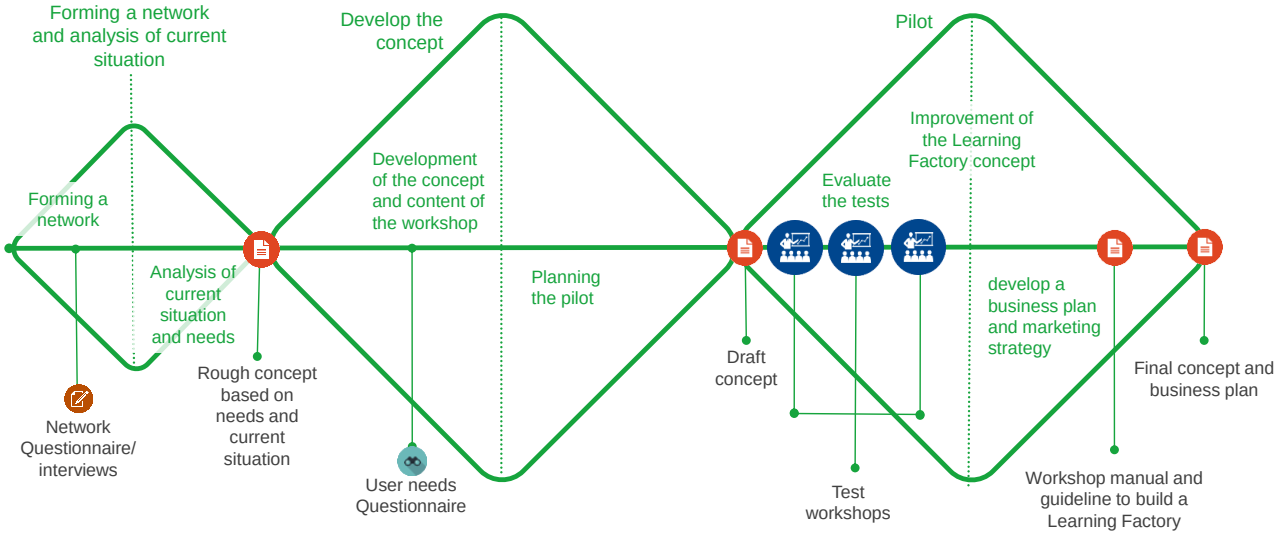
- A manual for facilitating a Learning Factory workshop (Workshop Manual)
- Guidelines for the development and implementation of a Learning Factory (Guideline)
- A continuation plan for the Learning Factory.

APPROACH

Figure 1 illustrates the approach adopted for the development of the Ecodesign Learning Factory. Each diamond represents two distinct phases: the divergent research phase of collecting information (left half of each diamond) and the convergent phase of processing and consolidating the information (right half). The process covered three such "diamonds":

1. **Status quo**: In the first diamond, the stakeholders were identified, their needs and requirements captured in interviews, and the findings consolidated in an outline concept.
2. **Concept development:** In the second diamond, the outline concept was revealed to the potential users of the prospective Learning Factory in a dedicated survey, which collected the users' feedback and identified current knowhow gaps and learning needs. These results were used to refine the concept.
3. **Pilot**: The third diamond covered testing and revision of the concept. The experience from the field was collected to contribute to a "Workshop Manual" and guidelines for the eventual establishment of a Learning Factory.

Figure 1: The Development Approach



Source: own design, Fraunhofer IZM

THE CONCEPT

Background

There are already several published ecodesign instruments and methods. However, this information is relatively hard to come by and often very complex in its nature, making it difficult for product design practitioners to find and use it in their everyday routines.

Objectives of the Learning Factory

The mission of the Learning Factory is to develop a faster and simpler means for its participants to grow and mature from ecodesign novices to true ecodesign users. To do so, the Learning Factory equips them with the means and expertise needed to develop commercially and ecologically sustainable products and services, minimize their environmental footprint in their entire lifecycle, and encourage companies to move closer to a circular economy.

The Learning Factory intends to (i) create awareness for ecodesign, (ii) help its participants get started in the area, (iii) provide them with the required toolkit for their practice, and (iv) explain the decisive questions that true ecodesign needs to ask.

Mission

The following mission statement was defined for the Ecodesign Learning Factory from the discussions with stakeholders and the two surveys:

> Practitioners and teachers in the fields of design, engineering, and business development attend the Ecodesign Learning Factory to learn how to design circular systems. They engage with a user-centric ecodesign process in which they employ the ecodesign tools and methods to minimize the environmental footprint of the entire lifecycle of their products and maximize the benefits for the business, the users, the stakeholders, and society at large.

Target Groups

The project team used the insights and interviews with network partners to define the core purpose of the training: To inspire circular and, by implication, systemic thinking. The question is: How can sustainable products be developed and kept in active use for as long as possible? The message is that the purpose of the circular economy is to protect the value of a product and not destroy it through recycling. The following specific contents were derived from the interviews with network partners and potential users:

- Instruments, principles, and strategies of ecodesign.
- Environmental assessment methods.
- User-centric and system design methods.
- Arguments and information relating to the (commercial) advantages of ecodesign – why ecodesign? Indicators for assessing the (commercial) benefits for companies. Positive effects of ecodesign on individual people, the planet overall, and business. The limits of ecodesign.
- Good practice examples of commercially viable business models and “sustainable” products and services. Best practices and use cases of circular economy products and business models already in use.

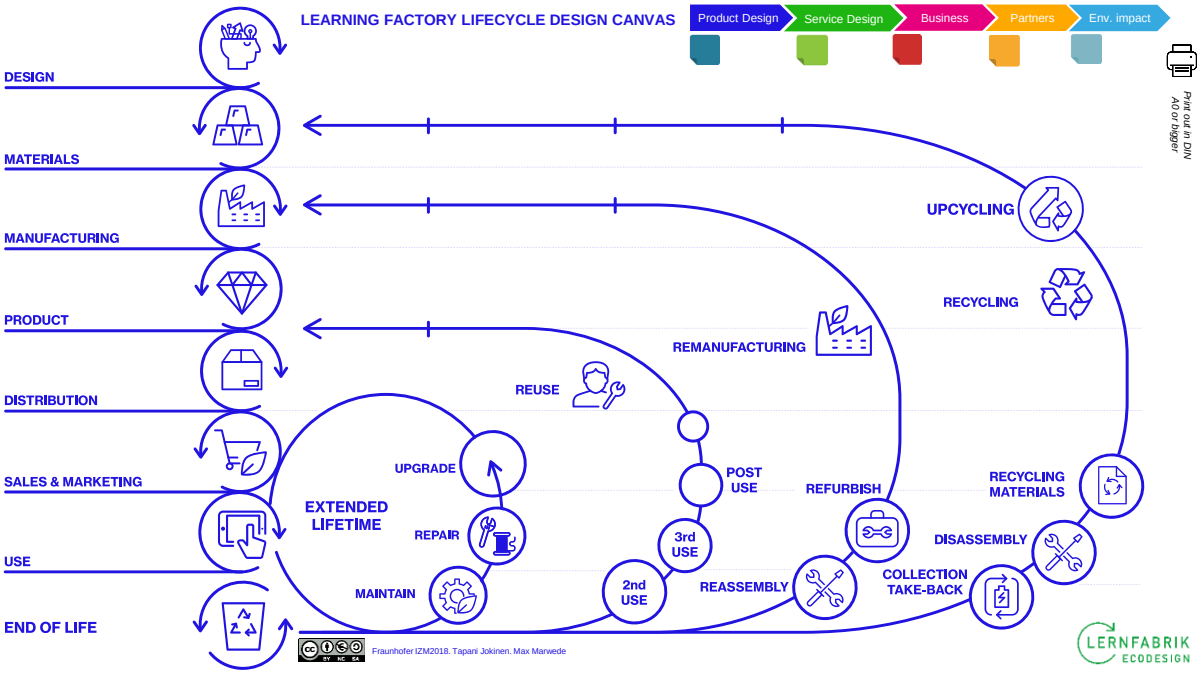
- Management of product life cycles: Strategic approaches for developing in the direction of a circular economy. User-friendly methods and guidelines for developing circular economy business models. Key activities for implementing the circular economy in existing businesses.

The choice and presentations of the contents received particular attention. The purpose of the chosen design was to give the information a visually engaging, uniform, and non-contradictory presentation and to simplify the instruments and contents with a sense for the context they are placed in. Simple infographics were prepared to help the audience take in the key insights at a glance. Additional user-friendly visual instruments were also designed to facilitate the work with circular systems.

Content was developed to cover the purpose and benefits of ecodesign and the ecodesign process, including content on the specific lifecycle phases “design”, “materials”, “manufacturing”, “product”, “distribution”, “use”, and “end of life” as well as “business models in the circular economy” and “implementation”. Each includes an introduction, a “ecodesign wheel” that captures the essential ecodesign principles for each phase, links to “how-to” videos, design tools (simple templates and instructions), design checklists (actions and strategies), and hands-on case studies from the market. Selected contents, such as the case studies, can be used in the workshops. The checklists (cf. ANNEX I) can be used to evaluate either the participants’ own systems or a given benchmark.

The workshop serves to illustrate the way of thinking in terms of the lifecycle, especially by means of Figure 2: In the circular system, the key is to keep a product for as long as possible in the active use phase by enabling repair, maintenance, and upgrades. The second step would be the reuse of the product for a similar or other purpose. The third cycle then concerns the refurbishment of the product, while the materials are finally recycled in the last cycle. This thinking is grounded in the circular economy model proposed by the Ellen MacArthur Foundation (2015a). Figure 2 is used as a template for designing a circular system in the workshop (as explained in the Workshop Manual). The participants identify elements that are necessary for achieving circularity by marking them with post-it notes. They see the system from different vantage points to answer questions like: “What does the product have to look like to be potentially circular?”, “Which services can I offer to close any gaps and deliver added value / satisfy a need?”, “How can my partners and I make money or save costs?”, or “Which partners do I need to provide these services and keep the system running?”

Figure 2: The Lifecycle System (Template)



Source: own design, Fraunhofer IZM

Business models for the circular economy can be designed by applying the shape of circular systems as reference. A simplified “Circular Economy Business Model Canvas” was developed (cf. Figure 3) to integrate aspects of sustainability and the circular economy in the visualization, analysis, design, and eventual presentation of business models. It offers a streamlined and user-friendly illustration of the key elements of circular economy business models and reveals how each element engages with the others to create added value for the whole system of actors that the company in question forms part of.

Figure 3: The Circular Economy Business Model Canvas

Source: own design, Fraunhofer IZM, following Hofmann (2017)

DIDACTIC METHODS

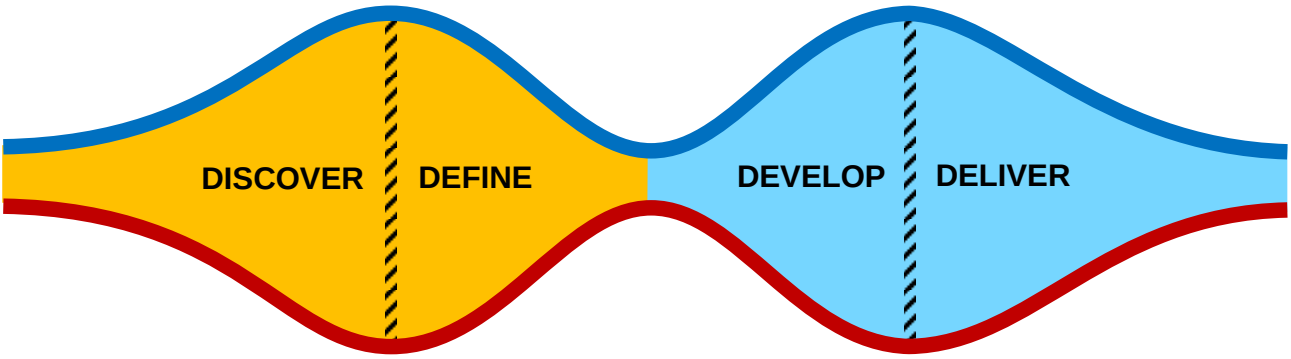
E-Learning via the Sustainability Guide

The contents and methods are provided under an open-source license through the online platform "Sustainability Guide" that was developed as part of the "EcoDesign Circle" project by SVID (Swedish Industrial Design Foundation). The Sustainability Guide is an online platform for ecodesign knowhow, methods, and use cases. The design tools, including instructions, checklists, and the ecodesign wheels, are available for download in the ecodesign category on Sustainability Guide, alongside practical use cases and more information about the circular economy. A workshop manual has also been prepared to facilitate training sessions and is also available for download. The workshop attendees have an opportunity to familiarize themselves with the contents to prepare for or follow up on the workshop they are joining.

Ecodesign Workshop (Training)

The underlying process of the Ecodesign Learning Factory has adopted the "double diamond" concept of the UK Design Council (cf. Figure 4), which breaks the design process down into four distinct phases: Discover – Define – Develop – Deliver. Any creative process begins by developing possible ideas (convergent thinking), after which ideas are refined and finalized (divergent thinking). The double diamond concept draws attention to the fact that this breathing process happens twice: first, when identifying and defining the challenge and, second, when developing the solution. This happens iteratively in the process of moving nearer to the best idea. Ideas are repeatedly refined, tested, and revised; "weak" ideas are dropped along the way (UK Design Council 2015).

Figure 4: The Ecodesign Process at a Glance



Source: own design, Tapani Jokinen, Fraunhofer IZM; revised version of the 4D or double diamond model of the UK Design Council (2015) and the design thinking process of the Stanford School (d.school 2018).

The Learning Factory's ecodesign process can be broken down into the following phases (for the structure of the workshop, cf. Figure 5). A sprint refers to a dedicated period of timed work in the individual groups. Before each step, the facilitator introduces the topic and the tasks for the participants:

1. *Introduction:* The introduction explains the purpose, methods, and ground rules for the workshop and the basic concepts of ecodesign. The attendees are also sorted into groups of four to six participants, and each group is assigned an ecodesign challenge (Sprint 1).
2. *Discover*: At the beginning of the first quarter of the double diamond, an ecodesign challenge is introduced.. In this "Discover" phase, the participants explore the needs of the user and the potential environmental issues through simulated user or expert interviews (Sprint 2).

3. *Define*: The second half of the first diamond covers the “Define” phase in which the findings from the interview are consolidated and grouped (Sprint 3). The point of this phase is to produce a specific design brief (Sprint 4) that captures the design and environmental challenges.

   Once the design brief has been established, it helps to visit a real-life production environment, e.g. our Start-A-Factory (cf. next paragraph) to make the impact of product design on its environmental performance more tangible in the actual production process. (Sprint 5)

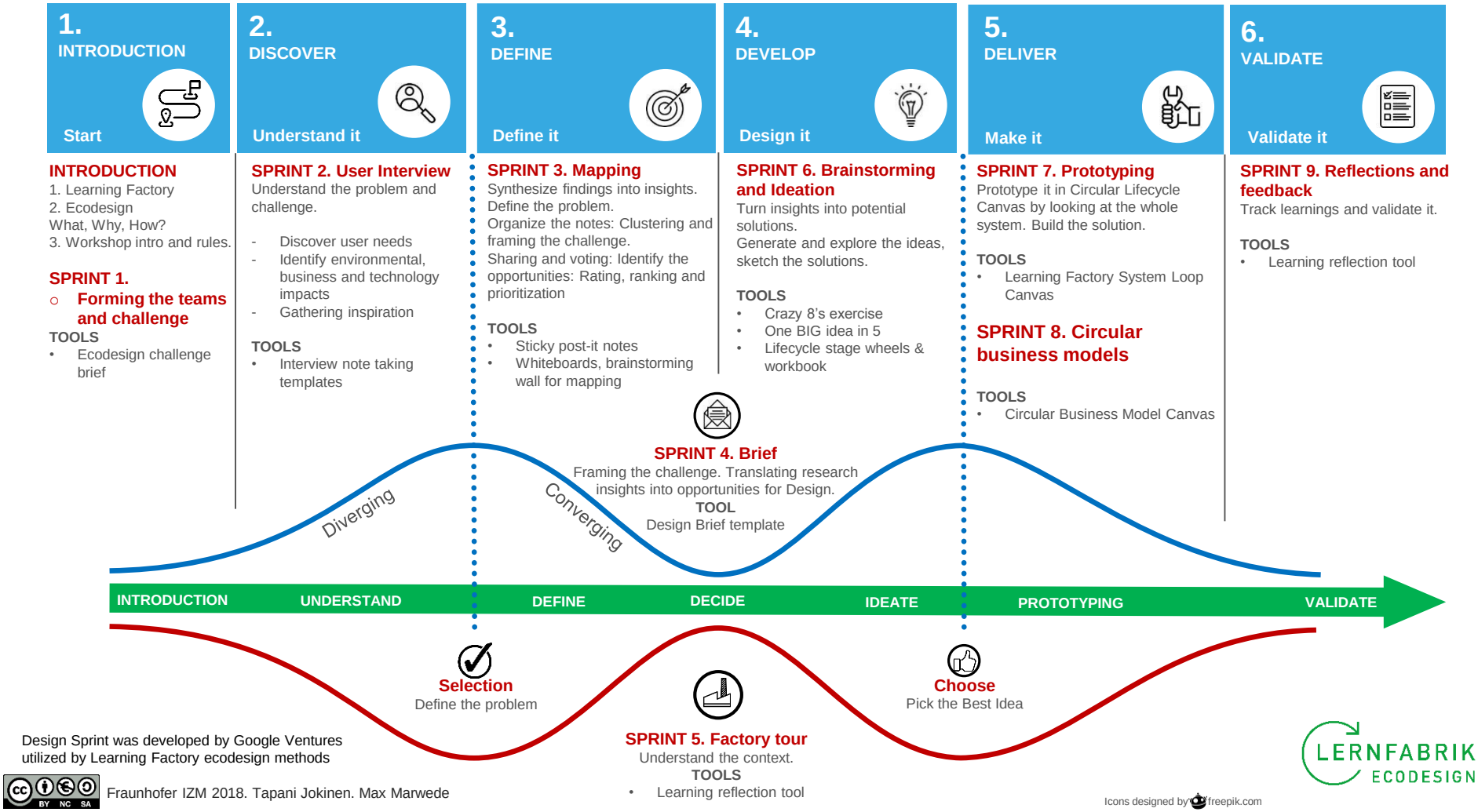
4. *Develop:* In the third quarter (second diamond), possible solutions are proposed and selected (Sprint 6).

5. *Deliver:* A prototype circular system is created in the last of the four phases (Sprint 7). In this prototype, the lifecycle of the circular system is followed to check which services can be offered, how the product should be designed, which partners from the network need to be brought into the loop, and how a revenue stream can be established. The objective is to keep the product “alive” for as long as possible. Attention is also paid to the environmental impact caused by the system and the potential ways to mitigate these effects. The final circular economy business model is then built around the chosen solution (the product / service system) (Sprint 8).

6. *Validate:* In the final step, the results are verified by means of a checklist (cf. ANNEX I), that is, checking the extent to which each aspect of the circular economy is represented (Sprint 9). The results are visualized in a radar diagram (using MS Excel), and feedback is collected.

More information about each step (Sprint) can be found in the “Workshop Manual”.

Figure 5: Structure of the Ecodesign Workshop



Source: Own design, Tapani Jokinen, Fraunhofer IZM

Optional Module: The Production Environment

To offer the participants a firsthand experience of the effects of design on actual production, a simple product can be created or the machines and industrial processes explained on site in an industrial setting. This should already relate to the specific challenges of ecodesign, e.g. by raising the following questions:

1. How does the design affect the production process?
2. How can the design help reduce waste and productions scrap?
3. How does the design affect the demand for resources and consumables?
4. How does the design impact on the number of required production processes (e.g. complexity of the assemblies, interconnects, finishes)?
5. Can the design help reduce power consumption in production (e.g. by using specific materials)?
6. Can waste materials and waste heat or other emissions be put to a secondary use? Can they be minimized?

Other phases of the lifecycle can also be addressed at this point, such as the use, repair, or recycling of the finished product. Sample products can be presented to highlight how design can make them harder or impossible to repair or recycle. This would offer an opportunity for the participants to reflect on how these insights relate to their own ideas. The module as a whole can be freely integrated in the workshop's proceedings.

One take-away insight from the project was the impact of safety and technical considerations on interaction with the participants in active facilities. Specifically: If industrial facilities are needed for commercial operations, they are either not available at all for training, or the participants need careful technical and HSE (health, safety and environment) instructions. Acquiring industrial machines only for teaching purposes in the Learning Factory is too expensive and not an option. Dual use would seem to be the sensible option, e.g. using machines in a demonstration space, a technical center, or a maker space.

At the Fraunhofer Institute in Berlin, the prototype lab facilities Start-A-Factory provided a suitable illustrative model: Start-A-Factory is a modern modular and mobile production line for assembling circuit boards, supported by flexible and modular lab spaces in a special customizable arrangement. External development teams can use these labs to develop and construct prototypes on site, potentially supporting companies in all phases of product design from the first concept to limited series production. Every step of the development process can be covered with the infrastructure of Start-A-Factory, and Fraunhofer IZM staff are on hand to advise and support the participating companies with more intricate problems, technical questions, or advice on more efficient product development choices.

Train the Trainer-Seminar

One specific use case for the Learning Factory is its use for train-the-trainer seminars aimed at academic teachers or ecodesign consultants. With its focus on teaching the methods and approaches primarily, the aim of a train-the-trainer seminar would be:

- To generally equip the participating teachers to prepare and facilitate the Learning Factory session themselves.
- To understand the goals and methods of the Ecodesign Learning Factory.
- To understand the process and agenda.

- To understand the purpose and goals of each step, to be able to explain the various activities, and to know the critical factors for the Learning Factory participants to complete their assignments successfully.
- To understand the place and role of the facilitator.

This relies on the "Workshop Manual" produced for the purpose.

PILOT PHASE

The purpose of the pilot was to test and improve the chosen methods and to check the possible replication of the Learning Factory around the Baltic Sea. The two most important sessions were the test run with students and the full-scale pilot run with professional designers and engineers. The test and pilot sequences in particular were evaluated by means of feedback surveys, verbal feedback, and observations made by the facilitators, leading to several adaptations. There were also one to two-day sessions in Lithuania, Poland, and Sweden, in which all phases were completed.

Several accelerated courses of the Learning Factory (less than 3 hours) were completed, varying the contents, duration, (sequence of) methods, and target groups for parts of the overall program. The short workshops sufficed to gain an insight into the process and the key methods. However, they were too brief for the participants to understand the overall concept. An additional train-the-trainer seminar was also completed with the aid of the workshop manual.

The test session with students included a guided tour of the lab facilities for circuit board construction and mounting and the (climate conditioning) infrastructure of the cleanroom. Each tour explained the processes and offered potential ideas about sustainable improvements. The full pilot included a visit to Start-A-Factory, again with an explanation of the production line and a discussion of energy and resource consumption and production waste. For the workshop in Sweden, a tour of "Urban Deli" was included. "Urban Deli" combines restaurant and café spaces, a supermarket, and hotel with a strict commitment to sustainability, e.g. by buying only food that would not be accepted by regular retailers while not compromising on the high-quality visual presentation of the produce. Food that is not sold will be used in the kitchens of the restaurant and hotel. In Poland, the participants visited the furniture and hardwood specialist "TAMO", dedicated to processing only regional materials, avoiding glues and other chemicals wherever possible, and recycling waste wood by sharing it with other producers, such as local artisans. The experiences from Berlin, Stockholm, and Gdynia suggest that these tours are an important confrontation with actual reality that shows the participants how ecodesign and the circular economy can be used effectively in our established economy (as well as understanding their potential limits).

CONTINUATION

In order to sustainably continue the Learning Factory, we developed a marketing plan together with the PR Department of Fraunhofer IZM. Several services have been prepared in line with the marketing plan:

- Public Ecodesign Learning Factory

- Institutional Ecodesign Learning Factory (for the staff of an institution or company)
- Advisory services for a company, using the Learning Factory methods over a longer period of time.
- Train-the-trainer seminars

With the aid of an online marketing specialist, a landing page has been developed for the Ecodesign Learning Factory that introduces the services on offer and includes an option of requesting offers directly from the website. We are also planning to offer train-the-trainer seminars through third parties with more direct access to the target groups and consulting enterprises – e.g. agencies working on resource efficiency. By completing a train-the-trainer seminar, such consultants would be certified to use the method for commercial purposes (limited in time and to a specific number of client companies or participants).

CONCLUSIONS AND INSIGHTS

The purpose of the entire venture was to provide training to professional designers and engineers on how to design circular systems. The iterative approach proved particularly helpful over the course of the project, i.e. the iterative development, testing, and refining of concepts. The following insights were gained from the project, as the concept was regularly reviewed and revised with a sounding board of partners from the EU-Interreg project "EcoDesign Circle", a stakeholder network, UBA as the commissioning , and potential and actual participants.

Replicability

The training can be offered without access to specialized production facilities, that is, all steps can be conducted in a regular, well-equipped workshop venue in a pen-and-paper format. The commissioning authority and the project partners of the project "EcoDesign Circle" have voiced their interest in the replication of the concept in other venues or industries. With this in mind, a visit to a production, repair, or recycling site can be included as an optional additional module. Such visits should focus on understanding how product design affects the environmental footprint of the product in each lifecycle phase. Even though the solutions will be very specific in each individual case, a look at actual practice – ideally, best practices – can show that ecologically sustainable business is possible in reality and that the ideas generated in the workshop are viable for real-life business.

Interdisciplinary Setup

The concept managed to engage the chosen target group. It became clear that the prime target audience would be "motivated novices" who would be receptive to a basic introduction to ecodesign in the circular economy. This group should be expanded to reach, in particular, into the business world (marketing, business development, executive management…). Specialists from the "end of life" and remanufacturing functions could also be included in the training. The transdisciplinary nature of the activities was generally perceived as a considerable, but rewarding effort. It served to show that ecodesign in a circular system can only function if it spans across disciplinary boundaries. Teachers or consultants could also be included through a train-the-trainer approach. The "Workshop Manual" has proved particularly helpful for these groups.

Teaching

All of the original conceptual and didactic requirements were fulfilled. Interviews were conducted with stakeholders and potential users surveyed to specify the final contents and didactic concept. This revealed the great interest in a potential expansion into aspects of the circular economy and, consequently, circular system design, circular economy business models and implementation strategies, and user-centric design methods. A didactic choice was made in favor of participative and applied "learning by doing" for the workshop format. This puts particular emphasis on getting an applied understanding of the methods, mindsets, and approaches for solving complex ecodesign challenges. It is for this reason that the workshop only intends to convey the "fundamentals" that are required to get a fuller grasp of the methods. The participants can build on this by exploring more specific contents through the Sustainability Guide.

International Cooperation

The international cooperation with several design centers has added value on many levels: Better cooperation and synergies for several project outcomes, improved communication skills in the design centers that are ready for use far beyond the end of each project, better contacts and stronger networks for ecodesign in the Baltic Sea region (also promising for future partnerships), insights into other cultures, characteristic strengths, and trends in the different regions, and an engagement with other ecodesign experts and interesting activities under way elsewhere.

Sustainability and Future Prospects

The approach chosen in this project has enabled us to develop and test several services that can match the needs of the chosen target groups very closely indeed. These are now ready for commercialization. Other ideas have been developed about the possible further evolution of the Ecodesign Learning Factory (e.g. covering service design in the circular economy) and the future use of the developed methods. Parts of the methods have, for instance, been used in a hackathon (with additional construction and prototyping activities). Another proposal is to employ the same method in hardware incubators and to put it at the disposal of development teams working in Start-A-Factory.

In conclusion, it can be said that there is a fundamental interest in the Ecodesign Learning Factory from different directions. A glance at the market alone shows this demand, as several "competitors" have stepped into the breach and begun to offer similar services, including several of the top-brand consulting firms. In business, political pressure and own willingness to change have inspired more interest in the circular economy. What is sorely missing, however, is solid evidence, beyond the few "proofs of concept", that the circular economy can be economically viable and self-sustaining and that commercial growth and the ecological footprint can indeed be decoupled. The lack of applied experience in the field also means a lack of practical knowhow about how circular models can be implemented on the ground. Companies need to acquire or grow further competences, e.g. for managing entire corporate networks, as well as the simple innovative spirit and wish to change (Maurer 2018). As long as a linear business remains a good choice for turning a profit, there is no pressure on companies to rethink their business models. The entire concept of the circular economy also remains beholden to the current economic mental models and has yet to accommodate more radical thinking, such as a deliberate rejection of the growth paradigm or the circular society that lets people participate in and contribute to the circular economy (Hofmann et al. 2018). While acknowledging all of these reservations, the Learning Factory remains a promising idea for showing the seed of change in its participants and stimulating the evolution of more sustainable design in the economy.

BIBLIOGRAPHY

d.school (2018): Get Started with Design Thinking. Online available at https://dschool.stanford.edu/resources/getting-started-with-design-thinking, last checked on 28.09.2018.

Ellen MacArthur Foundation (2015a): Circular Economy System Diagram. Online available at https://www.ellenmacarthurfoundation.org/circular-economy/interactive-diagram, last checked on 17.05.2017.

Graulich, Kathrin; Brunn, Christoph; Prieß, Rasmus; Quack, Dietlinde; Scherf, Cara-Sophie; Wolff, Franziska (2017): Ökologisches Design als Qualitätskriterium in Unternehmen stärken [Strengthening ecological design as a quality criterion in companies]. Umweltbundesamt. Dessau-Roßlau (Texte, 35/2017). Online available at https://www.umweltbundesamt.de/sites/default/files/medien/1410/publikationen/2017-05-08_texte_35-2017_oekologisches-design.pdf, last checked on 23.10.2018.

Hofmann, Florian (2017): Wertschöpfung in Kreisläufen. Das Gestalten von nachhaltigkeitsorientierten Geschäftsmodellen im kreislaufwirtschaftlichen Kontext. [Value creation in loops. The design of sustainability-oriented business models in the context of the circular economy.] Master thesis. Leuphana University, Lüneburg. Germany, Institute for Environmental Communication.

Hofmann, Florian; Zwiers, Jakob; Jaeger-Erben, Melanie (2018): Circular Economy als Gegenstand einer sozialökologischen Transformation? [Circular Economy as the Subject of a Socio-Ecological Transformation?] In: Holger Rogall, Hans-Christoph Binswanger, Felix Ekardt, Anja Grothe, Wolf-Dieter Hasenclever, Ingomar Hauchler et al. (Hg.): Jahrbuch Nachhaltige Ökonomie 2018/2019. Im Brennpunkt: Zukunft des nachhaltigen Wirtschaftens in der digitalen Welt. 1. Auflage. Weimar (Lahn): Metropolis (Jahrbuch Nachhaltige Ökonomie, 2018/2019).

Maurer, Robert (2018): Nachhaltige Produktentwicklung im Innovationsmanagement.[Sustainable product development in innovation management.] Master thesis. Technical University Brandenburg, Brandenburg, Germany. Technology and innovation management.

UK Design Council (2015): The Design Process: What is the Double Diamond? Online available at http://www.designcouncil.org.uk/news-opinion/design-process-what-double-diamond, last checked on 08.05.2017.

Umweltbundesamt (2015a): Leistungsbeschreibung "Europäische Ecodesign-Initiative zur Förderung ökologischer Produktgestaltung. [Terms of reference "European Ecodesign Initiative for the Promotion of Ecological Product Design.] UFOPLAN 2015 FKZ 3715 37 309 0. Umweltbundesamt.

Umweltbundesamt (2015b): Bieterfragen "Europäische Ecodesign-Initiative zur Förderung ökologischer Produktgestaltung. [Bidder Questions "European Ecodesign Initiative for the Promotion of Ecological Product Design.] UFOPLAN 2015 FKZ 3715 37 309 0. Umweltbundesamt.

ANNEX I: CHECKLISTS

Phase 1 - Design

How does the product system actually fulfil social needs?

- Does the product/service currently meet the users needs?
- Is the product/service able to adapt to changing needs?
- Does the products main and auxiliary functions are defined precise?
- Does the product fulfil these functions effectively and efficiently?

How does the product become a long lasting part of the user?

- Is the product build for durability?
- Is the product designed for upgrades?
- Is the product designed for maintenance and easy repair?
- Is the product designed for a second life having a different function?
- Is the product designed in a timeless look or fashion?
- Is a customization of the product possible?
- Did you check reasons for disposal of similar products on the market (malfunctions, fashion, performance other)?
- Is your product unique on the market, with its environmental friendly approach?

Phase 2 – Material

What do you have to consider in the production and supply of materials and components?

- Has the product components/materials with a small environmental burden?
- Is it possible to substitute materials with high environmental burden?
- Are you using low carbon emission materials?
- Are you using renewable materials (e. g. wood, paper, hemp,…)?
- Did you using recycled components/materials?
- Did you check the possibility to use waste from other companies as raw material?
- Did you reduce the number of material types?

Phase 3 – Manufacturing

What do you have to consider in the production process in your own company?

- Did you reduce the number of production processes?
- Did you reduce the environmental impacts (emissions, energy) of the production processes?
- Did you reduce the number of auxiliaries/consumables needed?
- Did you reduce the use of other inputs (besides materials) in the production (e.g. water, air,…)?

Are you using auxiliaries/consumables with low environmental burden?

Do you use renewable energy?

Did you reduce the waste generated?

Did you improve the yield?

Do you recycle or (re)use your own waste or emissions?

Did you consider the idea of industrial symbiosis?

Do you feed or sell your waste or emissions to other companies for use?

Do you use waste or emissions from other companies as input?

Do you feed or sell your (heat-) energy from manufacturing processes for other companies?

Do you use (heat-) energy from manufacturing processes from other companies?

Phase 4 – Product

What has to be considered while the product development?

Did you substitute materials with high environmental impact (while keeping the functionality of the product)?

Is the product designed for refurbishment/ remanufacturing?

Is the product designed for maintenance/repair?

Is the product designed for recycling?

What are key points for refurbishing/remanufacturing?

Is the product easy to disassemble?

Has the product low number of connections?

Are available, simple and low number of tools required to disassemble?

Is reversible and damage-free disassembly possible?

Is there an ease of re-assembly?

Is there an ease of identification of parts and materials?

Hat the product a potential to upgrade?

Is the product build in a modularity way?

What are key points for maintenance / repair?

Modular assemblies that enable the replacement of discrete components

Easy access to parts likely to need maintenance

Fault diagnostics available

Simple handling and mounting of parts

Part inter-changeability

Access to lubrication points

Redundancy features

Ease of final adjustments

Easy identification of components and leads

Reduced electrical connections

Consideration of safety for technicians

Use of robust connections

Standardization between product lines and across generations

What are key points for recycling?

Choice of materials that can be recycled in all parts of the world

Minimization of the number of materials used

Labelling/marking of parts with recycling codes or other permanent ways to identify materials

Avoidance of paints, additives and surface treatments

Use of inherent color

Avoidance of combinations of materials that are difficult to separate

Make it easy to separate components that are hazardous, toxic or not conventionally recyclable

Ability to separate materials/components with different recycling routes (e.g. Al, Fe, Cu, PCBs, plastics, ceramics, …)

Phase 5 – Distribution

What has to be considered for the distribution of the product?

Did you choose material with low environmental impact for transport packaging?

Is the transport packaging reusable/recyclable?

Did you reduce the weight of the transport packaging?

Did you reduce the volume of the transport packaging?

Which means of transport are used?

How does the vehicles get their energy (fuel, electro, sun,…)?

Can the transport be organized more efficiently?

Is local production and assembly possible? (avoidance of transportation)

Phase 6 – Use

What problems arise when using / operating the product?

Does the product/service require less energy (direct or indirect) than similar products?

Did you reduce the amount of consumables needed?

Did you choose consumables with low environmental impact?

Is the technical lifetime longer than similar products?

Did you reduce the number of maintenance and repair cycles?

Can the product be used (energy) efficiently?

Is there a long bonding relationship to the costumer? (touch points, brand perception,…)

Is the product used by several users (sharing)?

Did you consider the aesthetic lifetime of the product (timeless design, aging of materials, …)?

Phase 7 – End of Life

What do you have to consider in general?

Did you consider what's its highest and best use for the product at the end of its life? (e. g. reuse or recycle within your company or for other industries)

Is it possible to get the product back in a way that promotes your business model?

Can a method for product collection / return logistics be implemented?

Can parts of the product could be reused in other products?

Does the product still have a value once the costumer wants to get rid of it?

What problems arise in the recovery and disposal of the product?

Did you consider what happens to a product at the end of its life?

Do you know how the product is currently disposed of?

Do you know which materials are recyclable?

Is it possible to reuse components or materials?

Is it possible to reassemble the components without damage?

Are recyclable materials identifiable?

Can they be detached quickly?

Are any hazardous components easily detachable?

Do problems occur while incinerating non-reusable product parts?

Circular business model

Implementation of circular business models

Do you provide a platform to allow collaboration among product users?

Do you sell products or deliver and provide services?

Do you retain ownership of your products during the use-phase?

Is the circular business model largely supported by the company?

Are your customers and suppliers aware of circular business solutions?

Do you have product-take-back programs?

Do you involve customers as well as suppliers in your value-added processes (co-creation)?

How closely do you cooperate with your customers, suppliers and the whole circular business network?

Are there any legislations or government regulations that need to be followed for implementing a circular business model (in terms of product liability, parts recycling, materials usage etc.)?

Do you consider environmental and social aspects in the cost-benefit analysis (beside financial aspects)?

Do you know the financial and accounting impact of providing services instead of selling products?