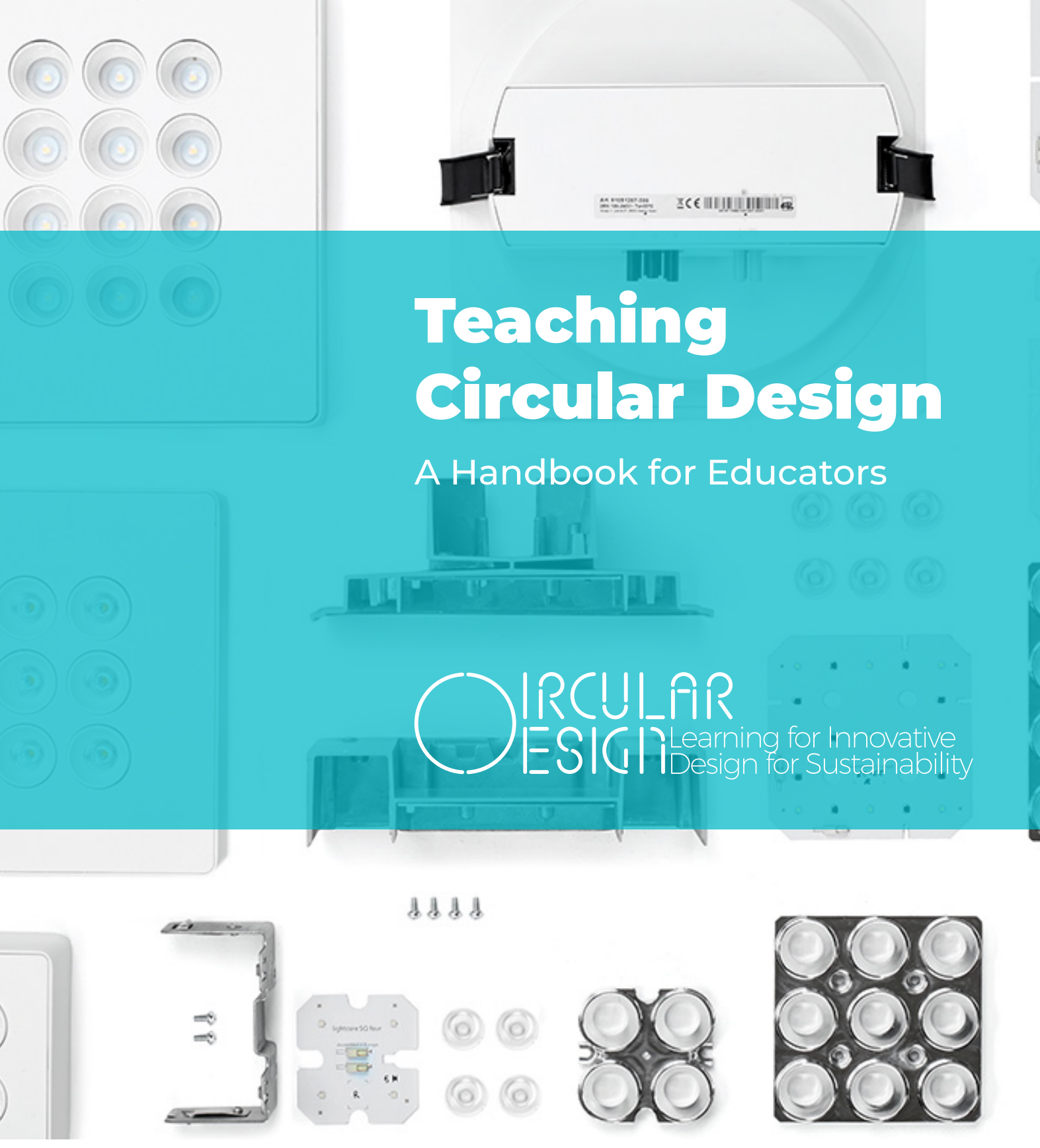

Teaching Circular Design

A Handbook for Educators

CIRCULAR DESIGN
Learning for Innovative Design for Sustainability

Co-funded by the Erasmus+ Programme of the European Union

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CIRCULAR DESIGN
Learning for Innovative Design for Sustainability

Colophon

Title: Circular Design Handbook - A learning guide for design professionals

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I. Preface

We are living in a world, where products are created to be replaced as frequently as possible instead of lasting long. The linear take-make-waste system that humanity has been living in for a long time is evolving at an even more critical state with fast consumption. The appliances we use, our furniture or our clothes, everything is produced in a way that ensures that we need to buy a new one in a rather short amount of time. Circularity focuses on the resources aspect of sustainability and is a holistic and futuristic way of thinking that considers the entire product lifespan as a whole and aims for a product to complete its purpose in a waste-free way. It is currently considered to be the most promising approach to ensure sustainable development for the society with minimal damage to our planet.

Circular economy can be described as a model that aims to rethink the biological and technical systems of production, consumption and afterlife to create a waste-free future. Circular design on the other hand, approaches this waste-free system from the perspective of creating tangible and intangible products, and aims to apply design thinking to establish a sustainable cycle.

The guide you are reading is the result of an extensive collaboration between academics and designers who have an expertise on various fields of circular design. Over the course of two years, this learning guide has been developed as a reader for the Circular Design Professional Development Course (PDC) that was created as a part of the Erasmus+ project Circular Design: Learning for innovative design for sustainability (CD:L4IDS) with partners from four European countries, Catalonia, Ireland, the Netherlands and Sweden. From each of these countries, an academic partner has collaborated with a design and an industry partner to develop, refine and test the modules of the course explained in this learning guide.

The aim of this learning guide is to help those who want to apply, teach or take the Circular Design Professional Development Course. The book relates basics of design profession to basics of circular design. In a way, this book is a “starters guide” for circular design.

II. Reading guidelines

Before starting, it is necessary to explain the purpose and the content of this guide to its potential users, namely course developers and course participants. In this chapter we will go through the elements of this learning guide and bring in a few suggestions on how these elements might be used.

The course structure, and therefore the guide is divided into 12 chapters in this book that correspond to the 12 modules of the developed course. Each module follows the same format of an introductory lecture and an exercise to follow.

The first two modules are introductory modules that explain the basics of Circular Economy and Circular Design. The following four modules are the general modules that one by one focus on four essential topics that any designers who are interested in circularity should have a basic knowledge of, such as systems thinking, co-creation, policies and life cycle assessment. The final six modules are the track modules. There are three tracks in this course: society, strategy and technology. Each track includes two track modules. The course is designed in a flexible way so that the instructors can create a unique combination of general and track modules based on the target group.

Suggested schedule
This course can be altered in multiple ways to fit the needs of the participants and instructors. The schedule was initially developed for a period of four months, where the course content is distributed over the entire period with regular gatherings. Figure II-1 shows this possible course schedule over four months. The schedule starts with an introduction day. This is followed by a day of General Modules after three weeks, and a day of Track Modules after six weeks. Participants work on their projects in the three weeks in between course days. As can be seen, General Modules and Track Modules are offered twice. The first series of modules will get people to the intermediate level, and the second series will get them to the advanced level. However, it is possible to leave the course at an intermediate level as well.

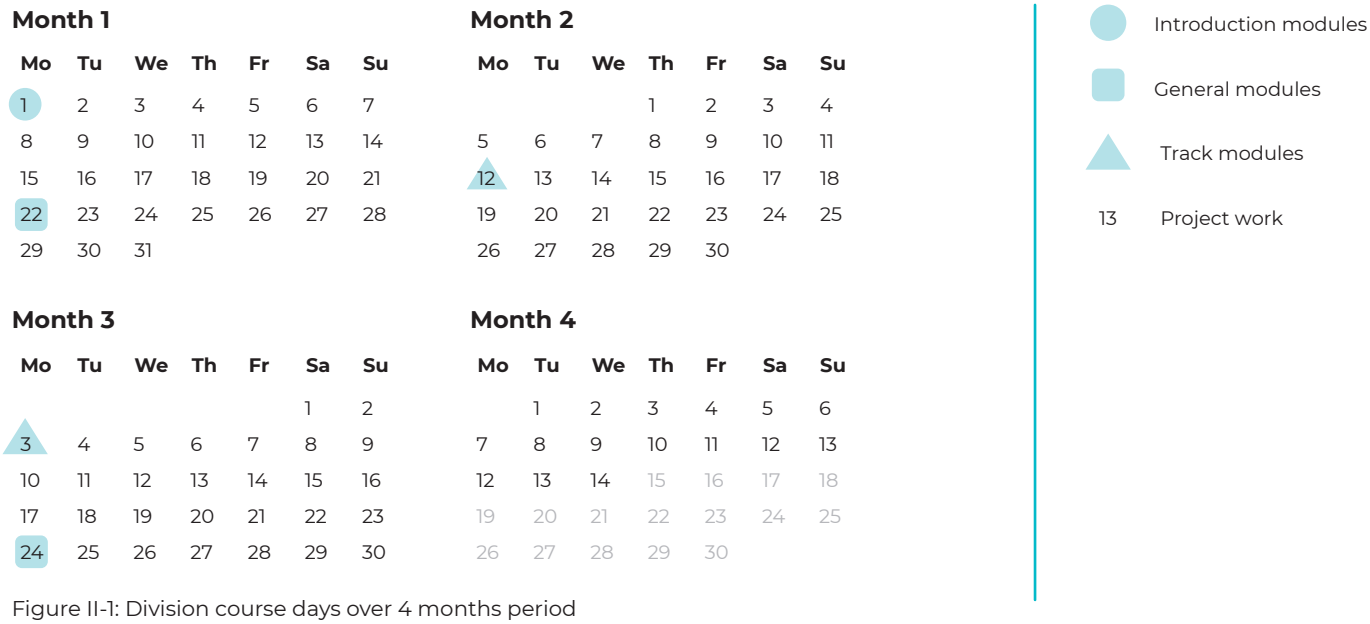

Figure II-1: Division course days over 4 months period

It is also possible to adjust the content according to the time constraints, by for instance distributing the contact hours into a more generous timeframe to create a slower paced course. Or the opposite, if the time is limited, it is possible to lighten the content and squeeze the entire course into a smaller duration. Alternatively, depending on the background of the participants, only one or two of the tracks can also be covered. A suggested course schedule that is covered in five full days can be viewed in Figure II.2

<table>
<tr><th rowspan="3">EXAMPLE COURSE SCHEDULE</th><th>DAY 1</th><th>DAY 2</th><th colspan="3">DAY 3</th><th colspan="3">DAY 4</th><th>DAY 5</th></tr>
<tr><th>INTRODUCTION MODULES</th><th>GENERAL MODULES</th><th colspan="3">TRACK MODULES</th><th colspan="3">TRACK MODULES</th><th rowspan="2">GENERAL MODULES</th></tr>
<tr><th>SOCIETY</th><th>STRATEGY</th><th>TECHNOLOGY</th><th>SOCIETY</th><th>STRATEGY</th><th>TECHNOLOGY</th></tr>
<tr><td>30min</td><td>Opening</td><td>Warm up</td><td>Track intro</td><td>Track intro</td><td>Track intro</td><td>Track intro</td><td>Track intro</td><td>Track intro</td><td>Warm up</td></tr>
<tr><td>1:30h</td><td rowspan="2">Circular economy (I-1)</td><td>Systems Thinking (G1-1)</td><td rowspan="2">Change & Transition (T1-1)</td><td rowspan="2">Business Model Design (T3-1)</td><td rowspan="2">Material Flows & Production (T5-1)</td><td rowspan="2">Change & Transition (T1-2)</td><td rowspan="2">Business Model Design (T3-2)</td><td rowspan="2">Material Flows & Production (T5-2)</td><td>Systems Thinking (G1-2)</td></tr>
<tr><td>1:30h</td><td>Stakeholders & Collaboration (G2-1)</td><td>Stakeholders & Collaboration (G2-1)</td></tr>
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<tr><td>1:30h</td><td rowspan="2">Design for Circular Economy (I-2)</td><td>Policy, Legislation & Standardization (G3-1)</td><td rowspan="2">Social Design (T2-1)</td><td rowspan="2">Product-Service design (T4-1)</td><td rowspan="2">Product Design (T6-1)</td><td rowspan="2">Social Design (T2-2)</td><td rowspan="2">Product-Service design (T4-2)</td><td rowspan="2">Product Design (T6-2)</td><td>Policy, Legislation & Standardization (G3-2)</td></tr>
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<tr><td>1h</td><td>Discussion</td><td>Wrap-Up & Track Overview</td><td>Wrap-Up</td><td>Wrap-Up</td><td>Wrap-Up</td><td>Wrap-Up</td><td>Wrap-Up</td><td>Wrap-Up</td><td>CLOSING DRINKS</td></tr>
</table>

Figure II-2: Suggested course schedule

Course Tracks
Participants can choose from three different tracks based on their interests and design disciplines: (1) Society, (2) Strategy, and (3) Technology. Each track covers two main topics with two modules that are both given in two parts. Depending on the organisation of the structure, participants can follow one, two or all the three tracks, as the modules are not repetitive and they cover completely different fields of circular design.

Modules
Three types of modules are offered in the courses: Introduction Modules, General Modules, and Track Modules. Introduction Modules are offered to all participants on the first day of the courses. They cover the basics and give an overview of the existing areas of study. In the General Modules, participants develop a greater understanding of topics relevant for Circular Design. These modules are offered to all participants as well. Track Modules cover knowledge and skills relevant to specific design disciplines. Participants follow different modules depending on their track choices.

There are two Introduction modules, which explain the origins of the circular economy and circular design consecutively, and also give an overview of the main schools of thought that play a role in both research and practice in this area.

Following the introduction modules, there are four general modules that go deeper into four common points of attention for those who are interested in the subject of Circular Design. These are systems thinking, stakeholders & collaboration, policy development and life cycle assessment & evaluation topics. In the proposed programme, these four general modules are divided into two parts with two lectures and two exercises in total. The second part of the general modules are suggested to be given in the final day of the course, as they have a conclusive nature that involve evaluation and feedback processes.

Finally, there are six track modules in this learning guide that together form the three tracks of the course. Each track is divided in two sessions where Part 1 and Part 2 of track modules are covered. This way, the participants get to work with a variety of tools but also do not get overwhelmed with the information.

Required Expertise
The participants are expected to have a design background, as the text regularly refers to basic design principles. However, the course has been given successfully to designers from different design disciplines from fashion design to graphic design, who are interested in circular design. The course is also applicable in an academic context with students who have a basic knowledge of design thinking and design processes.

Structure of the modules
Each of the modules follows a fixed structure. First, the learning outcomes are described that explain the knowledge and abilities the course participants should gain from the module. Then, to place the module in context, the key related concepts are provided. After the main content body of the module, a course programme is suggested with presentations and activities and exercises. Finally the module is concluded with literature references for further reading.

EXAMPLE COURSE SCHEDULE	DAY 1	DAY 2	DAY 3			DAY 4			DAY 5
	INTRODUCTION MODULES	GENERAL MODULES	TRACK MODULES			TRACK MODULES			GENERAL MODULES
			SOCIETY	STRATEGY	TECHNOLOGY	SOCIETY	STRATEGY	TECHNOLOGY	
30min	Opening	Warm up	Track intro	Track intro	Track intro	Track intro	Track intro	Track intro	Warm up
1:30h	**Circular economy (I-1)**	Systems Thinking **(G1-1)**	Change & Transition **(T1-1)**	Business Model Design **(T3-1)**	Material Flows & Production **(T5-1)**	Change & Transition **(T1-2)**	Business Model Design **(T3-2)**	Material Flows & Production **(T5-2)**	Systems Thinking **(G1-2)**
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30min	Lunch	Lunch	Lunch	Lunch	Lunch	Lunch	Lunch	Lunch	Lunch
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1:30h		Life Cycles, Assessment & Evaluation **(G4-1)**							Life Cycles, Assessment & Evaluation **(G4-2)**
1h	Discussion	Wrap-Up & Track Overview	Wrap-Up	Wrap-Up	Wrap-Up	Wrap-Up	Wrap-Up	Wrap-Up	CLOSING DRINKS

I1. Circular economy

In this first module the main characteristics of the circular economy (CE) are discussed. Which are the roots of CE and its principles. We also introduce the European Commission Circular Action Plan, the situation of CE in Europe and the role it plays in small and medium Enterprises (SMEs).

Learning outcomes
Participants will be able to...

1. Understand the limits of the current linear economic system
2. Identify the differences between a linear system and a circular economic and materials system.
3. Explain the main idea behind the concept of Circular Economy
4. Know opportunities that a Circular Economy offers.
5. Assess opportunities that Circular Economy can offer in a specific context.

Related topics
Linear versus circular economy, resource scarcity, environmental impacts, biodiversity, adaptability, resilience, sustainability, CE frameworks, drivers and opportunities of the CE, implementation of the CE, material and energy flow in the CE, , origins of the CE, principles of the CE, value creation in the CE, wellbeing.

What is Circular Economy?
Looking beyond the current “take, make and dispose” extractive industrial model, the circular economy is restorative and regenerative by design. Relying on system-wide innovation, it aims to redefine products and services to design waste out, while minimising negative impacts. Underpinned by a transition to renewable energy sources, the circular model builds economic, natural and social capital. It is based on four principles:

1. Waste equals food
2. Build resilience through diversity
3. Use energy from renewable resources
4. Think in systems.

The concept of a circular economy
In a circular economy, economic activity builds and rebuilds overall system health. The concept recognises the importance of the economy needing to work effectively at all scales for large and small businesses, for organisations and individuals, globally and locally. Transitioning to a circular economy does not only amount to adjustments aimed at reducing the negative impacts of the linear economy. Rather, it represents a systemic shift that builds long-term resilience, generates business and economic opportunities, and provides environmental and societal benefits.

The model (see figure I1-1) distinguishes between technical and biological cycles. In biological cycles, where food and biologically-based materials (such as cotton or wood) are consumed, loops are designed to feed materials back into the system through processes like composting and anaerobic digestion. These cycles regenerate living systems, such as soil, which provide renewable resources for the economy. Technical cycles, where technical products are consumed, recover and restore products, components, and materials through strategies like reuse, repair, remanufacture or (in the last resort) recycling. The notion of circularity has deep historical and philosophical origins. The idea of feedback, of cycles in real-world systems, is ancient and has echoes in various schools of philosophy. It enjoyed a revival in industrialised countries after World War II when the advent of computer-based studies of non-linear systems unambiguously revealed the complex, interrelated, and therefore unpredictable nature of the world we live in – more akin to a metabolism than a machine. With current advances, digital technology has the power to support the transition to a circular economy by radically increasing virtualisation, de-materialisation, transparency, and feedback-driven intelligence.

The circular economy model synthesises several major schools of thought. They include the functional service economy (performance economy) of Walter Stahel; the Cradle to Cradle design philosophy of William McDonough and Michael Braungart; biomimicry as articulated by Janine Benyus; the industrial ecology of Reid Lifset and Thomas Graedel; natural capitalism by Amory and Hunter Lovins and Paul Hawken; and the blue economy systems approach described by Gunter Pauli.

Principle 1
Preserve and enhace natural capital by controlling finite stocks and balancing renewable resource flows
ReSOLVE levers: regenerate, virtualise, exchange

Principle 2
Optimise resource yields, by circulating products, components and materials in use at the highest utility at all times in both technical and biological cycles
ReSOLVE levers: regenerate, share, optimise, loop

Principle 3
Foster system effectiveness by revealing and designing out negative externalities
All ReSOLVE levers

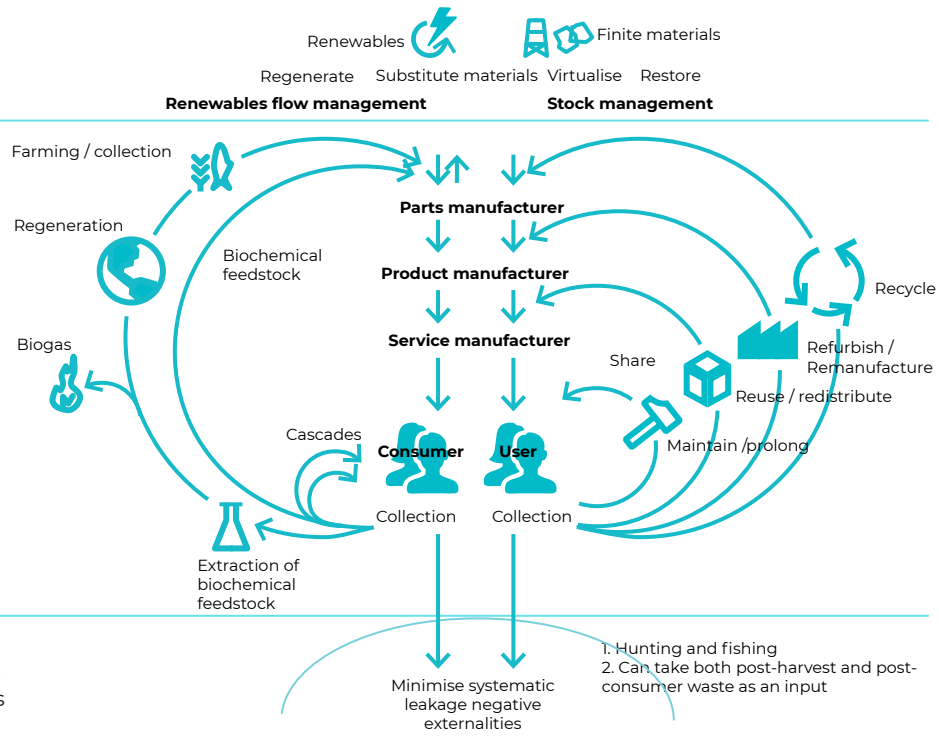


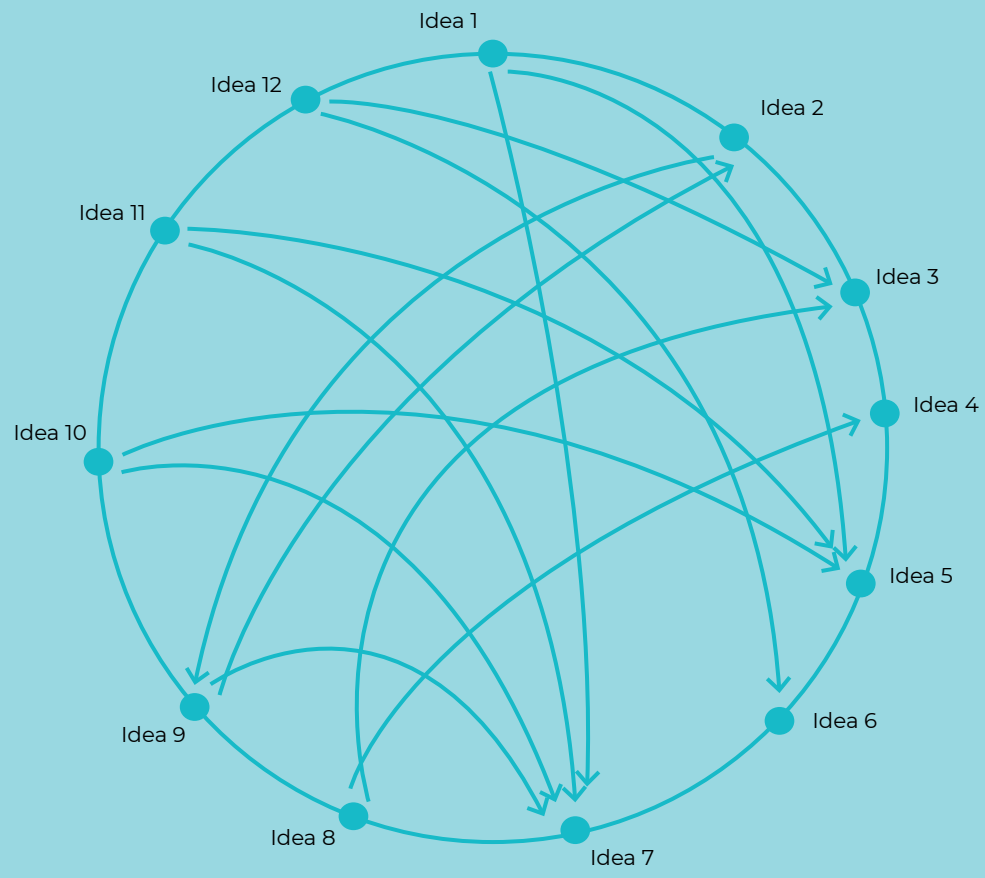
Figure I1-1. Circular Economy System Diagram. Drawing from Braungart a& McDonough, Cradle to Cradle (C2C) (Source: Ellen MacArthur Foundation, SUN and McKinsey Center for Business and Environment)

In Figure I1-1 the "Butterfly Diagram" shows the representation of the Circular Economy. It is based on three principles that conceives this economic system as a continuous positive development cycle; preserving and enhancing natural capital, optimising resource yields, and minimising system risks by managing finite stocks and renewable flows. In the middle of the diagram, the linear economy is represented, but it is regenerated by the collection of biological and technological nutrients creating different flows and cascades that reintroduce and transform the supply chain. This process follows the RESOLVE framework: REgenerate, Share, Optimise, Loop, Virtualise and Explore.

Sustainability as a wider concept has not been the first concern for all businesses. Circular economy is based on closed loop supply chains to create a sustainable future and fits well in a typical business outlook. It appears to only be possible if it guarantees profits and creates value for business in the long term.

Exercise I1-1 - Enredometre:

- Distribute 2 or 3 post-it's per person and markers.
- Everyone writes silently an idea to post it (3 minutes) Question: What can I do in my industry to align it with Circular economy principles?.
- There is a circle drawn on a flipover sheet where everyone posts their post to the outside of the circle (facing each other) and explains their content.
- At the end of this round, each one draws with curved lines that cross the circle, the relationships that he sees between his ideas and that of others.
- Three stickers are distributed per person and each one places them in those ideas that they like the most.
- The graphical result is analysed, that is, which ideas are more related and which ideas have more supports.
- The group analyses the idea and one or more powerful ideas are formulated



Exercise I1-2 - World Café

1) Setting:
Create a “special” environment, most often modelled after a café, i.e. small round tables covered with a checkered or white linen tablecloth, butcher block paper, coloured pens, a vase of flowers, and optional “talking stick” item. There should be four chairs at each table (optimally) – and no more than five.

2) Welcome and Introduction:
The host begins with a warm welcome and an introduction to the World Café process, setting the context, sharing the Cafe Etiquette, and putting participants at ease.

3) Small-Group Rounds:
The process begins with the first of three or more twenty-minute rounds of conversation for small groups of four (five maximum) people seated around a table. At the end of the twenty minutes, each member of the group moves to a different new table. They may or may not choose to leave one person as the “table host” for the next round, who welcomes the next group and briefly fills them in on what happened in the previous round.

4) Questions:
Each round is prefaced with a question specially crafted for the specific context and desired purpose of the World Café. The same questions can be used for more than one round, or they may build upon each other to focus the conversation or guide its direction. Question for this exercise:

What are the barriers and opportunities of introducing CE
in our companies with respect to:

- Production
- Product design and innovation
- Waste management
- Consumption/use of our products
- Policy and regulation affecting our company
  (add additional questions yourself if there are more tables)

5) Harvest: After the small groups (and/or in between rounds, as needed), individuals are invited to share insights or other results from their conversations with the rest of the large group. These results are reflected visually in a variety of ways, most often using graphic recording in the front of the room. Module Programme This module takes 3 hours, hence the following programme is suggested.

Module Programme

This module takes 3 hours, hence the following programme is suggested.

HOURS	TOPIC
30min	A presentation about the need of Circular Economy. The roots and principles of Circular Economy are presented and the main strategies of CE are addressed.
1h	So what? Activity. “Enredòmetre”. What can I do in my industry to align with CE principles?
30min	Presentation of the EU action plan for the Circular Economy. Current implementation and the situation of CE at EU, state and regional levels.
30min	World Café around barriers and opportunities of implanting CE in “our” companies. Production, Consumption, Waste management, Secondary raw materials, Policy.
30min	Wrap-ups of World Café and final discussion. Presentation of useful resources.

EXAMPLE COURSE SCHEDULE	DAY 1	DAY 2	DAY 3			DAY 4			DAY 5
	INTRODUCTION MODULES	GENERAL MODULES	TRACK MODULES			TRACK MODULES			GENERAL MODULES
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30min	Lunch	Lunch	Lunch	Lunch	Lunch	Lunch	Lunch	Lunch	Lunch
1:30h	**Design for Circular Economy (I-2)**	Policy, Legislation & Standardization **(G3-1)**	Social Design **(T2-1)**	Product-Service design **(T4-1)**	Product Design **(T6-1)**	Social Design **(T2-2)**	Product-Service design **(T4-2)**	Product Design **(T6-2)**	Policy, Legislation & Standardization **(G3-2)**
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1h	Discussion	Wrap-Up & Track Overview	Wrap-Up	Wrap-Up	Wrap-Up	Wrap-Up	Wrap-Up	Wrap-Up	CLOSING DRINKS

I2. Design for circular economy

This module focuses on how to interpret the principles of Circular Economy for developing design solutions, understanding key stakeholders, and developing circular design briefs.

Learning outcomes
Participants will be able to...

1. explain the main principles of circular design.
2. reflect on the opportunities and limitations of creating circular design solutions
3. identify elements of the biological and technical cycle
4. develop a design brief for circular design
5. define realistic goals, necessary tasks and expected outcomes for a circular design process.

Related Topics
Circular design principles, circular design briefs, circular design strategies, innovation, product life cycles, product lifetime, product lifetime extension, recycling, refurbishing, reuse, collaboration in design, social innovation, value proposition, whole systems design.

What is Circular Design?
Design is the practice of creative problem solving, and it involves restructuring of available resources to address a certain design problem. For the case of Circular Design, the aim is to use design methods to address problems defined under Circular Economy. As can be seen in Figure I2-1 (and as you have been informed in the previous module), Circular Economy involves a clear separation of technical and biological cycles, and strategies to first minimize the flow and then maximize the output of each cycle before safely re-positioning resources at the top of both cycles, without losing any resource ending up in landfill. The problem of Circular Design is, therefore, creating design solutions within closed-loop systems.

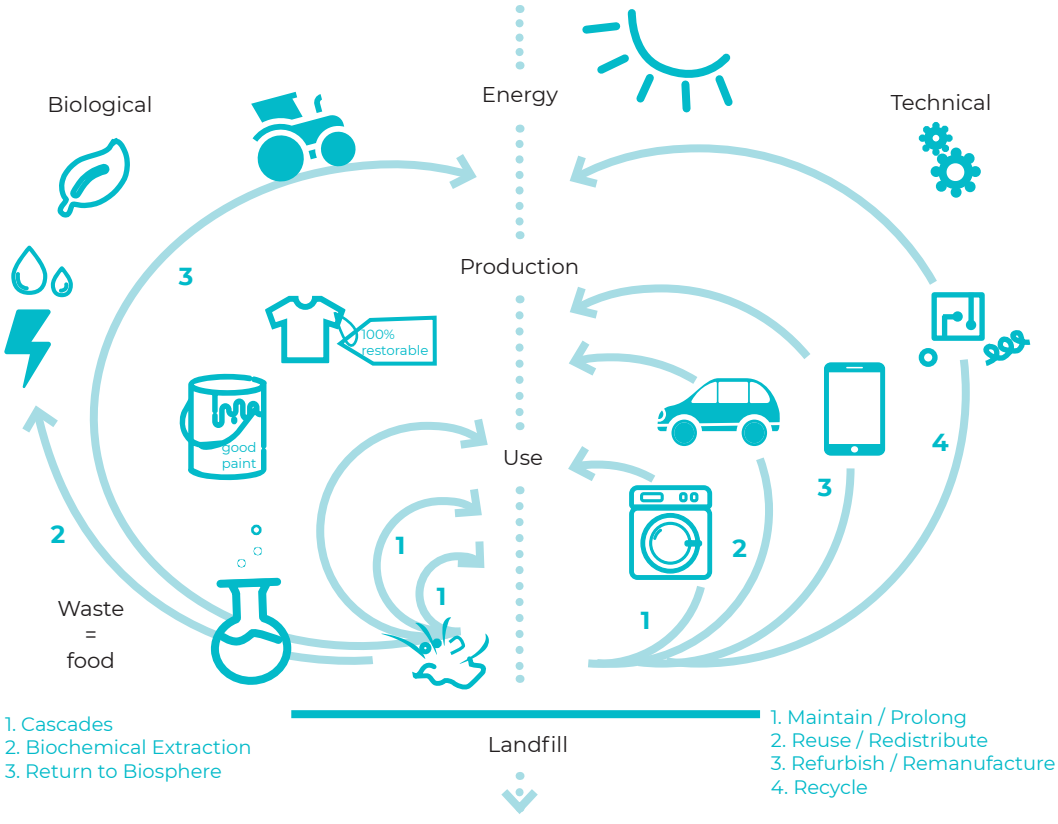

Figure I2-1. Concerns of Circular Design (highlighted on IDEO's Circular Economy Illustration)

However, product life-cycles are rarely easy to divide into two kinds of cycles (biological and technical) and different strategies - i.e. maintenance & repair, reusing & redistribution, refurbishing & remanufacturing and recycling for technical cycle, cascading, biochemical extraction and returning to biosphere for biological cycle. Each one of these strategies involves different stakeholders at different levels within different scenarios, which makes it hard to grasp the relationships amongst them at a glance. Below you can find some examples of the stakeholders potentially involved in each strategy.

Technical Cycle

1. Maintain & Prolong: Designing products that can be maintained and repaired to ensure long usage periods. Maintenance and repair may need different levels of expertise. They can be carried out by the users themselves or expert repair services.

2. Reuse & Redistribute: Designing services to reuse products for similar or different purposes. Facilitating the redistribution of products may require intervention of third parties to ensure that those products are reusable, functioning, and in viable condition.

3. Refurbish & Remanufacture: Designing products that can refurbished and/or upgraded, e.g. through part replacement. The ways to refurbish/ remanufacture a product can be done locally by individuals and repair services, or by manufacturers through salvaging reusable parts and building new products out of them.

4. Recycle: Recycling parts to acquire resources (e.g. metal, plastics, glass, etc.) and introduce them back into the production cycle. Recycling requires designated facilities to separate and process these parts, as well as responsible users to responsibly and correctly arrange their waste disposal. As can be realised from the above list, from the first strategy (i.e. maintain & prolong) to the fourth strategy (i.e. recycling), the amount of energy necessary and the complexity of the value chain increases. Also, designing products that can embody all these strategies for all its parts may not be possible and a combination of these strategies may be required to ensure nothing ends up in a landfill.

Biological Cycle

1. Cascades: Using the biological resources in levels according to their embedded values and energy. An example can be using trees to produce fruit, then use the wood for products, reuse those, and finally burning it for energy recovery. Through cascading their applications the embedded value can harnessed more effectively. Cascading requires expertise with the biological material.

2. Biochemical Extraction: A biochemical approach, where what is considered as biological waste can yield valuable nutrients and chemicals. This requires separation of biological waste and biorefineries with specific expertise to extract the nutrients.

3. Return to the Biosphere: Biological waste is returned to the biosphere to enrich their biological streams. To this end, biological and technical cycles should be completely separated and biological parts/products should not be contaminated by non-biodegradable and/or toxic materials. The strategies in the biological cycle involves complete separation of these materials from technical cycles and treatment of these resources with maximum efficiency before returning them to the biosphere. For this purpose, expertise in assessing the embedded value of biological resources is required.

The strategies in the biological cycle involves complete separation of these materials from technical cycles and treatment of these resources with maximum efficiency before returning them to the biosphere. For this purpose, expertise in assessing the embedded value of biological resources is required.

Developing a Circular Design Brief

Design briefs are important tools to frame the problems of a design project and to help designers create innovative solutions. In the case of Circular Design, the general purpose of a project might be set (i.e. closing the loop on material flows to eliminate waste), however the problems are different for each project. Hence, developing a comprehensive design brief which highlights the most important problems with regards to Circular Economy, the involved stakeholders and their roles is crucial.

Note for educators: Involved stakeholders are covered in more detail under G2 - Stakeholders and Collaboration module. It might be a good idea to introduce stakeholders and their impact on designing for Circular Economy as part of this module.

Exercise I2-1 - Explore Best Practices

Purpose of the exercise: Get familiar with best practices in designing for Circular Economy and how they are implemented in real life.

This is an exercise to explore how Circular Economy gets done in real life, aiming to inspire your future practice and to showcase what you will be equipped to accomplish at the end of this course. In groups of two:

1. Select a case study. You can use the Circular Design Best Practice Publications or Circular Economy case studies (links below in Methods and Tools section)
2. Try to find other sources of information on those cases and explore the ways and the extent they are realized.
3. Discuss the accomplishments and limitations of those cases with regard to Circular Economy.
4. Discuss how the strategies adopted in those case studies can be implemented in your sector/practice.

Exercise I2-2 - Develop a Circular Design Brief

Purpose of the exercise: Define circular design problems, goals, necessary tasks and expected outcomes.

This is a simple exercise requiring a lot of thought. On a piece of paper, try to take notes under the following headings for your product:

1. Can your product go through the Circular Economy strategies? Identify the ones it cannot.
2. Why can't it go through these strategies? Identify parts, materials, production techniques, services (or lack thereof), local challenges, etc. that prevent them
3. Identify how you want to address this through design.

Module Programme

This module is supposed to take 3 hours, hence the following programme is suggested:

HOURS	TOPIC
1h	Lecture: Circular Design
30min	Exercise I2-1: Explore Best Practices
10min	Break
20min	Class Discussion: on Best Practices
20min	Lecture: Developing a Design Brief and Introduction to Stakeholders
40min	Exercise I2-2: Develop a Circular Design Brief

Key actions

- Familiarise yourself with Circular Economy strategies
- Identify opportunities for design solutions to enable value recapture.
- Consider your key stakeholders that need to be involved to adopt Circular Economy strategies.
- Prepare a design brief reflecting on your products and services, identifying the main challenges

Methods and tools

- JIménez, A. (2019). Circular Design Best Practice Publications. Link: http://circulardesigneurope.eu/

- Ellen MacArthur Foundation. (n.d.). Circular Economy Case Studies. Link: https://www.ellenmacarthurfoundation.org/case-studies

- Forum for the Future. (n.d.). Design for Demand - Designers Lecture. Link: http://designfordemand.forumforthefuture.org/

- IDEO (n.d.). IDEO Circular Design Guide - Understand Circular Flows. Link: https://www.circulardesignguide.com/post/loops

- IDEO (n.d.)IDEO Circular Design Guide - Circular Buy-In. Link: https://www.circulardesignguide.com/post/buy-in

- The Thing from the Future (by Stuart Candy &, Jeff Watson, Situation Lab). Link: http://situationlab.org/futurething-print-and-play-edition/

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Ellen MacArthur Foundation. (n.d.). What is Circular Economy?. Link: https://www.ellenmacarthurfoundation.org/circular-economy/what-is-the-circular-economy

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McDonough, W. & Braungart, M. (2002). *Cradle to Cradle: Remaking the Way We Make Things.* New York: North Point Press.

Benyus, J. (1998). *Biomimicry: Innovation Inspired by Nature.* New York: Marrow

EXAMPLE COURSE SCHEDULE	DAY 1	DAY 2	DAY 3			DAY 4			DAY 5
	INTRODUCTION MODULES	GENERAL MODULES	TRACK MODULES			TRACK MODULES			GENERAL MODULES
			SOCIETY	STRATEGY	TECHNOLOGY	SOCIETY	STRATEGY	TECHNOLOGY	
30min	Opening	Warm up	Track intro	Track intro	Track intro	Track intro	Track intro	Track intro	Warm up
1:30h	**Circular economy (I-1)**	**Systems Thinking (G1-1)**	Change & Transition **(T1-1)**	Business Model Design **(T3-1)**	Material Flows & Production **(T5-1)**	Change & Transition **(T1-2)**	Business Model Design **(T3-2)**	Material Flows & Production **(T5-2)**	**Systems Thinking (G1-2)**
1:30h		Stakeholders & Collaboration **(G2-1)**							Stakeholders & Collaboration **(G2-1)**
30min	Lunch	Lunch	Lunch	Lunch	Lunch	Lunch	Lunch	Lunch	Lunch
1:30h	Design for Circular Economy **(I-2)**	Policy, Legislation & Standardization **(G3-1)**	Social Design **(T2-1)**	Product-Service design **(T4-1)**	Product Design **(T6-1)**	Social Design **(T2-2)**	Product-Service design **(T4-2)**	Product Design **(T6-2)**	Policy, Legislation & Standardization **(G3-2)**
1:30h		Life Cycles, Assessment & Evaluation **(G4-1)**							Life Cycles, Assessment & Evaluation **(G4-2)**
1h	Discussion	Wrap-Up & Track Overview	Wrap-Up	Wrap-Up	Wrap-Up	Wrap-Up	Wrap-Up	Wrap-Up	CLOSING DRINKS

G1. Systems thinking

This module focuses on developing a systematic approach that is formulated into demonstrable added value through circular products, services and business models. The participants will be able to understand the system context of complex issues (political, economic, socio-cultural, technological, ecological, demographic) and distinguish between different system levels. Also, the participants learn to take the various interests of the stakeholders into account in order to create added value both from the perspective of individual organisations and from the perspective of society as a whole. The modules essence is to identify the most important solution elements and stakeholders of the system and delineates the system boundaries of the design assignment.

Systematic thinking is an integration of systems thinking and system-oriented design (human-centered design). The increase in complexity of many societal systems causes traditional design methods to be inadequate.

Designers need better ways to design responsibly and avoid unwanted side effects. The systemic design integrates systems thinking of design towards environmental, social and economic sustainability. This module focuses on collaborative system design. We use a systemic approach to examine complex problems in a more complete and precise way.

Learning outcomes
Participants will be able to...

1. understand the main schools of thought in complexity discourse
2. create a vision for a circular society
3. define system boundaries for a given design problem
4. describe societal, socio-technical, product-service, and product-technology systems in relation to circularity
5. describe the relationships between these different system levels

Related topics
Adaptation, cascades, causal analysis, cause-effect chains, energy flow, feedback loops, forecasting, future studies, industrial ecology, industrial symbiosis, interconnectedness, interdependence, product life cycles, macro systems, material flow, mesosystems, microsystems, network analysis, regenerative thinking, scenarios, sub-systems, systemic leakage, systems analysis, systems dynamics, systems modelling, systems resilience, systems scales, systems thinking

Systems Thinking with Multilevel Design Model
Solving complex societal issues requires innovation at micro, meso and macro levels. Successful transformation towards a circular economy can only take place if developments at the various aggregation levels of the system to reinforce each other. How these levels can be defined differs per situation. For example, a distinction can be made between changes at the level of the individual, the group, the community or society. Changes in one organisation are closely related to changes in the ecosystems of all stakeholders involved. A distinction can also be made between changes at the level of the product-technology system, the product-service system, the socio-technical system and the social system as a whole. Design professionals need to act consciously at all levels and make use of the mutual influence of developments at the lowest, most tangible level, at the complex change processes at the highest, most abstract level, as well as at the intermediate levels.

The Multilevel Design Model (MDM) combines the iterative design approach that is generic enough to describe both the design process of new tangible products and new product-service systems, as well as to describe in a simplified manner the way that complex societal change processes may take place. The cycles of MDM are based on the description of a design or change process as a cyclic iterative process consisting of four phases: (1) Reflection, (2) Analysis. (3) Synthesis, (4) Experience, where on each system level a similar description of the design, change or transition process is being applied (see figure G1-1).

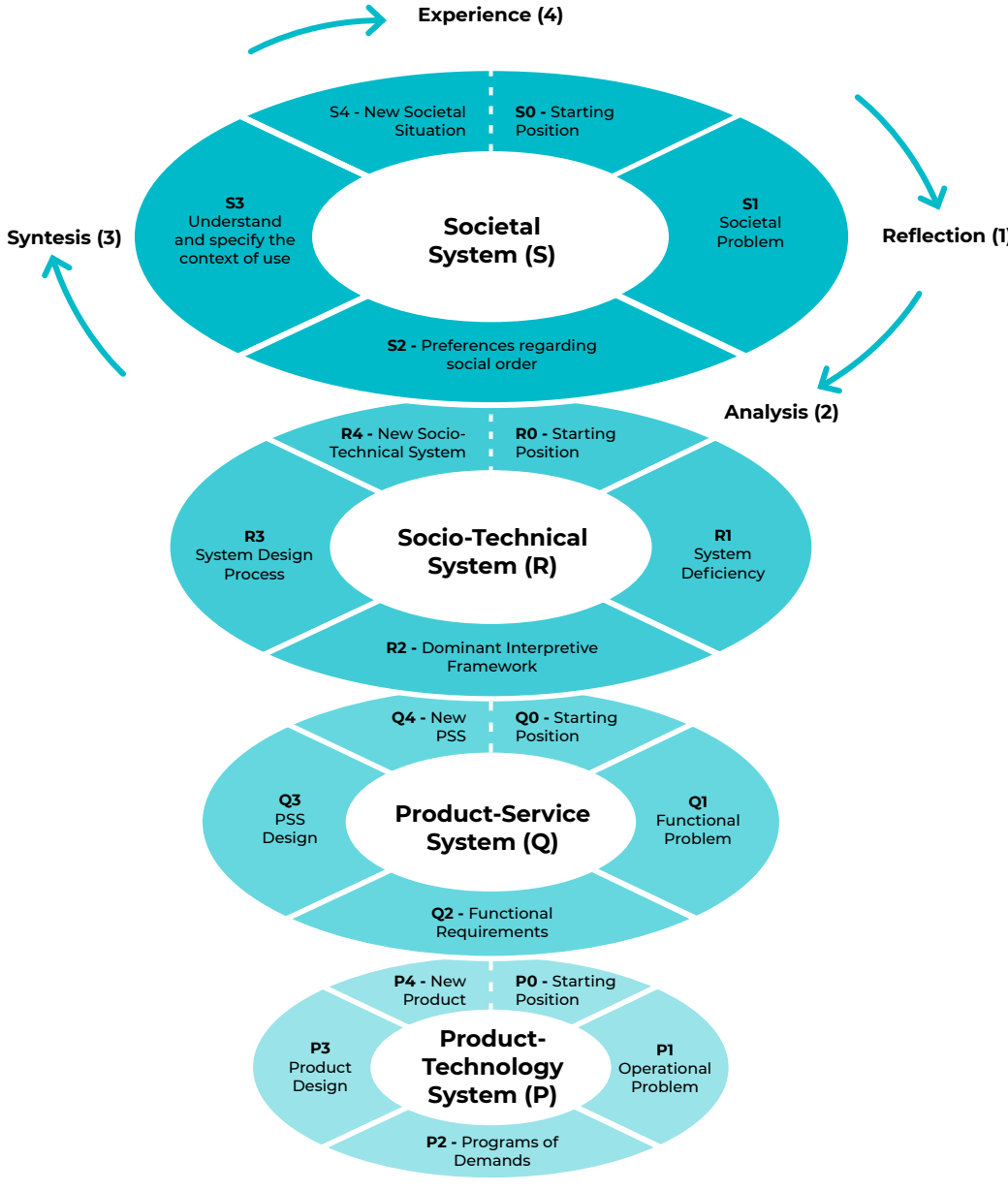


Figure G1-1: Multilevel Design Model

Societal system

The highest level of the multilevel design model has been defined as the societal system, being 'the community of people living in a particular country or region and having shared customs, laws, and organisations' (Oxford dictionaries). This is built up from a combination of material, organisational, policy, legal, social, cultural or infrastructural elements. Changes that take place at this level are often referred to as a 'transition', which can be considered as a gradual, continuous process of societal change, where the character of society (or of one of its complex subsystems) undergoes structural change. While the other systems can more or less be defined and demarcated, at the societal system level a complete summary can no longer be made of the elements that do or do not make up the components of the

system. It extends over several influence spheres and domains, where the boundary between these areas cannot easily be determined. Also the societal system does not fulfil a distinct function, but is made up of functions that are not necessarily related.

Socio-Technical system
The second level of the multilevel design model is the socio-technical system. This can be defined as 'a cluster of aligned elements, including artefacts, technology, knowledge, user practices and markets, regulation, cultural meaning, infrastructure, maintenance networks and supply networks, that together fulfil a specific societal function' (Geels, 2005). Changes that take place at this level are often referred to as a 'system innovation', which can be defined as 'a large-scale transformation in the way societal functions are fulfilled. A change from one sociotechnical system to another' (Elzen et al. 2004, 19). At this level, a large number of components are combined that are not necessarily formally related to each other. Several elements together form a joint system that fulfils a combination of functions that have a narrow, joint relationship with each other. Product-service systems, accompanying infrastructure, government legislation and cultural as well as social aspects may form a mutually interdependent whole. In contrast to the first two levels, the socio-technical system continues to function if one or more elements are missing, and elements may even assume each other's function.

Two general aspects of socio-technical systems are relevant for product circularity: (1) the key mechanisms behind the current system are the result of the historical evolution of a complex set of relationships between producers, consumers and policymakers; and (2) the balance of a system is dynamic, implying that it is constantly subjected to internal and external change that might push it towards or away from improved product circularity.

Socio-technical systems are shaped by an array of interrelated factors, including PESTLE and other factors:

PESTLE:
- Political factors
- Economic factors
- Social factors
- Technology and innovation factors
- Legislative factors
- Environmental factors

Next to this, also consider:
- Demographic factors
- Urbanisation and infrastructure
- Cultural factors
- Business models and marketing

Product-Service system
The third level of the multilevel design model is formed by product-service systems. A product-service system is built up of physical as well as organizational components, which form a united and cohesive whole that

together fulfils a specific function, usually definable in time and place. The system fulfils one or more clearly defined functions that can no longer be performed if one of the technical or organizational components is missing. The product-service system can indeed be compatible with certain policy, legal, social, cultural or infrastructural elements, but these do not form an inextricable part of the product-service system.

Product-Technology system
Technological products form the base level of the MDM. These can be defined as physical objects that originate from a human action or a machine process. As these objects are made up of technical components, the term 'product-technology system' is used. This refers to tangible, inextricably linked technical systems, physically present in place and time. With most of these artefacts, you could 'drop them on your toes'.

Product-technology systems generally fulfil one or more clearly distinguishable functions. A system dysfunction occurs as soon as one or more technical components are missing.

Promoting and monitoring product circularity thus requires knowledge of the way the system in which the product plays a role behaves (e.g. a car in the transport system). For the implementation of effective business models, policy measures and consumer action, it is essential to identify and understand the systemic links between a product, the business model of which it is a part, and the societal context that determines its life-cycle.

The linear model based on the cost-efficient production of goods sold to consumers has become the dominant means of addressing many needs, such as for mobility, communication, housing and food. Some of the drivers propelling this model to dominance include the availability of relatively cheap and abundant natural resources and energy, as well as various technological and social innovations, ranging from engines and electricity, for example, to assembly lines for the mass production of goods.

Dynamic systems
Dynamic systems deal with complexity, it refers to higher order systems that involve multiple subsystems. By integrating system thinking and its methods, systemic design carries user-centred design to complex and multistakeholder service systems [5].

The principles of systemic thinking make us aware that there are no perfect solutions. The choices we make will have an impact on other parts of the system. By anticipating the impact of each commitment, we can minimise its severity or even use it for its own benefit. Therefore, systems thinking allows us to make informed decisions. By understanding and changing structures that do not work well (including our models and mental perceptions), we can expand the available options and create more satisfactory long-term solutions for chronic problems.

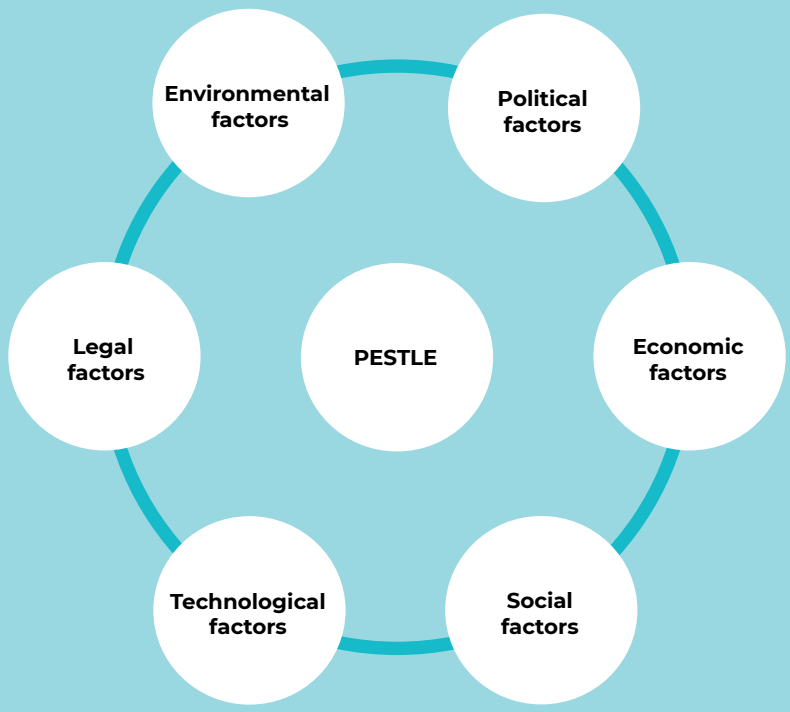
Wicked problems

System challenges in circularity are often complicated and ill-defined. In 1973, Horst Rittel coined the term 'Wicked problems' as a class of social system problems which are ill-formulated. This implies the information is confusing, where there are many clients and decision makers with confusing values, and where the ramifications in the whole system are thoroughly confusing (see figure G1-3).

Figure G1-3 Characteristics of Wicked Problems

Exercise G1-1: Utopia/Dystopia

Looking into the future, how will the world look like in 25 years. This can either be a positive, optimistic scenario. Or it can be a negative, pessimistic scenario. Make an impression of both situations, visualising a the future of a totally non-circular world in the first scenario, and a totally circular world in the second scenario. See how those scenario's mirror each other. What are the elements that radically different in each scenario, and what are the elements that are the same? You can use the elements of the PESTLE analysis to make your scenarios. PESTLE is an abbreviation for Political factors, Economic factors, Social-cultural factors, Technological factors, Ecological factors and Legal factors. Others use the DESTEP abbreviation, where the D includes the Demographic factors (and Polital and Legal are then combined). What can you learn from this comparison, and what do you think are the most important elements to change the future in the prefered direction?



Exercise G1-2 - Multilevel Design Model (MDM) exercise

-Take the worksheet “MDM Worksheet 2 columns”. The worksheet shows a simplified version of the multilevel design model. The left column indicates the problem area, the right column indicates the solution area.

- Fill in the worksheet for your circular design project. On the left you describe the problem, which you could also call the challenge, or the issue that you are working on. If you prefer to work from bottom to top then you start with the smallest problem you are working on, after which you zoom out step by step to the social challenge of which that problem is a part. If you prefer to assess the problem from top to bottom, you can start with the societal challenge to which you want to contribute with your circular design project, after which you gradually zoom in on the concrete circularity problem that you want to solve.

- On the right you describe the circular design solution you have developed. If you prefer to work from bottom to top, you can start with the new circular product you have come up with, after which you zoom out step by step to the circular product-service system or the circular business model of which your circular product is a part, to the socio-technical system of which it is a part, to the ideal circular society that you eventually try to realize. If you prefer to work from top to bottom, you start with your vision for the ideal circular society, after which you zoom in step by step on the specific socio-technical system you are working on, on the product-service system or business model, on the circular product you have developed.

- Once the model has been completed, you can check whether there is a logical relationship between the problems you have described in the left-hand column and the solutions that are listed in the right-hand column. Does the ‘solution’ in the right column indeed solve the ‘problem’ in the left column? And is there a logical relationship between the problems at the different system levels in the left column, and the solutions at the different system levels in the right column?

Note: The definition of the different system levels is not absolute, but depends on the scale of the specific project you are working on. For a nano-researcher, a grain of sand may be the highest system level of a multilevel model, in which the grain of sand can be subdivided into crystals or molecules, which in turn are composed of atoms, which in turn are composed of protons and electrons. On the other hand, for an astronomer, a planet may be the smallest level of a multilevel model, where that planet is part of a solar system, which in turn is part of a galaxy like our Milky Way.

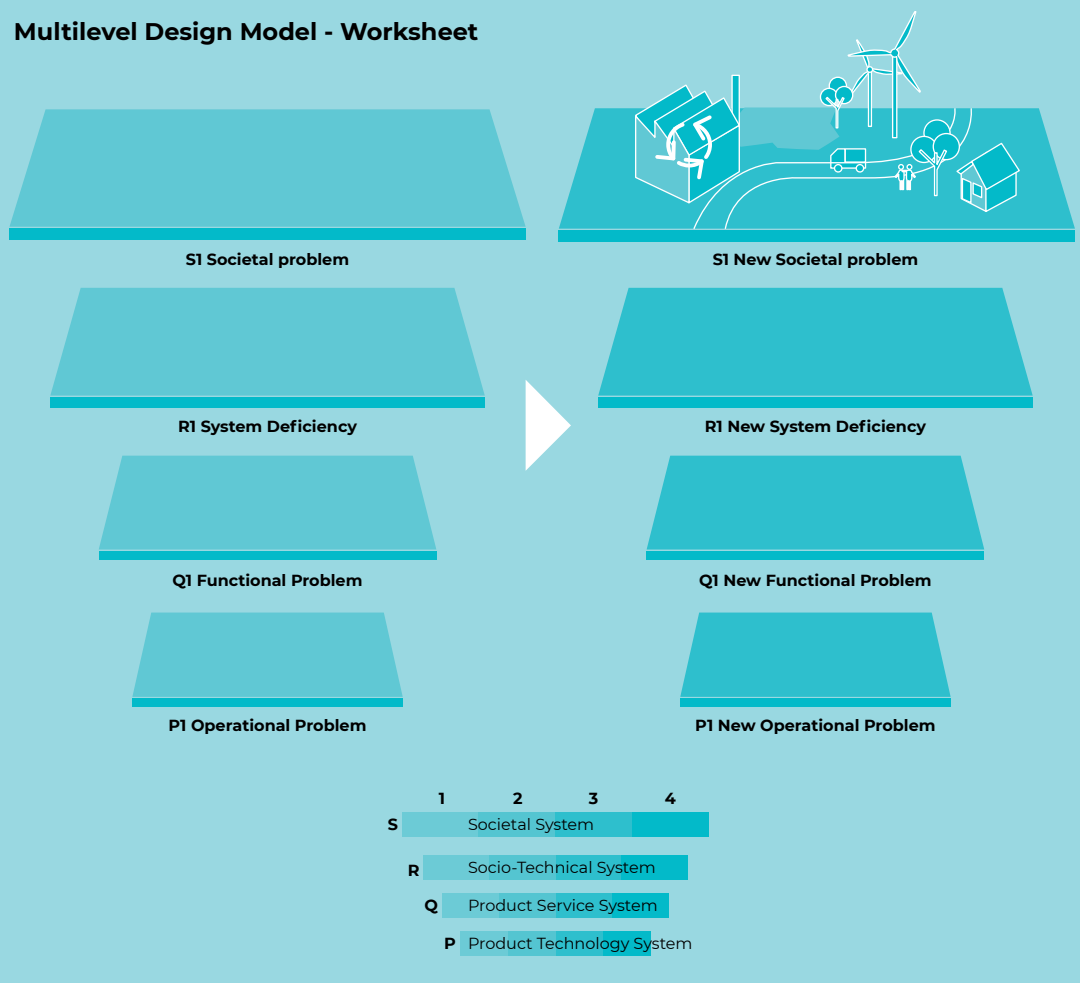


Figure G1-4: MDM Worksheet 2 columns

Module Programme

HOURS	TOPIC
BLOCK 1 1h	A presentation is given about systems thinking and the need for a systems perspective in circular design.
2h	Utopia/Dystopia exercise 1
BLOCK 2 1h	A presentation is given about the Multilevel Design Model (MDM). A general outline of the MDM is presented, important aspects of the systems thinking approach are addressed, and characteristics of the MDM, how to use it, and supporting tools are discussed.
2h	Multilevel Design Model exercise 2

Key actions

- Mapping the political, economic, socio-cultural, technological, environmental, demographic and technological developments relevant to the issue under consideration.
- Making an overview of the relevant stakeholders, seen from the initial situation of the project. This can be either organisations or individuals. Exploring and naming the interests of the stakeholders in the initial situation of the project.
- Identifying the existing relationships (e.g. organisational, financial, power and other relevant stakeholder relationships).
- Determining on the basis of these overviews which stakeholders should be involved in the development process.

Methods and tools

- Multilevel Design Model
- PESTLE factor analysis
- Utopia/Dystopia Canvas

Literature

P. Joore, H. Brezet. A Multilevel Design Model: the mutual relationship between product-service system development and societal change processes. (2015) Journal of Cleaner Production 97 (92-105)

F. Geels The dynamics of transitions in socio-technical systems: a multi-level analysis of the transition pathway from horse-drawn carriages to automobiles (1860–1930) Technol. Anal. Strateg. Manag., 17 (2005), pp. 445-476

B. Elzen, F. Geels, K. Green (Eds.), System Innovation and the Transition to Sustainability: Theory, Evidence and Policy, Edward Elgar Publishing Ltd (2004)

EXAMPLE COURSE SCHEDULE	DAY 1	DAY 2	DAY 3			DAY 4			DAY 5
	INTRODUCTION MODULES	GENERAL MODULES	TRACK MODULES			TRACK MODULES			GENERAL MODULES
			SOCIETY	STRATEGY	TECHNOLOGY	SOCIETY	STRATEGY	TECHNOLOGY	
30min	Opening	Warm up	Track intro	Track intro	Track intro	Track intro	Track intro	Track intro	Warm up
1:30h	**Circular economy (I-1)**	Systems Thinking **(G1-1)**	Change & Transition **(T1-1)**	Business Model Design **(T3-1)**	Material Flows & Production **(T5-1)**	Change & Transition **(T1-2)**	Business Model Design **(T3-2)**	Material Flows & Production **(T5-2)**	Systems Thinking **(G1-2)**
1:30h		**Stakeholders & Collaboration (G2-1)**							**Stakeholders & Collaboration (G2-1)**
30min	Lunch	Lunch	Lunch	Lunch	Lunch	Lunch	Lunch	Lunch	Lunch
1:30h	Design for Circular Economy **(I-2)**	Policy, Legislation & Standardization **(G3-1)**	Social Design **(T2-1)**	Product-Service design **(T4-1)**	Product Design **(T6-1)**	Social Design **(T2-2)**	Product-Service design **(T4-2)**	Product Design **(T6-2)**	Policy, Legislation & Standardization **(G3-2)**
1:30h		Life Cycles, Assessment & Evaluation **(G4-1)**							Life Cycles, Assessment & Evaluation **(G4-2)**
1h	Discussion	Wrap-Up & Track Overview	Wrap-Up	Wrap-Up	Wrap-Up	Wrap-Up	Wrap-Up	Wrap-Up	CLOSING DRINKS

G2. Stakeholders and collaboration

This module introduces co-creation and collaboration among stakeholders and different ways of defining stakeholders as well as methods and tools for collaboration at different stages of a project.

Learning outcomes
After this module, participants will be able to...

1. Identify relevant stakeholders in relation to a design problem
2. Integrate the values and views of the stakeholders in the design process and outcomes
3. Reflect on the main theories, methods and tools for effective co-creation and collaboration
4. Engage relevant stakeholders in a circular design process
5. Organise a stakeholders workshop
6. Apply group facilitation techniques.

Related concepts
Co-creation, co-creation workshops, conflict resolution, cooperation, creative facilitation, cross-cultural collaboration, cultural differences, effective communication, empathy, leadership, negotiation, participatory methods, project management, stakeholder engagement, stakeholder workshops, team building, team evaluation, teamwork, user research

Participation and Collaboration in Design: A Little History
Participatory design emerged back in the 80s in the Nordic countries in workplace studies. The purpose was to democratically include stakeholders affected by design outcomes and enable them decision making processes early on during the design process.

Over the years, the method evolved to include other stakeholders - in addition to users - to facilitate know-how sharing and initiate problem solving through collaboration, acknowledging the insights of each stakeholder as important and necessary. Over the last decade, users' potential in innovation was further investigated, giving more insights on lead-user innovation. Furthermore, the innovation processes have become more and more open for participation, ways of collaboration beyond the immediately available stakeholders being explored through approaches like open innovation. These approaches blur the lines among stakeholder roles, as the design of products began to involve many stakeholders other than professional designers. It is important to understand these processes of collaboration and co-creation to enable a more inclusive design process and democratise product development. In this module, ways of collaborating with different stakeholders at different stages of the design process will be discussed.

Understanding Material Flows and Involved Stakeholders
All Circular Economy strategies (see I2-Design for Circular Economy)) require a holistic understanding of the product life-cycle and material flows, as well as all the stakeholders involved, their roles in this process and the way they do and can carry out those roles.

Circular design is not only the design of products, but also the design of whole systems with existing and potential stakeholders to create innovative, environmentally sustainable solutions. In the Circular Economy diagram you have studied before in I1 - Circular Economy module, you have seen four generally involved stakeholders in relation to the strategies: parts manufacturers, products manufacturers, service providers and users.

These stakeholders were defined for their primary roles there (e.g. parts manufacturers are primarily involved in producing parts). However, there are other stakeholders mentioned in the previous section (e.g. recycling facilities, raw material producers, bio-chemical experts, etc.). In addition, the ways these stakeholders carry out their roles have fundamental effects on later stages (e.g. the way a parts manufacturer produces parts affects the recycling of them). Table G2-1 presents an extended table of stakeholders with the strategies they are potentially responsible for.

	Waste management	Waste Biochemical experts / Labs	Waste Renewable material producers	Users	Service providers	Product manfacturers	Part manufacturers	Recycling Facilities
Mantain & Prolong			■	■	■	■	■	
Reuse & Redistribute			■	■	■	■	■	
Refurbish & Remanufacture			■	■	■	■	■	
Recycle	■			■	■	■	■	■
Cascades			■	■		■	■	
Biochemical extraction	■	■	■	■				
Return to biosphere	■			■				

Table G2-1. Stakeholders affecting the circular economy strategies

As can be seen in Table G2-1, every stakeholder has the potential to affect different strategies. For example, the way a product manufacturer assembles parts affects their potential to be reused, refurbished and recycled. Similarly the way renewable material producers process biological materials affects cascading and biochemical extraction. What is important for circular design is to identify and define every stakeholders potentially involved in the life-cycle of a product through collaboration, and re-imagine the whole system through defining intervention points.

Defining stakeholders

In this module, ways of identifying all affecting and affected stakeholders for your design project will be introduced. While anybody affecting or affected by a design outcome is considered a stakeholder, in design projects the primary stakeholders are considered to be producers, designers and users. Their relations are depicted rather straightforward as well:

1. Producers hire designers and produce and sell the design outcome
2. Designers translate user demands into design outcomes
3. Users provide designers with insights and purchase the products.

This very reductive perspective on stakeholders and their roles has started to change in recent years in two ways. The first is that there are many more stakeholders directly or indirectly affecting the products. Secondly their involvement in the product development process contributes to understanding limitations and opportunities at every level (see G-1 Systems Perspective) as long as they can communicate, exchange knowledge and co-create solutions. To this end, you will need to identify the stakeholders directly and indirectly affecting your product. Figure G2-1 provides an example, placing directly affecting ones in the inner circle and indirectly affecting ones in the outer circle for a typical product development process. However, it should be noted that the placements do not indicate a hierarchy among them.

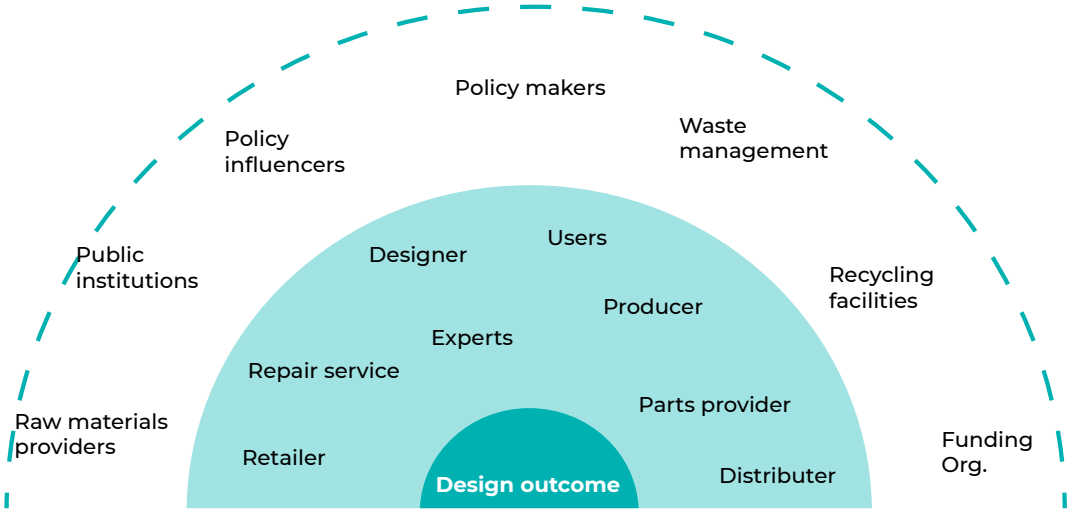


Figure G2-1. An example of stakeholders directly and indirectly affecting and affected by a design outcome

The second way our perspective has changed about stakeholders is the emergence of hybrid roles among these stakeholders and interchanging responsibilities. With the rise of the D.I.Y. movement back in the 1970s, the emergence and increased accessibility of digital desktop manufacturing tools like 3D printers and laser cutters in 36 fabrication labs and makerspaces, as well as Web 2.0 technologies and user-generated content online, a radical shift towards end-users undertaking design and production processes. These hybrid roles require different aspects to be considered, e.g. users' skills and fabrication capabilities, digital and physical tools for designing products, which can only be introduced into the product development process through collaboration. Similarly, these hybrid roles may lack more advanced knowledge, skills and resources required for product development, which may only be compensated through collaborative processes.

Reconciling Differences: Designing a stakeholder workshop
Co-creation workshops are common tools to initiate conversations among various stakeholders around a design problem, to reconcile different perspectives and to explore opportunities. Differing backgrounds of stakeholders and their different Interests, capabilities, terminologies,

experiences, contexts, etc. are generally tacit and opaque, and may not be readily stated by them. Bringing these stakeholders together and initiating a constructive conversation among them requires facilitation to unfold their tacit knowledge.

There are many methods, tools and techniques for facilitation, addressing collaboration at different stages of the design process. Therefore, prior to selecting tools and methods, the following should be decided:

1. Purpose: It is important to clearly state the purpose of any session, and the goal(s) should be achievable.
2. Participants & their expectations: Which stakeholders are needed for the specified goal(s) of the workshop? How diverse are their backgrounds? What motivates them to participate in this co-creation workshop?
3. Duration: How much time can stakeholders spare for this workshop?
4. Expected Outcomes: Parallel to the specified goals, what kind of outcomes do you expect?
5. Resources: What kind of resources (i.e. human, monetary, other) do you have to conduct this workshop?

The next step is structuring the co-creation workshop and deciding on methods and tools to utilise. There are many tools and techniques available online, and every method and tool can be adapted to the purpose of your workshop. Below, some tools and techniques that can be used in a co-creation workshop are introduced:

- **Group Discussions** are (semi-) structured communicative settings where participants express their opinions and views, share their experiences and discuss possible actions on certain topics.
- **Appreciative Inquiry** is an approach to understand what works best within processes and explore how those can further improved via a stakeholder workshop setting, it would enable participants to discover the best in their practices and envision even better versions of those processes into the future.
- **Context Mapping** is a generative technique for participants to explore the use context of products and services, and to reveal the tacit knowledge about their use. It can be especially useful for exploratory workshops and inspire novel ideas.
- **Customer Journey Mapping** is a narrative approach to map users' experiences with certain products and services, and enables the assessment of the features of them. Initially emerged as a marketing technique, it can be adapted for other purposes to make sense of
- **Stakeholder Mapping** is about identifying key stakeholders in decision making, stakeholders directly or indirectly affecting and affected by the design outcome. Through mapping how each stakeholder affects and is affected by the design outcome, your participants can identify their own levels of involvement. user experience.

Exercise G2-1 - Design a stakeholder workshop

For this exercise, you are asked to design a co-creation workshop with your stakeholders with the general purpose of (1) clarifying your goals, (2) building your group of stakeholders, and (3) gathering insights and unravelling tacit knowledge.

First, you will need to:

1. identify your project goals
2. decide on who to invite to your workshop and why
3. set a duration for your workshop
4. assess your resources
5. define what you expect from this workshop

Upon deciding on these, you will need to select methods and tools to facilitate knowledge exchange and cocreation within this diverse group. You can use the above mentioned tools and methods. In addition, you can use online educational resources like Frog Collective Action Toolkit (available in the OER). You should get feedback on the design of your workshop, finalise it and implement it in real life. Do not forget to document your workshop! The next part of this module will start by interpreting the outcomes of your first co-creation workshop.

Collaborative Assessment and Creating an Implementation Plan
In the first part of this module, you were introduced to collaboration and co-creation, and some tools and methods to facilitate a workshop. You designed a co-creation workshop and conducted it in real-life. You should have enough information to define main opportunities and barriers around your project, as well as more detailed goals for your project.

The next stage is about collectively generating ideas to achieve your goal(s), assessing them, selecting the most prominent one, and devising an implementation plan to realise it. There are many idea-generation tools that can be used collaboratively, some are introduced below:

- **Brainstorming** is a group creative technique in which participants are expected to generate as many spontaneous ideas as possible. The ideas do not need to be thought-through or exceptional, and the purpose is to create as many ideas as possible.
- **Storyboarding** is about illustrating the steps of a narrative, and is used in design discipline as a way of communicating how designs are used. Collaboratively creating narratives and storyboards can help your participants to generate more refined ideas and assess them.
- **Brainwriting** is another group creative technique, where individual participants write or draw their ideas, and pass it on to the next participant, who then develops the idea further. After a few rounds, the participants end up with many, relatively mature ideas
- **Role Playing** is a quick technique to evaluate ideas, where the participants assume certain roles and test them out using mock-ups. Although it is not absolutely necessary, using props can improve the effectiveness of the technique.

With these tools, your stakeholder group can reconcile and integrate differing values and opinions, and create innovative ideas for the goals of the project. The following stage would be assessing these ideas and selecting the most prominent one for realization. Selecting ideas may be challenging for your stakeholder group and may require additional the involvement of additional stakeholders. You might need to re-define your project's goals and refine your ideas upon their inclusion to the project. Finally, when everybody is content with the re-defined goals and refined idea, you need to plan for its implementation.

Exercise G2-2 - Co-design and plan

For this exercise, you are asked to design another co-creation workshop with your stakeholders, building upon the outcomes of the first one and with the purpose of (1) generating ideas and bringing them to maturity, (2) assessing the prominent ideas and selecting the most prominent one, and (3) creating an implementation plan and task division. While preparing this co-creation workshop, do not forget the basics (i.e. project goals, participants, duration, resources, expected outcomes). You can use idea-generation tools introduced in this module, or online educational resources like Frog Collective Action Toolkit (see OER).

You should get feedback on the design of your workshop, finalise it and implement it in real life. Do not forget to document your workshop by recording audio and video and taking notes throughout!

Module Programme

HOURS	TOPIC
BLOCK 1 1h 30min	Lecture: Participation and Collaboration in Design
	Exercise G2-1: Design a stakeholder workshop
BLOCK 2 1h 30min	Class discussion: Outcomes of your workshop
	Lecture: Participation and Collaboration in Design
	Exercise G2-2: Co-design and plan

Key Actions

- Identify the stakeholders that are directly and indirectly affecting and affected by the future design outcome.
- Develop and design a stakeholder workshop to reveal the roles of these stakeholders and the ways they can collaborate on the design and development process, and the barriers and opportunities for this project.
- Develop another stakeholder workshop to collaboratively assess these barriers and opportunities and create an implementation plan for the design process.
- Further develop the design brief you developed in I2- Design for Circular Economy according to the outcomes of the workshop.

Methods and Tools

- Frog Collective Action Toolkit.
  Link: https://www.frogdesign.com/work/frog-collective-actiontoolkit
- IDEO DesignKit - Human-centred Design Toolkit.
  Link: http://www.designkit.org/
- Participatory Methods (by the Institute of Development Studies, University of Sussex). Link: http://www.participatorymethods.org/

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EXAMPLE COURSE SCHEDULE	DAY 1	DAY 2	DAY 3			DAY 4			DAY 5
	INTRODUCTION MODULES	GENERAL MODULES	TRACK MODULES			TRACK MODULES			GENERAL MODULES
			SOCIETY	STRATEGY	TECHNOLOGY	SOCIETY	STRATEGY	TECHNOLOGY	
30min	Opening	Warm up	Track intro	Track intro	Track intro	Track intro	Track intro	Track intro	Warm up
1:30h	**Circular economy (I-1)**	Systems Thinking **(G1-1)**	Change & Transition **(T1-1)**	Business Model Design **(T3-1)**	Material Flows & Production **(T5-1)**	Change & Transition **(T1-2)**	Business Model Design **(T3-2)**	Material Flows & Production **(T5-2)**	Systems Thinking **(G1-2)**
1:30h		Stakeholders & Collaboration **(G2-1)**							Stakeholders & Collaboration **(G2-1)**
30min	Lunch	Lunch	Lunch	Lunch	Lunch	Lunch	Lunch	Lunch	Lunch
1:30h	Design for Circular Economy **(I-2)**	**Policy, Legislation & Standardization (G3-1)**	Social Design **(T2-1)**	Product-Service design **(T4-1)**	Product Design **(T6-1)**	Social Design **(T2-2)**	Product-Service design **(T4-2)**	Product Design **(T6-2)**	**Policy, Legislation & Standardization (G3-2)**
1:30h		Life Cycles, Assessment & Evaluation **(G4-1)**							Life Cycles, Assessment & Evaluation **(G4-2)**
1h	Discussion	Wrap-Up & Track Overview	Wrap-Up	Wrap-Up	Wrap-Up	Wrap-Up	Wrap-Up	Wrap-Up	CLOSING DRINKS

G3. Policy, legislation and standardization

Economical systems have largely linear resource use by design, resulting in avoidable environmental and human health impacts, inefficient use of natural resources and over-dependency on resources that are not locally available. Moving to a circular economy would alleviate these pressures and concerns, and deliver economic, social and environmental benefits.

However, moving towards a resource-efficient, low-carbon economy is partly dependent on adopting adequate policies (for other elements see module G1). Strategies for a circular and low-carbon economy are linked and can support each other through more efficient use of natural resources. This in turn means that links between resource use and energy, water and biodiversity also will need attention. (EEA, 2016b)

Learning outcomes
Participants will be able to...
1. Explain the main policy and legislation regarding circular design
2. Explain the main idea behind EC action plan for circular economy
3. Access relevant policies for a given design context
4. Identify what parts of policy and legislation applies to their operational context
5. Translate policy and legislation into action plans for their organisation
6. Develop designs/production processes/business ideas that are in line with current and upcoming CE policy and legislation.

Related Concepts
Circular procurement, climate laws, competition regulations, consumer regulations, emissions, enforcement, environmental taxes, European policy, externalities, financial guarantees, financial regulations, fiscal frameworks, Green Deal, industry regulations, ISO 14000, ISO 26000, material regulations, national policies, Paris agreement, policy making, product passports, product regulations, provisions, REACH, regulatory frameworks, Rio Declaration on Environment and Development, subsidies, trade regulations, warranties, waste regulations

Circular Economy in Europe
In May of 2015, the European Commission presented the Circular Economy Package. It demonstrates clear signals to economic operators that the EU is using all the tools available to transform its economy, opening the way to new business opportunities and boosting competitiveness.

The Circular Economy package is expected to help European businesses and consumers to make the transition to a Circular Economy. It is composed by "Closing the loop - European Action Plan for the Circular Economy", a broader action plan with 54 concrete actions with timetable and a monitoring section, and a legislative proposal on waste management and recycling updating key waste sector Directives that has been adopted in July 2018.

The EC plans and measures cover the full lifecycle: from production and consumption to waste management and the market of secondary raw materials. Also, they aim to extract the maximum value and use from all raw materials, products and waste, fostering energy savings and reducing greenhouse gas emissions. This paradigm change plan, includes collaboration and government commitment at the national, regional and local levels.

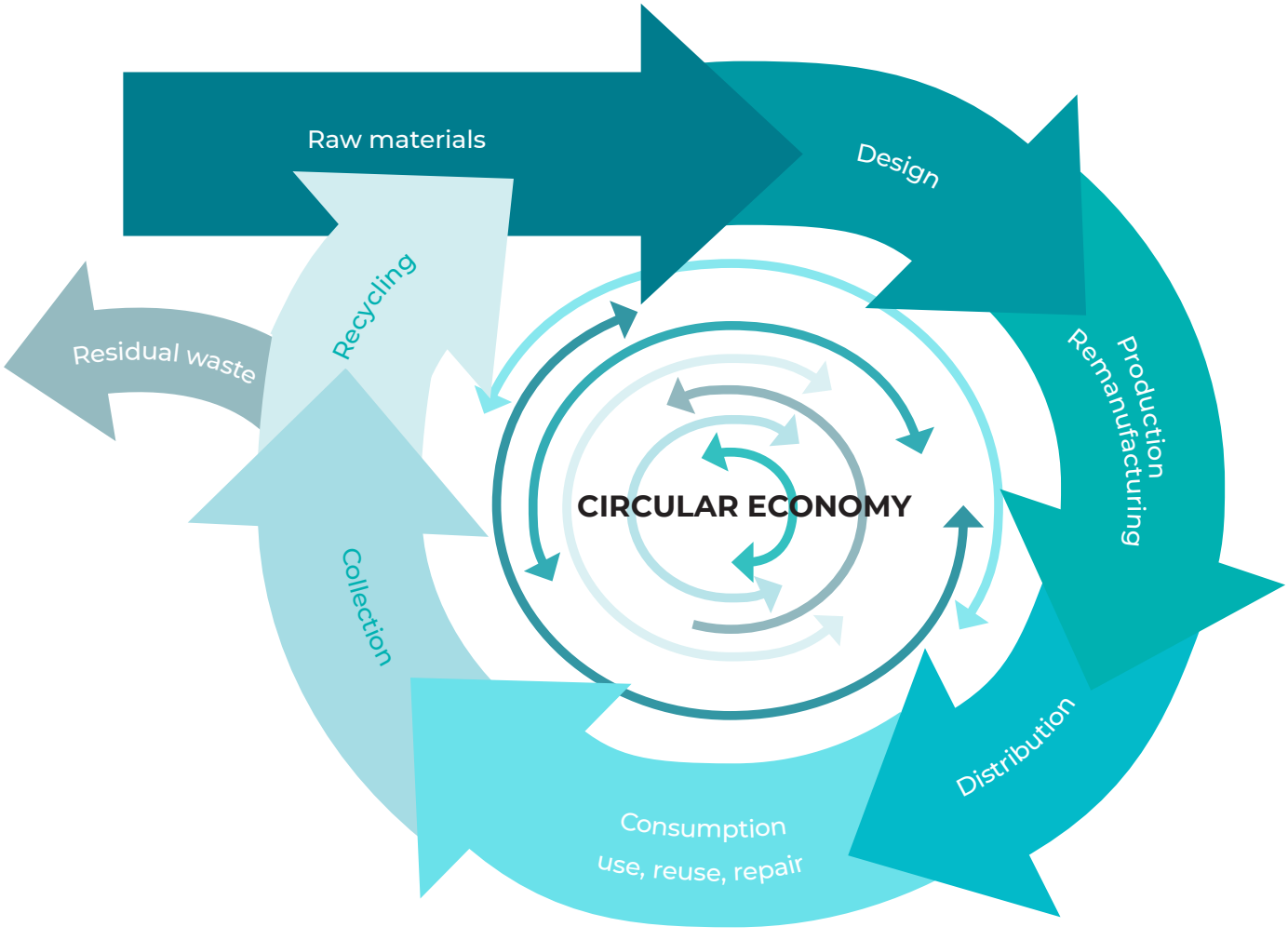

Figure G3-1. Circular Economy System Diagram
(Source EC's Circular Economy Package)

- **Production:** The objectives are focused on providing incentives to boost circular product design and to develop innovative and efficient production processes. The Production Key actions would be to implement and put in normalising the reparability, durability and recycling in the production process. To achieve best practices for waste management and resource efficiency in industrial sector and finally to create industrial symbiosis.

- **Consumption:** Repair and reuse of products to avoid waste generation and provide consumers with reliable information on environmental impact of products are the main objectives. In order to achieve them, eco-design is crucial to allow the availability of spare parts and encourage reuse activities. A better labelling will avoid the false green claims and independent testing programmes will assess possible planned obsolescence.

- **Waste Management:** To improve waste management in line with the EU hierarchy and to provide long-term vision and targets to guide investments. Legislative proposals on waste will be prepared, an example is the EU Strategy for Plastics in a Circular Economy that proposes concrete actions designed to make the vision for a more circular plastics economy a reality. Also it is important to work with EU Member States to improve waste management plans, including to avoid overcapacity in residual waste treatment (incineration and mechanicalbiological treatment).

Plastics
The EU Strategy for Plastics in a Circular Economy will tackle the issue focusing the strategy on four areas;
- To improve the economics and quality of plastics recycling,
- To curb plastic waste and littering,
- To drive investments and innovation toward circular solutions and finally harness global action.

To achieve that, the objectives are:
1. Revision of waste: setting a new target of 55% recycling of plastic packaging waste by 2030.
2. Plastic Bag Directive: to reduce consumption to 90 bags per person by 2019 and 40 bags by 2026.
3. Eco-Design Working Plan: Improving product design to address durability, reparability and recyclability.
4. Marine Strategy Framework Directive: Member States obliged to monitor and reduce their marine litter.

As part of this Marine Strategy, in May 2018 a Ban on 10 groups of single-used plastic products was announced by the European Commission, including plastic cotton buds, cutlery, plates, straws, drink stirrers and balloon sticks. Additional measures for food containers, drink cups, wrappers, cigarette buds, lightweight plastic bags and drink bottles were announced as well. The ban will be effective in 2021.

Thus, challenges linked to the production, consumption and end-of-life of plastics can be turned into an opportunity for the EU and the competitiveness of the European industry.

Secondary raw materials
Secondary raw materials: The Circular Economy system creates a market for secondary raw materials. For make it works, the increase of use of secondary raw materials is precise, as well as the use of recycled nutrients and treated wastewater.

In a legislation scale, quality standards and minimum requirements for secondary raw materials have to be defined for each specific area, considering the EE-wide electronic system, for cross-border transfer of waste.

Demand for many Critical Raw Materials is growing in various sectors and the contribution from recycling is largely insufficient to meet the demand.

The Action Plan on Circular Economy set out to issue a report where a list of 27 Critical Raw Materials were established at the EU level (table G3-1). The list contains raw materials which reach or exceed thresholds for both economic importance (export restrictions and the EU trade agreements) and supply risk (mining/extracting and processing/refining).

Critical Raw Materials			
Antimony	Fluorspar	LREEs	Phosphorus
Baryte	Gallium	Magnesium	Scandium
Beryllium	Germanium	Natural graphite	Silicon metal
Bismuth	Hafnium	Natural rubber	Tantalum
Borate	Helium	Niobium	Tungsten
Cobalt	HREEs	PGMs	Vanadium
Coking Coal	Indium	Phosphate rock	

Table G3-1. The 2017 List of Critical Raw Materials to the EU (HREEs = Heavy Rare Earth Elements 10, LREEs = Light Rare Earth Elements 11, PGMs = Platinum Group Metals 12)

In order to tackle the problem, Member States should take measures to achieve the best possible management of waste containing significant amounts of Critical Raw Materials, prevent products constituting the main sources of these materials from becoming waste and include in their waste management plans nationally appropriate measures regarding collection and recovering of waste

Innovation, Investment & Monitoring:
A diverse group of initiatives and programs are being developed to create the right environment for innovation and investment for the Circular Economy. The Horizon 2020 initiative launched on “industry 2020 in the Circular Economy” (budget 650 million) could be an example. There is also, a Pilot “innovation deals” to address potential regulatory obstacles for innovators and a targeted outreach of EU funding for SMEs. The monitoring European framework of Circular Economy is still being developed. It is important to assess whether sufficient actions have been taken and to set new priorities towards the long-term objectives of CE.

Also, they can help to identify success factors in Member States and to understand the various element of CE are developing over time. By the time, some Circular Economy indicators are available in the Eurostat Website that provide information of each Member State about production and consumption, waste management, raw materials and competitiveness and innovation. Another type on monitoring is the materials flow diagram. It shows all raw material; how they enter, flow and (eventually) leave the EU.

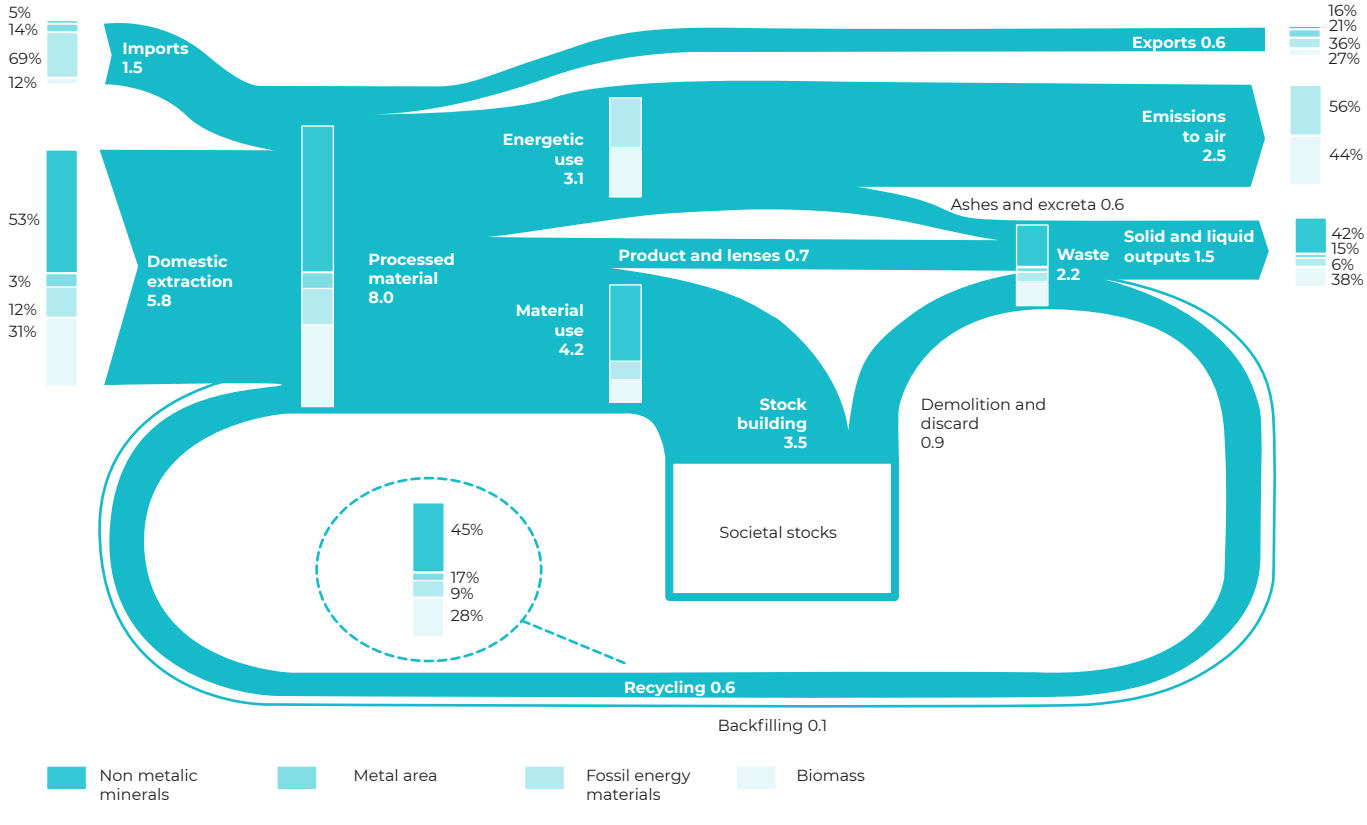

Figure G3-2. Material flows in the economy (EU-28,2014).

Figure G3-2 presents an overview of material flows in Europe in 2014. We can see that a very small percentage of materials re-enter the system as recycled materials. These aspects point to a significant potential for improvement in particular by increasing the share of materials recycled as secondary raw materials and decreasing the production of waste.

As mentioned earlier, the monitoring European framework of Circular Economy is still being developed. For that reason, the Commission will be improving the knowledge base and data availability. Also, it will harmonise the methodologies for calculating recycling rates and funding several research projects that will deliver better data to complement the official statistics. In the academic world, there is not one universally recognized indicator of "circularity" yet, but on individual company scale, eco-design tools and assessments can be applied.

The Circular Economy in the 4 hubs

Catalunya, Spain

The Circular Economy Spanish Strategy is currently being prepared but there is already a pact signed by more than 300 economic entities where they undertake the commitment to promote the transition to the Circular Economy. However, at a regional level, Catalunya developed its own Green Economy and Circular Economy Strategy that boost the business creation, entrepreneurship and internalization. In figure G3-3, the main business opportunity areas are noted.

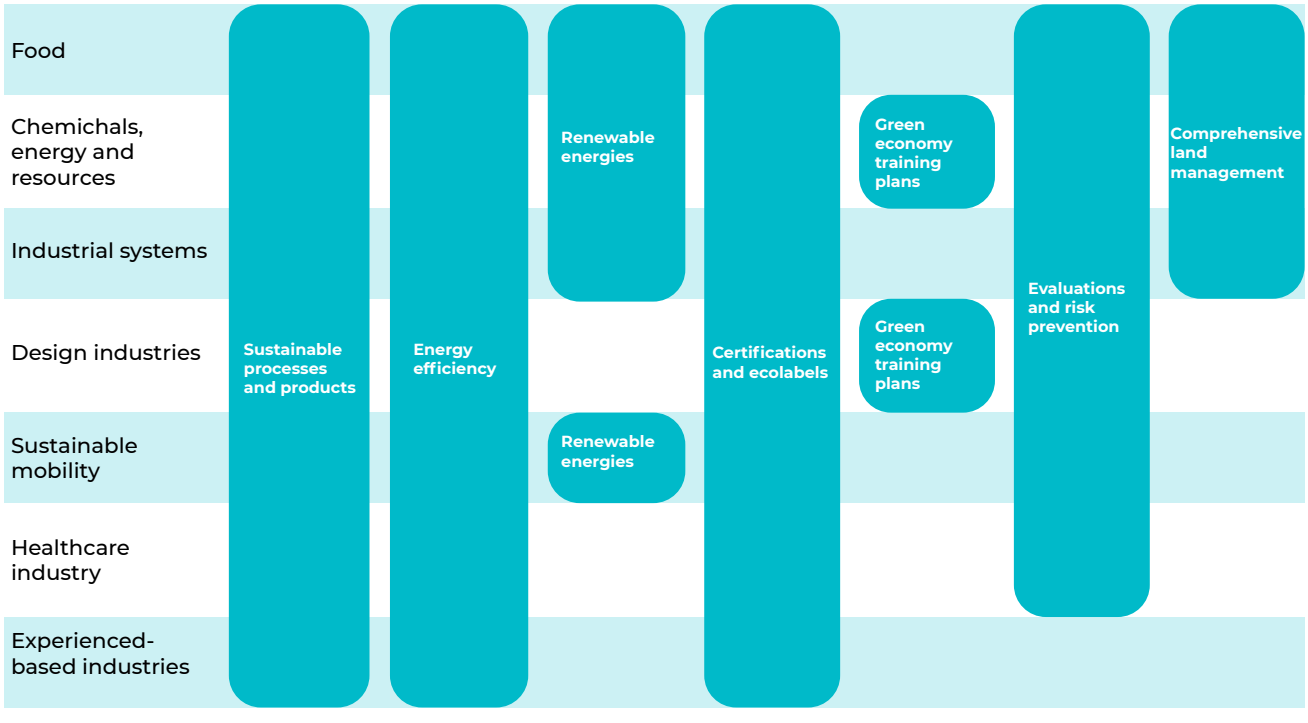

Figure G3-3. Main businesses opportunity areas for Circular Economy (Generalitat de Catalunya, 2015, Impuls a la economia verda i circular)

The opportunity areas criteria for Circular Economy businesses are based on the resources efficiency, smart and clean technologies, the environmental and human health impact reduction and the production of more sustainable products and services that generate added value, wealth and land employment.

The policies to convey this economy transition are:

- Demand generation and market making
- To boost the internalisation
- Promotion of employ creation and entrepreneurship
- To improve access to finance
- To impulse Research, development and innovation

Friesland, The Netherlands

Encouraged by the global problem of population and consumption growth, The Netherlands has the objective of a 50% reduction in the use of primary raw materials (minerals, fossil and metals) by 2030, and converting the Dutch economy into a sustainable-driven and fully circular economy by 2050.

The plan “A Circular Economy in the Netherlands by 2050” deploys five instruments for the priority sectors (biomass and food, plastics, manufacturing industry, construction sector, consumer goods):

1. Fostering legislation and regulations: the goal is to remove regulatory barriers and to develop legal frameworks that encourage innovation, promote dynamics and support investments.
2. Intelligent market incentives: this intervention is intended to promote the demand for recyclates and biobased materials, to stimulate circular business models and reinforce the national and international markets for these types of raw materials.
3. Financing: Investments in circular products and services have a different risk profile, depreciation periods and cost-benefit balance. There is a demand for insight into a wider social cost-benefit balance and active support for circular business models.
4. Knowledge and innovation: The development of knowledge (education and research) are essential for the desired transition. The objective is to provide those who play a central role in society with the information required to take decisions.
5. International cooperation: The transition to a Circular Economy is an international challenge that requires a radical change in global production and consumption patterns. Thus, the objectives are creating international conditions for a circular economy, to export the Dutch knowledge and expertise abroad by circular business and to contribute to an international circular economy without negative impact on low-income countries.

For a number of key sectors and areas, specific Circular ‘National Transition Agendas’ with clear targets are formulated. For instance, the Agenda for Plastics (2018) formulated a number of national ambitions: to reduce incineration of plastics with 44% from 1300 Kton to 740 Kton (2015-2030); increase the use of biobased plastics from 20 - 370 Kton; Reduce the use of virgin (fossil fuel based) materials from 1700 - 1090 Kton; increase mechanical recycling from 250 to 750 Kton and chemical recycling from 0 to 250 Kton. (figure G3-

Desired Situation Plastic Flows in the Netherlands (in Kt, simplified scheme)

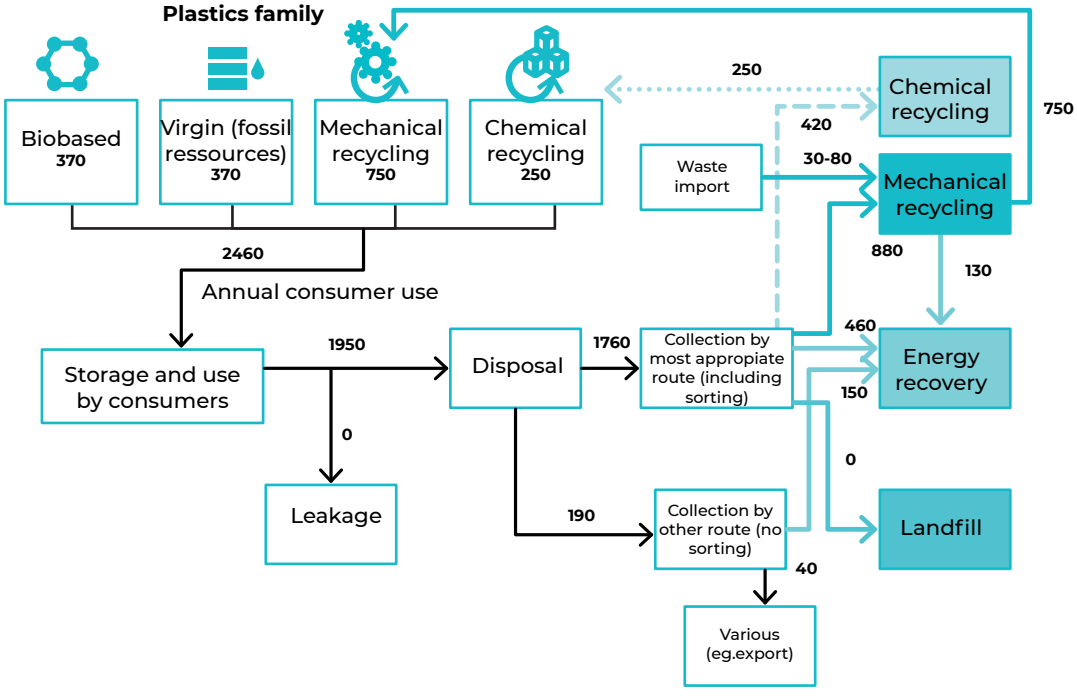

Figure G3-4: Plastic cycles in The Netherlands envisioned for 2030

The Province of Friesland in the North of the country is developing its own policy and initiatives based on these National policy directives. It wants to become a the most innovative region for circular economy of the country. Targets include:

- In 2020 the number of companies involved in CE has doubled
- In 2015 the Province purchases at least 50% of its goods via circular procurement (target will be revised in 2021 to see if it can be set higher)
- In 2025 the region belongs to the top three circular regions in Europe

For each of the key sectors specific action agendas are elaborated, in cooperation with all stakeholders of the sector. For Plastics the ambition of the Stakeholders involved is to eliminate incineration of plastics altogether (landfilling was already banned earlier) in 2025, thus reaching a circular system much earlier than the National ambitions. A detailed execution programme is provided for this.

Ireland

There is not a specific plan for the CE but The National Economic and Social Council (NESC) launched a research report on the circular economy in Ireland. Its purpose was to identify and document case studies of circular economy practices and also to examine some of the key enablers and barriers to their further development.

The research report concludes with recommendations on the transition pathways, enabling conditions, metrics and innovation system needed to progress the circular economy. In its consideration of the research work, the Council developed four broad reflections which are presented within the report:

- There is momentum in circular economy practices in Ireland but action is needed to build on the early advantage.
- The full potential of the circular economy for Ireland has yet to be identified.
- The meaning and nature of the circular economy needs to be understood more widely.
- The development of the circular activity requires a holistic and strategic policy approach so as to maximise opportunities.

However, there are other plans and strategies in Ireland that support the Circular Economy by similar concerns. An example could be The National Policy Statement on the Bioeconomy which encourages to achieve a sustainable economy and society, the decarbonisation of the economy, to foster new jobs and competitiveness and to ensure regional prosperity. All of this seeking the efficiency and reuse of raw materials, the reduction of greenhouse emissions, the innovation in industry and eviting the rural decline. Also, Ireland is running the Project Ireland 2040 and the National Waste Prevention Programme (NWPP), a suite of elements continued to evolve to reflect the changing economic and policy context around waste prevention and the circular economy (see figure G3-5).

Figure G3-5. EPA, 2017, The National Waste Prevention Programme (NWPP)

Sweden
The Swedish goal is to be fossil free by 2040. Its government realizes that a circular, bio-based economy is one of the keys to achieve this goal. There isn't a specific plan for Circular Economy but the government launched some other strategies that boost Circular Economy and for a long tradition Swedish companies consider greater demand for green products, good business partners, and the availability of technology and leadership to be important driving forces for investment in eco-innovation.

Furthermore, Sweden has been pioneer in its Tax incentives for repairs, an attempt to help steer the Swedish economy from a linear economy to a circular economy and redirect parts of the workforce from production of new products to repair and maintenance.

The Swedish Strategy for Sustainable Consumption (see figure G3-6) focuses on what the State can do, together with municipalities, the business sector and civil society, to make it easier for consumers to act sustainably. The focus areas are:

Figure G3-6. Government focus areas for sustainable consumption.
(Swedish Ministry of Finance. 2016. Strategy for Sustainable Consumption)

Apart of this strategy, there are various programmes and platforms that support the Circular economy by financing new businesses and initiatives and fostering the research and the innovation. Some examples are: Swedish Cleantech , Swedish Incubators & Science Parks (SISP), Vinnova and more.

Exercise G3-1

This case study presented is about a 50 cl PET bottle for water. Until now, in many countries there is no deposit for this bottle so it is usually thrown in the waste basket. Describe the current customer journey of buying, drinking and disposing of this bottle, and what happens with the bottle in the waste system.

Then describe possible customer journeys:

- For using the PET bottle but with a deposit, collection and recycling system
- For using a reusable personal bottle and fresh water tap points in the city

Describe what is needed in both new systems from the customer, from industry and from government.

Exercise G3-2

Participants are given a summary sheet of " Towards a circular products initiative' in the EU- Policy Participants are asked to go through the policy brief based and reflect on the two new product journeys that have been created in the first session. Identify which steps can be challenging or which designerly concerns have not been embedded in the policy brief.

Module Programme

HOURS	TOPIC
BLOCK 1	A presentation is given about the role of policy-making in circular design and the existing policies of circularity. The presentation ends with the explanation of the small assignment.
	A case study is given to the participants for them to go through.
	Based on this case, the participants are asked to create a product journey by using the given template.
	Participants present product journeys.
BLOCK 2	The instructor explains the second part of the exercise.

HOURS	TOPIC
	Participants are given a summary sheet of " Towards a circular products initiative' in the EU- Policy brief and perform exercise 2.
	Participants are asked to go through the policy brief based and reflect on the product journey that has been created in the first session. The idea is to identify which steps can be challenging or which designerly concerns have not been embedded in the policy brief.
	Participants present their ideas. The outcomes of the exercise are discussed.

Key actions

- Understanding the importance of policies that support circular development. Being able to assess the legislative limits of implementing a circular design in practice
- Obtaining a general knowledge on existing policies regarding circularity
- Being able to identify potential points of improvement in existing policies
- Being able to think of alternative scenarios that enable the standardization of circularity principles

Methods and tools

- Action points
- Case-study
- Product journey mapping
- Policy analysis

EXAMPLE COURSE SCHEDULE	DAY 1	DAY 2	DAY 3			DAY 4			DAY 5
	INTRODUCTION MODULES	GENERAL MODULES	TRACK MODULES			TRACK MODULES			GENERAL MODULES
			SOCIETY	STRATEGY	TECHNOLOGY	SOCIETY	STRATEGY	TECHNOLOGY	
30min	Opening	Warm up	Track intro	Track intro	Track intro	Track intro	Track intro	Track intro	Warm up
1:30h	**Circular economy (I-1)**	Systems Thinking **(G1-1)**	Change & Transition **(T1-1)**	Business Model Design **(T3-1)**	Material Flows & Production **(T5-1)**	Change & Transition **(T1-2)**	Business Model Design **(T3-2)**	Material Flows & Production **(T5-2)**	Systems Thinking **(G1-2)**
1:30h		Stakeholders & Collaboration **(G2-1)**							Stakeholders & Collaboration **(G2-1)**
30min	Lunch	Lunch	Lunch	Lunch	Lunch	Lunch	Lunch	Lunch	Lunch
1:30h	Design for Circular Economy **(I-2)**	Policy, Legislation & Standardization **(G3-1)**	Social Design **(T2-1)**	Product-Service design **(T4-1)**	Product Design **(T6-1)**	Social Design **(T2-2)**	Product-Service design **(T4-2)**	Product Design **(T6-2)**	Policy, Legislation & Standardization **(G3-2)**
1:30h		**Life Cycles, Assessment & Evaluation (G4-1)**							**Life Cycles, Assessment & Evaluation (G4-2)**
1h	Discussion	Wrap-Up & Track Overview	Wrap-Up	Wrap-Up	Wrap-Up	Wrap-Up	Wrap-Up	Wrap-Up	CLOSING DRINKS

G4: Life cycles, assessment & evaluation

Various methods and tools exist that can be used by designers to assess and evaluate the sustainability of designs. Designers can use these methods in different phases of the design process. They will help to identify opportunities for sustainability improvements and make sure that efforts are on target. Assessment and evaluation will either be done against pre-defined targets or a benchmark. Hence the setting of targets and/or selection of benchmarks are important factors in this module as well.

Learning outcomes
Participants will be able to...
1. Explain the main sustainability principles, goals, and values
2. Define clearly stated CE goals for a given design context
3. adopt a systems-thinking approach in a real design problem
4. Know the main methods and tools for the assessment and evaluation of sustainability
5. Define intervention points in product lifecycle to develop design solutions 6. perform a basic impact assessment of a product.

Related concepts
CE indicators, ecological footprint, ethics, fairness, LCA, impact assessment methods, material flow analysis, measurements levels, monitoring, responsibility, risk assessment, sustainability assessment and evaluation methods, stewardship, sustainability goals, sustainability indicators, sustainability measurements, sustainability targets, sustainability values, sustainable development

Values of the Supply Chain
In the stages of the closed loop supply chain four main values can be identified. The basic one is the source value, that refers to the direct cost reductions and savings. It embraces a range of actions and strategies (reuse, repair, refurbishing, remanufacturing and recycling) that create new markets and can reduce-cost of land filling and waste treatment, and also helps to avoid legal fees and taxes. This not only means to add a new action line in the supply chain or create secondary markets, a completely rethinking of the supply chain is key for improving closing loops. Once the source value is developed and placed, it has to be communicated to stakeholders and customers to create the environmental value, that is the reduction of the ecological footprint and the improvement of the green image. This might raise customer satisfaction and loyalty creating the customer value, making it easy for them to take part in the closed loop. The last, Information value, is often forgotten, but actually it is a big opportunity to analyse and assess the customer behaviour and the loop supply chain processes in order to improve them to more efficient and valuable circular economy system.

Assessment and Evaluation
Assessment and evaluation can be used at multiple stages during the innovation process. It can be used to assess a current situation, with current solutions offered by a company or their competitors. It can then help identify hotspots and or circular hurdles. Those hotspots and hurdles can subsequently be used to define goals and targets for a dedicated innovation project.

During that project, assessment and evaluation can be used to reflect on early ideas, to compare concepts and to validate final results. Assessments and evaluations can be undertaken for the purposes of decision making within the innovation team, to communicate within the organization, e.g. project leaders or bosses, and to communicate to external stakeholders, such as suppliers, clients, governments or citizens.

Both the phase of the project, as well as the intended audience of the assessment and evaluation will have an impact on the appropriate type as well as the extensiveness of a chosen method.

Goal setting
Circularity, like sustainability are to a certain extent holistic concepts. Making them measurable, almost automatically implies decomposing them into concepts that are more easily quantifiable. If the client and the innovation team share a vision with regard to which articulation of circularity they are striving for, measurable targets may not be required. In other cases, dedicated targets may be defined, but all involved should realize that those targets are just aspects of circularity or sustainability.

Benchmark selection

In most cases, a potential circular solution is intended to replace an existing system, which could for instance be a linear product, with no or limited cascading/downcycling of materials. In some cases it is obvious what is the benchmark against which to compare proposed new circular systems, in others this requires more careful work. It is important though to always carefully consider system boundaries of a comparison. For instance, redistributing a large batch of products to have them re-used as they are now, but by private individuals, might extract a valuable sizable material stream from a closed system, and make them end up, after limited extended use, in a landfill or waste incineration. Hence, zooming in and zooming out with regard of your proposed solution and the benchmark is sensible in determining the appropriate system boundaries.

Exercise G4-1 - Goals setting & selecting benchmarks

Define a (fictive) goal for your organisation, in the form of a circular solution. If you cannot identify a circular opportunity, or don not have an organization at the moment, just select a case where you have sufficient knowledge of products and value chains to run through the exercises. Subsequently, consider and select a (fictive) benchmark. Discuss in small groups what would be the appropriate system boundaries to compare the benchmark with the circular system you defined as a goal.

Life cycle assessment

The most common tool for sustainability assessment is Life Cycle Assessment (LCA). It maps all the material and energy going in (and out) of your product system, as well as emissions (see figure G4-1). These are subsequently mapped with regard to their contribution to a range of environmental impacts, such as climate change.

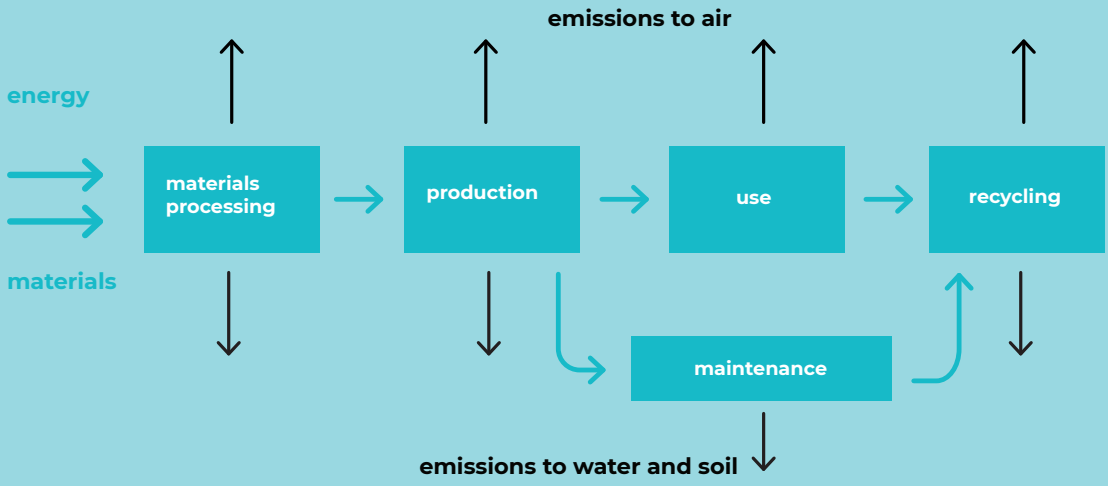

Figure G4-1: The basic calculation system of LCA (Vogtländer JG. A practical guide to LCA for students, designers and business managers, cradle-to-grave and cradle-to-cradle. VSSD: Delft, the Netherlands, 2010.)

Dedicated tools for assessing social aspects, or dedicated circularity aspects are under development, but do not have the sophistication yet of an environmental LCA. Exercise G4-2: Mapping most relevant indicators Looking at the impact categories of LCA, discuss in small groups which of those are most relevant in your industry. Do the same for social aspects.

There are multiple levels of sophistication of LCA, for instance in choosing to work with standardized datasets. Hence, an LCA can be as quick as a one-hour exercise or take months of work. What is appropriate depends on the audience of the outcome and the phase of the design process. Focusing on the quicker methods, options for working with standardized average data and using single indicator, such as carbon footprint will be discussed. Examples of assessments and evaluation at different phases of the design process will be provided.

Discussion 1: your own industry
In small groups, discuss the most relevant factors (environmental, social, circular) of your industry. Identify in which phases and for which audiences you might want to do assessments and evaluations. Try to identify methods and indicators most relevant for those needs. Circular indicators

Circular indicators
Specifically for circular economy, some indicators have been developed by Granta Design in collaboration with the Ellen MacArthur Foundation. These indicators mainly consist of a Material Circularity Indicator, which maps how restorative material flows are for a given case.

Exercise 3: circular flows
On print-outs of the CE butterfly model (see figure G1-1), map (possibly in small groups) the currently available solution(s) as well as potential future solution(s). indicate the most relevant environmental, social, economic and circular indicators for your case. Select one (depending on time an relatively easy or tricky one) and discuss how to define that indicator in a measurable way.

Module programme
Two modules of 1 ½ hours each, hence the following programme is suggested.

HOURS	TOPIC
BLOCK 1 20min	Lecture: goal setting and benchmark selection
20min	Exercise 1: defining (fictive) goal, and selecting (fictive) benchmark. Translation to design objectives
20min	Lecture 2: basics of sustainability/circularity assessment
30min	Exercise 2: Mapping of most relevant environmental, social, economic and circular indicators for their own industry
BLOCK 2 30min	Lecture: Fast-track, streamlined LCA, single indicators. LCA at different moments in design process.
20min	Discussion 1: on their own industry.
20min	Lecture: Circular indicators
20min	Exercise 3: mapping potential future flows on butterfly model, defining indicators for their industry.

EXAMPLE COURSE SCHEDULE	DAY 1	DAY 2	DAY 3			DAY 4			DAY 5
	INTRODUCTION MODULES	GENERAL MODULES	TRACK MODULES			TRACK MODULES			GENERAL MODULES
			SOCIETY	STRATEGY	TECHNOLOGY	SOCIETY	STRATEGY	TECHNOLOGY	
30min	Opening	Warm up	Track intro	Track intro	Track intro	Track intro	Track intro	Track intro	Warm up
1:30h	**Circular economy (I-1)**	Systems Thinking **(G1-1)**	**Change & Transition (T1-1)**	Business Model Design **(T3-1)**	Material Flows & Production **(T5-1)**	**Change & Transition (T1-2)**	Business Model Design **(T3-2)**	Material Flows & Production **(T5-2)**	Systems Thinking **(G1-2)**
1:30h		Stakeholders & Collaboration **(G2-1)**							Stakeholders & Collaboration **(G2-1)**
30min	Lunch	Lunch	Lunch	Lunch	Lunch	Lunch	Lunch	Lunch	Lunch
1:30h	Design for Circular Economy **(I-2)**	Policy, Legislation & Standardization **(G3-1)**	Social Design **(T2-1)**	Product-Service design **(T4-1)**	Product Design **(T6-1)**	Social Design **(T2-2)**	Product-Service design **(T4-2)**	Product Design **(T6-2)**	Policy, Legislation & Standardization **(G3-2)**
1:30h		Life Cycles, Assessment & Evaluation **(G4-1)**							Life Cycles, Assessment & Evaluation **(G4-2)**
1h	Discussion	Wrap-Up & Track Overview	Wrap-Up	Wrap-Up	Wrap-Up	Wrap-Up	Wrap-Up	Wrap-Up	CLOSING DRINKS

T1. Change and transition

Learning outcomes
Participants will be able to...
1. describe the three levels of change within the transition perspective
2. describe the four phases of change that may be recognized within the transition process
3. identify possible barriers and carriers for successful change and transition
4. develop strategies for change and transition in a circular direction
5. describe the various types of niche experiments that may contribute to transitions
6. describe the different ways that a niche experiment can contribute to a transition

Transitions
The effective change from a linear economy to a fully circular economy can be seen as a far-reaching transition process. Such a transition can be defined as a process of fundamental and irreversible change in a society's current way of functioning, into a new way of functioning. Transitions can be identified in societal systems like energy, mobility, water, agriculture and health care. Examples of possible transitions are the transition from coal energy supply to gas energy supply to renewable energy supply, or the transition from a linear economy to a circular economy.

Multilevel transition perspective
In transition studies, a transition may be considered as an alignment of processes within and between three different levels: "niche innovations", "socio-technical regimes", and the "socio-technical landscape". This is often described with the dynamic multilevel model (see figure T1-1).

In the middle of the model, an existing socio-technical system can be seen in which all elements are aligned with each other. For instance the technology that is being available is aligned the ways of people using that technology, and the cultural and social habit of citizens are aligned to the existing regulations and policy's of government. This combination of the existing situation can be called the "socio-technical regime" which determines 'the rules of the game'. According to Rip and Kemp (1998), a socio-technical regime is the 'grammar or rule set comprised in the coherent complex of scientific knowledge, engineering practices, production process technologies, product characteristics, skills and procedures, ways of handling relevant artefacts and persons, ways of defining problems - all of them embedded in institutions and infrastructures'.

The socio-technical landscape then refers to broader contextual developments that influence the socio-technical regime and over which regime actors have little or no influence. Developments in the landscape consist of both slowly changing trends (e.g. demography, ideology, spatial structures, geopolitics) and sudden external shocks (e.g. wars, economic crises, political transformations).

Niche innovations are emerging social or technical innovations that differ radically from the prevailing sociotechnical
system and regime, but are able to gain a foothold in particular applications, geographical areas, or markets (e.g., the military), or with the help of targeted policy support.

The key claim of the multilevel perspective is that effective transitions take place through the alignment of processes within and between these three levels, as shown in Figure T1-1. In order to be able to steer the transition processes to some extent, it is therefore necessary to identify these processes, and in particular theinteractions between these processes. In order to influence transitions, the processes at the various system levels must be influenced in parallel.

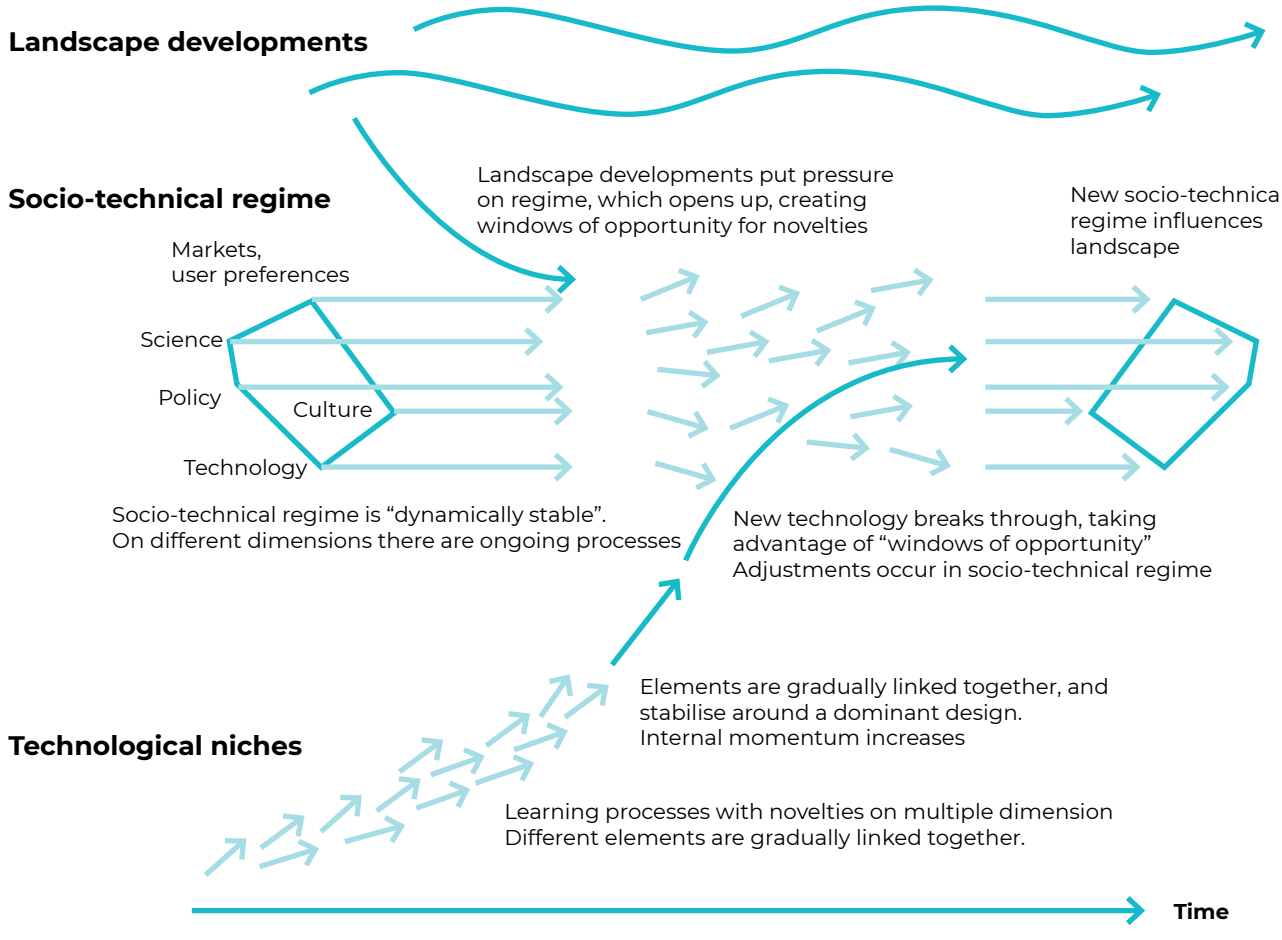

Figure T1-1: Dynamic Multilevel Perspective, Geels (2002)

Four phases of the transition process
The multilevel perspective describes four phases that may take place in transition processes. These processes can often take decades to complete.

In the first phase, radical innovations emerge in niche environments. These innovations take place, as it were, outside the existing regime, in a relatively protected environment. These niche innovations are often uncertain and are not always successful. A few of the many experiments are successful, but many will also fail, or only develop on a very small scale.

In the second phase of the transition process, some of these niche developments are conquering their own place in the market. This will create a stable environment in which the niche innovation can flourish, even if it is often not yet on a large scale. The existing regime and the niche innovation co-exist in this phase. Slowly but surely, the associated infrastructure, the accompanying legislation, the behaviour of citizens is gradually adapting to the new innovation, the corresponding policy is being created, and the innovation is gradually developing into a stable innovation.

In the third phase, innovation breaks through more comprehensively. Innovation is now beginning to compete with the elements of the existing regime. The extent to which the niche innovation is a successful alternative to the existing situation depends, on the one hand, on the development of the niche innovation itself. How successful is the new concept, and is it really a better alternative than the existing solutions? Of course, this also depends on the problems in the existing regime. The more urgent the problem of the existing situation (e.g. environmental problems, air quality, scarce raw materials), the greater the chance that an alternative will be successful. Another aspect concerns the vested interests of the existing actors in the regime. The more they have invested in the existing situation (e.g. by building expensive factories, existing infrastructure, and existing business models), the more these actors will stick to the current regime. There is therefore an economic battle between old and new technologies. A business battle between newcomers and established companies. A political battle involving changes in regulations, standards, subsidies and taxes. And finally, a discussion about ideas, about a vision of the world and the social acceptance of the current versus the new situation. The greater the problems of the current regime, the more 'windows of opportunity' will arise for alternative solutions.

In the fourth phase of the transition process, the existing regime is being replaced by a completely new one. In this phase there is widespread application of the new innovation, with lasting changes in the field of infrastructure, policy, industrial and market structures, lifestyles and views on normality. The new regime is institutionalized at this stage and is increasingly taken for granted.

Transition Management

Many transitions have taken place or are currently in progress, but they don't necessarily lead to a more sustainable society, ecology and economy. Some transitions actually lead to a very non-sustainable society. A sustainability transition can be defined as a "radical transformation towards a sustainable society, as a response to a number of persistent problems confronting contemporary modern societies" (Grin et al 2010). The field of Transition Management can be considered as a specific governance concept aimed at steering the transition process in a preferred, sustainability direction. Transition management combines concepts from complexity theory, social theories and insights from the field of governance. Transition management can be considered as a process-oriented and participatory steering philosophy that enables social learning through iterations between collective problem structuring, vision development, coalition building, experimenting and monitoring (Kemp et al, 2007).

Exercise G1-1 - Create a transition path towards a circular regime

In this exercise your aim is to determine a path towards a 100% circular society, taking into account the four phases of the transition model.

1. First, determine the current non-circular system that you want to work on.
2. Second, you determine what are the elements of this regime, among other related to the existing technology, infrastructure, regulations, cultural aspects, habits, and other relevant aspects.
3. Next you define your ideal 100% circular societal system that you have in mind. Again take a look at the elements that you described in step 1 and 2.
4. Describe what is necessary to reach that new envisioned situation. Take a look at exercise template T1-1 and try to define the various phases that could take place, in order to reach the final situation. What are the small and experimental niche innovations that are needed for the 100% circular vision to become a reality? How can these innovations become more stabilized, and exist in parallel to the current linear, non-circular regime? And how can the current regime be totally replaced by the new envisioned circular regime?

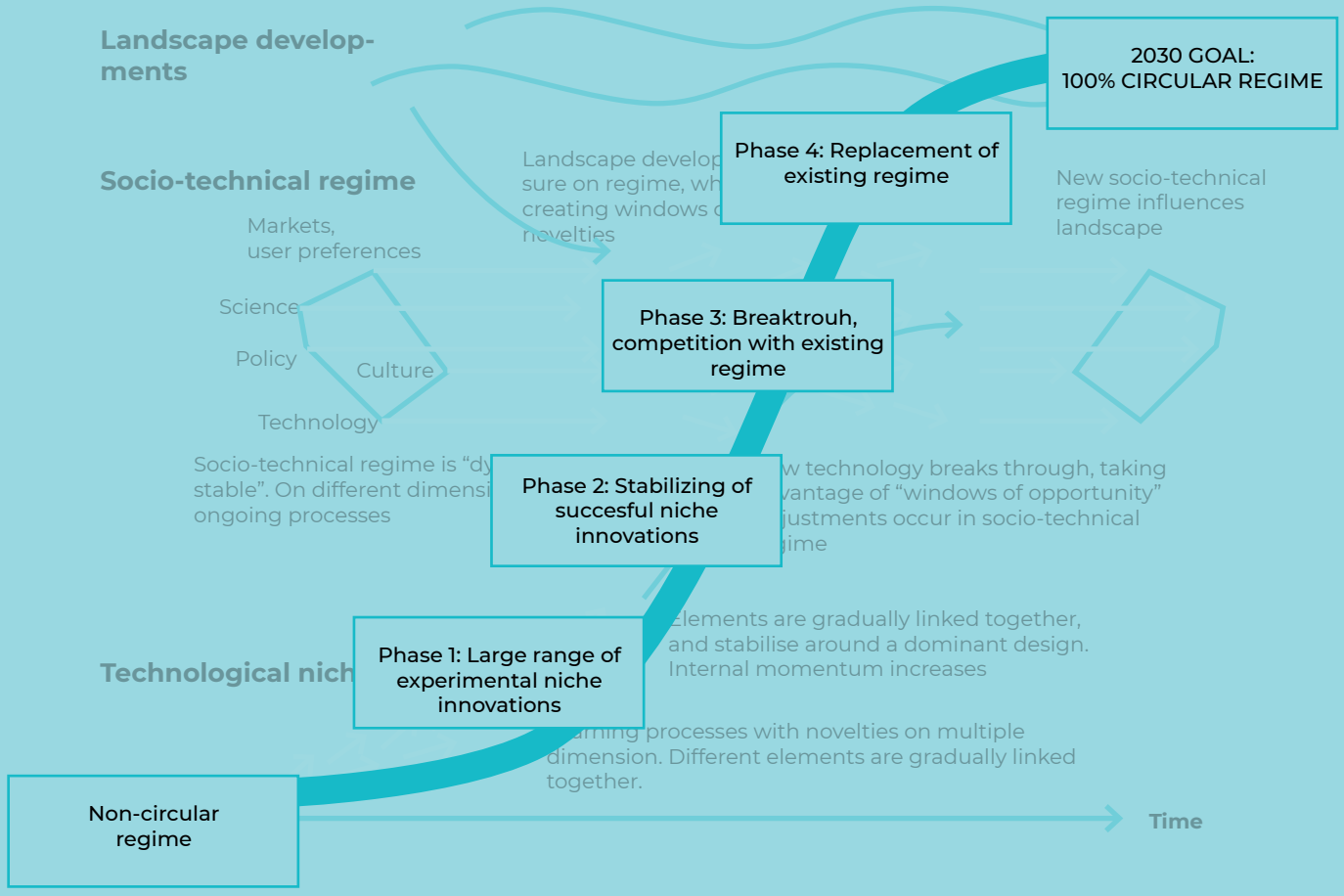

Figure T1-2: Exercise Template

Experimenting within transitions
Because the development of innovations within niches is so important within the concept of transitions, a specific course of study has arisen aimed at managing these developments, called Strategic Niche Management. This can be defined as: 'strategic niche management is the creation, development and controlled phase-out of protected spaces for the development and use of promising technologies by means of experimentation, with the aim of (1) learning about the desirability of the new technology and (2) enhancing the rate of application of the new technology' (Kemp, Schot et al. 1998).

Initially, it is mainly an analytical approach to assessing innovation programmes and then adapting them. This approach examines an innovation programme from four perspectives, namely (1) a social network analysis, (2) an analysis of the expectations; (3) a multi-level analysis of the experiment or programme's environment; (4) an analysis of the learning process. Within the strategic niche management approach, the intention is to develop protected environments where new innovations can be developed. The emphasis here is not so much on the development of the innovation itself, but on the associated learning process about the way in which this innovation can be used to achieve certain sustainability objectives, and the associated changes in elements of the socio-technical regime that this requires.
The use of specific experiments at the niche level plays an important role in the management of transitions. Different definitions are used for this, covering somewhat related approaches. Among others, the following concepts are used: (1) Niche experiments, (2) Bounded socio-technical experiments, (3) Grassroots experiments, (4) Transition experiments, (5) Sustainability experiments.

A Niche Experiment (1) may be defined as *"A first step towards the development of a niche for new technologies and concepts. While an experiment is carried out under "laboratory-like" conditions, developing a niche means exposing the innovation step-by-step to real-world conditions. It involves a second stage of interaction with users and learning about constraints and requirements in a less isolated environment than an experiment ... [Experimentation] stretches from the initial diffusion phase of a new technology to the time when a technology is sufficiently stabilized to survive without protection, to be replicated or extended and to induce a transformation of the technological regime"* (Weber et al., 1999).

A second concept concerns the Bounded Socio-Technical Experiment (2). This can be defined as *"An attempt to introduce new technology or service on a scale bounded in space and time; a collective endeavour, carried out by a coalition of diverse actors, including business, government, technical experts, educational and research institutions, NGOs and others; a cognitive process in that at least some of the participants explicitly recognize the effort to be an experiment, in which learning by doing, trying out new strategies and new technological solutions, and continuous course correction"* (Vergragt and Brown, 2007).

A third concept concerns the Grassroots Experiment (3). This can be defined as follows: "Innovation is an experimental process ...We use the term 'grassroots innovations' to describe networks of activists and organizations generating novel bottom–up solutions for sustainable development; solutions that respond to the local situation and the interests and values of the communities involved. In contrast to mainstream business greening, grassroots initiatives operate in civil society arenas and involve committed activists experimenting with social innovations as well as using greener technologies" (Seyfang and Smith, 2007) . In addition, there is also the concept of Transition Experiments: (4): "An innovation project with a societal challenge as a starting point for learning aimed at contributing to a transition" (Van den Bosch and Rotmans, 2008). And finally there is the Sustainability Experiment (5): "A planned initiative that embodies a highly novel socio-technical configuration likely to lead to substantial (environmental) sustainability gains" (Berkhout et al., 2010). In table T1-1, a comparison is made between more classical innovation experiments and the concept of transition experiments.

Table 1: Distinctive characteristics of transition experiments (Van den Bosch and Rotmans, 2008)

	Classical Innovation Experiment	**Transition Experiment**
Starting point	Possible solution (to make innovation ready for market)	Societal challenge (to solve persistent societal problem)
Nature of problem	A priori defined and well-structured	Uncertain and complex
Objective	Identifying satisfactory solution (innovation)	Contributing to societal change (transition)
Perspective	Short and medium term	Medium and long term
Method	Testing and demonstration	Exploring, searching and learning
Learning	1st order, single domain and individual	2nd order (reflexive), multiple domains (broad) and collective (social learning)
Actors	Specialized staff (researchers, engineers, professionals, etc.)	Multi-actor alliance (across society)
Experiment context	(partly) controlled context	Real-life societal context
Management context	Classical project management (focused on project goals)	Transition management (focused on societal 'transition' goals)

Deepening, broadening, scaling up
What exactly is the contribution of an experiment to the transition process? To describe this, Van den Bosch defines three different mechanisms on which an experiment can contribute to a transition. These are deepening, broadening and scaling-up. The three mechanisms are shown in figure T1-2.

In the 'deepening' mechanism, the experiment is mainly used as a means to learn from. The actors involved can, for example, learn about a local change in working methods, about new ways of acting, about changing values and perspectives. They can also learn about necessary changes in the area of

physical infrastructure, or the institutional or economic context. In other words, this involves learning about the relationship between the various components of the system in relation to each other.

The mechanism of 'broadening' can be defined as repeating an experiment in different contexts. It is important to note that broadening does not refer to repeating without further variation. Broadening is about carrying out different experiments in different contexts. Broadening refers to the idea that different experiments that exist at the same time can elaborate on each other and together make a contribution to an emerging field or an emerging community. In the way, the knowledge about the context of a specific innovation is extended to other contexts, and the the experiment can increase its influence. By broadening an experiment, a new culture or a new working method can be disseminated in a different context or a different application domain. By broadening the scope, new application areas or functions for a transition experiment or a social subsystem are explored.

The mechanism of 'scaling up' is defined as embedding an experiment in a new dominant way of thinking, acting and organising, at the level of a societal system. Scaling up can be seen as the step from experiments to the level of niches and ultimately to a regime shift. It can be seen as the bundling of various learning experiences in local projects to a global niche level. In addition, 'scaling up' can be seen as the transfer of positive experiences in niches towards mainstream practices in the regime. This is therefore more about the societal embedding of experiments and the embedding of experiments in the existing structures of a regime. 'Scaling up' will increase the influence and stability of a new constellation of culture, practices and structure. When an experiment is being 'scaled up', this results in a fundamental change in the dominant way in which societal needs are being met. 'Scaling up' means that sustainable practices that are initially different or unusual become the dominant or mainstream practice. Thus, through 'scaling up', experiments can influence the way in which societal needs are fulfilled in a more sustainable direction. In other words, scaling up means shifting sustainable practices from experimentation to mainstream.

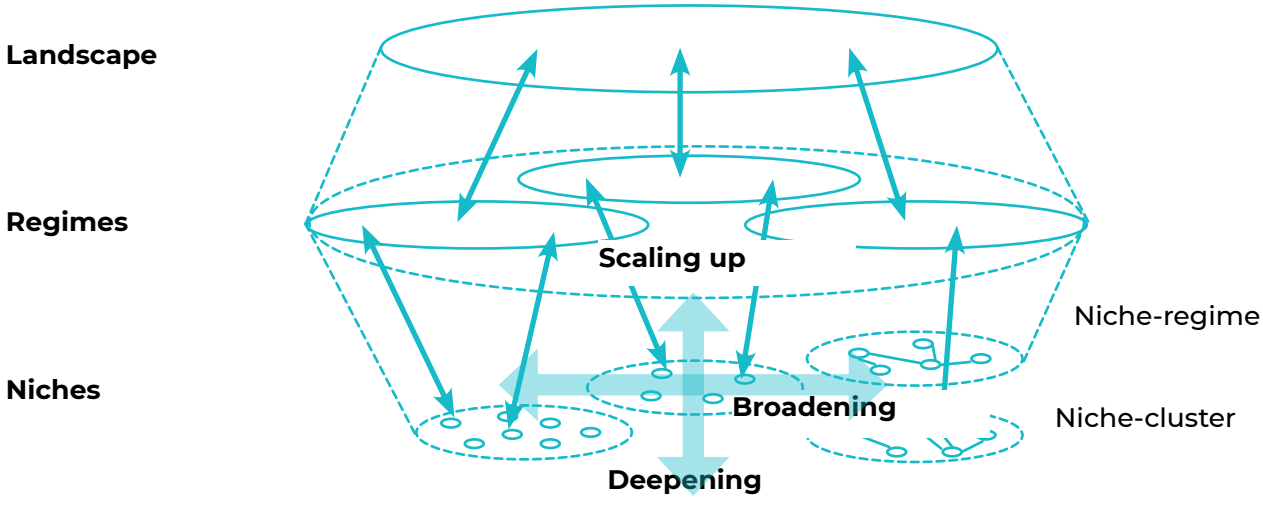

Figure T1-2: Deepening, Broadening & Scaling up transition experiments in niches in relation to Multi-Level Perspective (Van den Bosch and Rotmans, 2008)

Exercise T1-2 - Define and improve your niche-experiment

1. Define your niche-experiment. Describe briefly what circularity challenge your niche-experiment is about. See table T1-1 for a comparison of a niche experiment and a regular innovation experiment.
2. Define your leading long- or medium-term vision for circularity, to which your experiment should contribute. Things to take into account when thinking about this vision are: How innovative or different is the vision from business as usual? How attractive is the vision? How many actors do share the same vision?
3. Determine who are the relevant actors for your project and for your circular project ambition. Take into account financial actors, citizens, company's, NGO's, government actors and other relevant stakeholders.
4. Assess the quality of the network around your circular experiment. Do you think that important actors are missing? Are the actors involved able to provide the necessary resources? Do you expect major resistance from any particular actor or social group and if so, do they have enough power to affect the project?
5. Determine what are relevant landscape developments. Determine which developments support your circular experiment or can be made supportive, and which developments may be a hindrance to the success of your experiment?
6. Determine what are the most relevant 'regimes 'for your niche experiment. You can for example think of the energy regime, the scientific regime, the transport regime. Determine how much your project distinguishes itself from the dominant regime. Note that more than one regime may be important for your project.
7. Determine what you can learn from your project, given your ambitions and analysis of landscape and regime. Think about lessons about technical aspects, cultural lessons, policy lessons, about markets, new financial arrangements, juridical conditions. Determine how you can improve the learning process within your project.
8. Action. Determine what is the next step to take to make your experiment a reality. What is the first action that you will now take? And what is your second action?

Module Programme
This module is supposed to consist of two modules of 3 hours each, hence the following programme is suggested:

HOURS	TOPIC
45min	Lecture: Three levels of the transition model
15min	Break
45min	Lecture: Four phases of the transition process
15min	Break
1h	Exercise 1: Determine the transition path towards a 100% circular regime

HOURS	TOPIC
45min	Lecture: Different types of experiments within transitions
15min	Break
30min	Lecture: Fast-track, streamlined LCA, single indicators. LCA at different moments in design process.
45min	Lecture: Deepening, broadening and scaling-up
15min	Break
1h	Exercise 2: Define and improve your niche experiment

Literature

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EXAMPLE COURSE SCHEDULE	DAY 1	DAY 2	DAY 3			DAY 4			DAY 5
	INTRODUCTION MODULES	GENERAL MODULES	TRACK MODULES			TRACK MODULES			GENERAL MODULES
			SOCIETY	STRATEGY	TECHNOLOGY	SOCIETY	STRATEGY	TECHNOLOGY	
30min	Opening	Warm up	Track intro	Track intro	Track intro	Track intro	Track intro	Track intro	Warm up
1:30h	**Circular economy (I-1)**	Systems Thinking **(G1-1)**	Change & Transition **(T1-1)**	Business Model Design **(T3-1)**	Material Flows & Production **(T5-1)**	Change & Transition **(T1-2)**	Business Model Design **(T3-2)**	Material Flows & Production **(T5-2)**	Systems Thinking **(G1-2)**
1:30h		Stakeholders & Collaboration **(G2-1)**							Stakeholders & Collaboration **(G2-1)**
30min	Lunch	Lunch	Lunch	Lunch	Lunch	Lunch	Lunch	Lunch	Lunch
1:30h	Design for Circular Economy **(I-2)**	Policy, Legislation & Standardization **(G3-1)**	**Social Design (T2-1)**	Product-Service design **(T4-1)**	Product Design **(T6-1)**	**Social Design (T2-2)**	Product-Service design **(T4-2)**	Product Design **(T6-2)**	Policy, Legislation & Standardization **(G3-2)**
1:30h		Life Cycles, Assessment & Evaluation **(G4-1)**							Life Cycles, Assessment & Evaluation **(G4-2)**
1h	Discussion	Wrap-Up & Track Overview	Wrap-Up	Wrap-Up	Wrap-Up	Wrap-Up	Wrap-Up	Wrap-Up	CLOSING DRINKS

T2. Social design

Design is the discipline of generating solutions to problems and opportunities through the art of making “something new”. This module focuses on Social Design. The term Social Design can mean different things to different people. Social Design deals with the responsibility of the designer to bring social change and improve the quality of life, but also with an open, participative and collaborative way of finding design solutions.

Learning outcomes
Participants will be able to...
1. explain and make use of leading theories on social design.
2. understand the differences between social and user-based design.
3. work with purpose economy, common goods and sharing economy, citizen empowerment concepts.
4. work with alternative systems.
5. identify strategies to engage relevant user groups into alternative systems.

Key insights
Human-centered design, poverty, urban development, intervention design, participatory design, collective intelligence, collective thinking, shared economy, shared ownership and responsibility, peer-to-peer, citizen empowerment.

Social design
Design has multiple social dimensions associated with the diversity of users and experimentation situations. Design affects society and, at the same time, society influences and conditions design. Social design must include users, experts and stakeholders in all phases of design. Social design finds its issues in the current social challenges: poverty, urban development, sustainability, healthcare, migration, education and much more.

Human-centered design [1] is an approach to the development of interactive systems that aims to make systems usable and useful by focusing on users, their needs and requirements, and applying human factors / ergonomics, knowledge of usability and techniques. This approach improves efficiency and efficiency, improves human wellbeing, user satisfaction, accessibility and sustainability; and counteract the possible adverse effects of the use on human health, safety and performance.

Grassroots movements
Grassroots movements describe the formation and scaling up of local communities that once originated in a given region or district, while these communities share a common denominator such as a certain political view or preference for specific economic or demographic development. Commonly these communities rise to larger influential levels while keeping its bottom-up approach. Grassroots rely fully upon the commitment of individual members and their contribution, and therefore commonly have a more horizontal decision making structure - with a focus on community empowerment. The latter giving grassroots movements a more spontaneous or natural power structure compared to the more traditional, top-down, ones.

Grassroots are easily recognized in local and world politics, and this kind of activism coupled up with social media and hashtags in a digital age is shaping our world in ways we can yet only imagine. Clear examples of political grassroots movements are for instance the #MeToo movement or the Arab Spring, but the more recent Climate Protests or Catalan Independence are also made possible due to grassroots movements.

These grassroots movements are not limited to politics at all, let alone that grassroots movements have been or can be considered designed in some levels (called AstroTurfing), more importantly, these movements can stem from good, or bad, product-service or system design too.

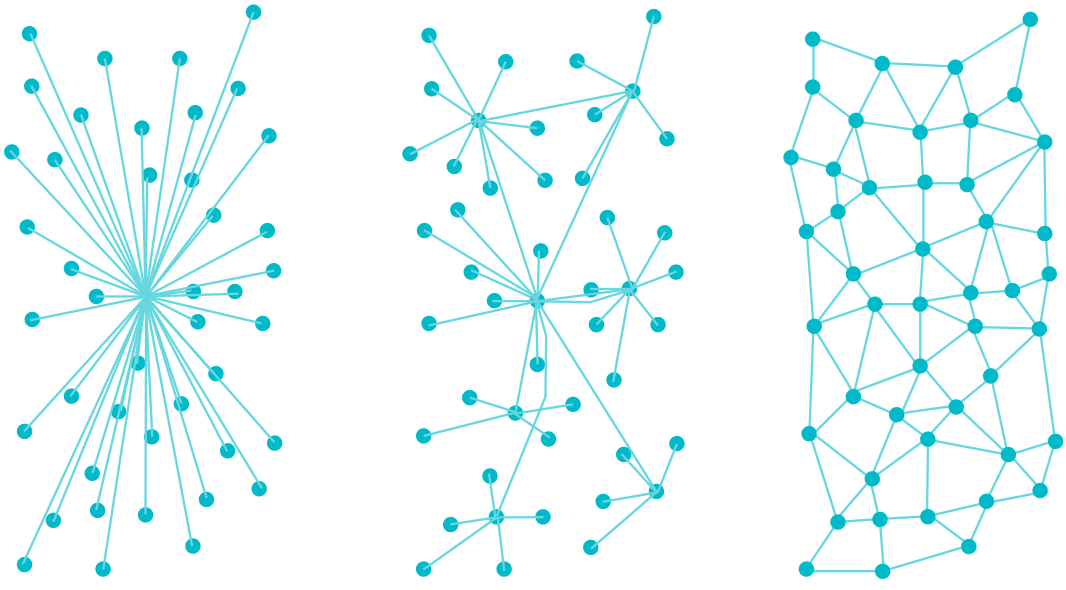
Grassroots in Social Design
A great example of grassroots movement in social structures is the way Africans handle their financial transactions. Due to the complexity of getting bank loans and/or other financial tools such as investments, but moreover, the fact that African countries commonly have a great fluctuation in the value of their currencies has resulted in a flourishing e-commerce and Mobile Financial Services unmatched by most other continents. In Africa, for instance, phone credit is a stable currency, shared amongst families, and it is now common to do a large variety of different types of transactions over increasingly large distances using only phone credit. The interesting part being the fact that due to a bad design of economy, service design has provided a solution for the people who need it.

A different way where grassroots movements have had consequences for design (in this case city) or spatial design, is literally built upon a historic freight rail line elevated above the streets on Manhattan's West Side. New York neighbours and the city government eventually saved this place from demolition in 2009, and since then the overhead railway has been turned into a magical hybrid public space combining gardens, parks, showcases of visual and tangible art, and the old closed off railway itself has been re-designed and rebuilt into a huge public masterpiece; the High Line.

Figure T2-1: Broodnodig Foundation in the Netherlands

On an increasingly local level, in Rotterdam, the Netherlands grassroots movements have also had its consequences. The foundation BroodNodig (freely translated as "Absolute Need"), has had the goal to counter the problem of bread waste within the city (about ⅓ of consumed bread ends up in streets or in the trashcan) an unseeingly valuable waste stream, as it appears bread waste is an ideal fuel (like a very strong espresso) for digestion systems, which turn bio-waste into biogas due to natural processes by colonies of bacteria. It turns out you can cook about one hour on one gas stove using one (uneatable) loaf of bread. BroodNodig has developed a grassroots movement placing hundreds of special trash bins throughout the city meant only for bread, which are collected by electric transport, and brought to a large digester which in its turn makes sustainable gas which heats the city. Now, what was first a job of BroodNodig alone, has now been fully adopted by the municipality.

Sharing Economy



Centralised (A) **Descentralised (B)** **Distributed (C)**

Figure T2-2: Different forms of networks in a sharing economy

Sharing Economy is something we by now breathe and know, which is taking over our old traditions in commerce, by adding an important layer of service over product-use. Sharing economy is about shared ownership and shared responsibility, collaborative insurance and peer-to-peer.

Sharing economy is best explained by the simplest example of a student house, sharing for instance an appliance like a washing machine, that everyone has chipped in to make use of. They share responsibility over quality of use, washing powders, timeslots, making repairs or buying a new one if needed. It's usage fully relies on trust in between the peers using the appliance, and the intermediator company is left out of the equation thus moving towards a decentralized or distributed model as seen on the right in the figure above.

An important misconception is that some renowned for-profit companies that provide services to share goods, are also part of the sharing economy principles. But, "when a company is an intermediary between consumers who don't know each other it is no longer sharing at all" (Giana M. Eckhardt and Fleura Bardhi, Harvard Business Review), these intermediary companies merely provide a paid service to basically help other people to rent or lease out individual services (Uber: personal transport) or products (AirBnB: housing) while earning money over its transactions. A better term, according to the same authors, would actually be "Access Economy".

Sharing Economy, or Access Economy has severe consequences for how we design products, and especially looking at sustainable and circular principles, it is an important way to make use of product idle times and at the same time dodge current complex regulations in terms of product ownership and usage. There are a few key drivers that make the argument for a sharing economy, they are, amongst others; having access to products or services is preferable to ownership, unused - or idle - value of a product or service is a waste of value, and what can be viewed as waste in one segment can become value in another. Similarly, a very important driver in between the user groups is trust, as peers are continuously judged by other peers and rely on reviews and star-based value systems making it possible to overcome the initial fear of 'danger for strangers'.

An unveiling example where trust plays a very central role to the shared product or service amongst a group of peers is the Dutch so-called "Broodfonds" (ENG: "Fund for bread"). With the strong rise in numbers of soleproprietorship or self-employment in the Netherlands, risks to the individuals behind these single manned companies increase too. While normally a larger company is supposed to insure its employees for accidents that happen to its employees through costly and complex insurance companies, self-employed small companies are in effect uninsurable because of that same insurance regulation complexity. Hereafter, even if a self-employed company is able to pay the high monthly costs, large insurance companies come with a heap of exceptions to specific accidents, consequently the risk stays at the self-employed. It is for those reasons Broodfonds came into existence, where groups of a maximum of 50 self-employed people pay a certain amount each month (say a 100 EUR) to the foundation to insure themselves and others in that specific group. This group of 50 people are collected through acquaintances, and selected on motivation and type of work. While each pays a certain amount in the collective bank account each month, a collective amount is saved. Then if anything bad happens to anyone from within that group, the saved money is used to pay out a regular monthly salary by the collective. There are few rules except reciprocal trust, and even if a self-employed group member has a burnout (which is normally uninsurable) or has broken their knee while their work involves a lot of kneeling you can request the collective for the salary. The trust usually goes two ways, you don't want to use the saved money of the collective, and you usually don't want to check whether someone is telling lies about an illness. Hence, the product and service of insurance has been completely redesigned.

When combining circular principles with sharing economy we can talk about wasting perfectly working but used machinery, or idle times of production processes. There are a few interesting angles here too that can be named. One common reason for (production) companies to not buy second hand production machinery or facilities, is the fact that insurance companies cannot guarantee the proper working of such machinery, which in first glance seems logical, as you never know what has been done to it over the years. This means though, that insurance companies either ask significantly higher rates if companies do choose to let their employees work with second-hand machinery, the same goes if other friendly companies wish to make use of idle times of production facilities, if something happens you're uninsured.

Meaning the incentive to do so remains low, not stimulating a more circular industrial marketplace. A company who has found a way around this is for instance SnappCar, where idle times of cars are shared amongst peers, but the most important part being the insurance, normally if you lend your car to a friend and you are not in the car, you are not insured, if you use the SnappCar platform you are, even if you are not acquainted. In this example, the way we make use of transport has been redesigned.

Citizen Empowerment
Aristoteles once said “the worst form of inequality is to try to make unequal things equal”, being even worse than treating equal cases unequal. We may be about 80% the same in many cases, but there will always be a group of people who do not fit the same standardized or centralized governance, regulations, products, or help. Citizen empowerment has a lot to do with decentralization of power or services, and especially customization of local needs, unveiling what is truly necessary to solve an issue without trying to make it fit the system that only works for the rest of the 80%. As we have been standardizing systems for decades, for instance that of health, there are increasingly cases that are harder to solve as they appear to have their fundamental issues laying outside of the playing field, and where the system is actually losing grip on these subject matters, making it costlier in the end by treating them as equal.

A great example is told by the Dutch Eelke Blokker [2], “When I was director of a homeless retreat, I met Marcel, he had a debt of 14.000 EUR, and 48 different (governmental) institutions worked on his specific case to get him out of this, adding this up led to a cost of 269.000 EUR a year.” This meant aid workers cost about 20 times more each year than the actual debt of Marcel, without actually getting him out of debt. Let’s say that they directly paid off his debt, it would have given the government around 255.000 EUR, to spend on other cases. This illustrates that a centralized or standardized approach does not always benefit the individual nor the complete system, and citizen empowerment can prove to be a vital tool in global governance and commerce.

Exercise T2-1: Concept Map

In this module we will apply the principles of collective design and the tools associated in a systemic/holistic point of view. Systemic thinking broadens the range of available options to solve a problem by broadening our thinking and helping us to articulate problems in a new and different way.

The drawing of causal and concept diagrams forces the group to develop shared images, or stories, of a situation. Graphic tools are efficient vehicles to identify, describe and communicate their understanding of systems. Remember that less is better. Start small and simple and add more elements to the story as needed.

The group is invited to represent ideas and information like boxes or circles, and then connect with arrows labelled in a hierarchical structure of descending branches. The relation between concepts can be articulated in the linking of phrases such as causes, requirements or contributions.

Exercise T2-2: Discussion (and consensus)

The number of elements in a concept map is determined by the needs of the story and the people who use the map. A simple description could be sufficient to stimulate dialogue, discussion and, finally, consensus for the group.

The team has to focus on the elements that people seem to overlook and try to arouse the group's curiosity about the problem that is being debated. To focus the conversation, we ask: "What about this problem that we do not understand?" Eventually, Delphi method can be used to reach consensus thought interactive forecasting within participants. The tool must be understood as the first step of collective design. Smart phones and other electronic devices can be used to guide the discussion and reach the consensus [3]

Module Programme
This module is 2 blocks 3 hours, hence the following program is suggested for the first block. The second block should be filled with an excursion plus discussion to a grass-roots movement in your region.

HOURS	TOPIC
45min	Lecture: Social Design
15min	Break
45min	Exercise 1: Concept map
15min	Break
1h	Exercise 2: Discussion and consensus

Literature
1. "IDEO: The Field Guide to Human-Centered Design". 1st Edition © 2015

2. Eelke Blokker. https://www.human.nl/de-publieke-tribune/lees/eelke-blokker.html 3. J.M. Monguet and A. Trejo. "Smart Delphi: An Interactive Approach to Digital Consensus". https://app.smartdelphi.com/

EXAMPLE COURSE SCHEDULE	DAY 1	DAY 2	DAY 3			DAY 4			DAY 5
	INTRODUCTION MODULES	GENERAL MODULES	TRACK MODULES			TRACK MODULES			GENERAL MODULES
			SOCIETY	STRATEGY	TECHNOLOGY	SOCIETY	STRATEGY	TECHNOLOGY	
30min	Opening	Warm up	Track intro	Track intro	Track intro	Track intro	Track intro	Track intro	Warm up
1:30h	**Circular economy (I-1)**	Systems Thinking **(G1-1)**	Change & Transition **(T1-1)**	**Business Model Design (T3-1)**	Material Flows & Production **(T5-1)**	Change & Transition **(T1-2)**	**Business Model Design (T3-2)**	Material Flows & Production **(T5-2)**	Systems Thinking **(G1-2)**
1:30h		Stakeholders & Collaboration **(G2-1)**							Stakeholders & Collaboration **(G2-1)**
30min	Lunch	Lunch	Lunch	Lunch	Lunch	Lunch	Lunch	Lunch	Lunch
1:30h	Design for Circular Economy **(I-2)**	Policy, Legislation & Standardization **(G3-1)**	Social Design **(T2-1)**	Product-Service design **(T4-1)**	Product Design **(T6-1)**	Social Design **(T2-2)**	Product-Service design **(T4-2)**	Product Design **(T6-2)**	Policy, Legislation & Standardization **(G3-2)**
1:30h		Life Cycles, Assessment & Evaluation **(G4-1)**							Life Cycles, Assessment & Evaluation **(G4-2)**
1h	Discussion	Wrap-Up & Track Overview	Wrap-Up	Wrap-Up	Wrap-Up	Wrap-Up	Wrap-Up	Wrap-Up	CLOSING DRINKS

T3. Business model design

Business modelling is a way to describe the rationale of how a company or organization creates, delivers and captures value. 'Value' can be defined in economic, social, cultural or another context. The most common use of business modelling is when it encompasses one organization, often a commercial company, and is focused on creation of economic value for that company and it customers. Value creation is mostly seen in terms of turnover, profit and earning money.

Learning outcomes
Participants will be able to...
1. know the main barriers and carriers for the commercialisation of circular products
2. know the main circular business model archetypes
3. determine the existing business models of products
4. design a circular business model for a product
5. build a business case for a circular product
6. understand the value creation through including everyone involved in the product life-cycle

Related topics
Base of the pyramid, blue economy, business model canvas, business opportunities, buy-back systems, circular business models, collaborative consumption, cost savings, CSR, dematerialisation, eco-innovation, economic obsolescence, economic resilience, employment benefits, externalities, finance in a CE, functional service economy, green marketing, localisation, open innovation, ownership, performance, performance economy, price volatility, product access, product value extension, product-service systems, resource value extension, servitization, sharing economy, stewardship, sustainable business cases, sustainable business models, supply risks, take-back systems.

Business Model Canvas
A common and often used approach to design business models is the Business Model Canvas (BMC) (Ostwalder and Pigneur, 2010). The Canvas is made out of 9 building blocks that together give insight into the business model. Central in the Canvas are the Value proposition. Feeding into that are the key activities, resources and partners, and the connected cost structure. The value proposition is brought through channels and customer relationships to the customers segments.

1. Key Resources – Key resources are the assets required to offer and deliver the previously described elements...
2. Key Activities – ...by performing a number of key activities.
3. Key Partnerships – Some activities are outsourced and some resources are acquired outside the enterprise.
4. Customer Segments – An organization serves one or several customer segments.
5. Value Propositions – It seeks to solve customer problems and satisfy customer needs with value propositions.
6. Channels – Value propositions are delivered to customers through communication, distribution, and sales Channels.
7. Customer Relationships – Customer relationships are established and maintained with each customer segment.
8. Revenue Streams – Revenue streams result from value propositions successfully offered to customers.
9. Cost Structure – The business model elements result in the cost structure.

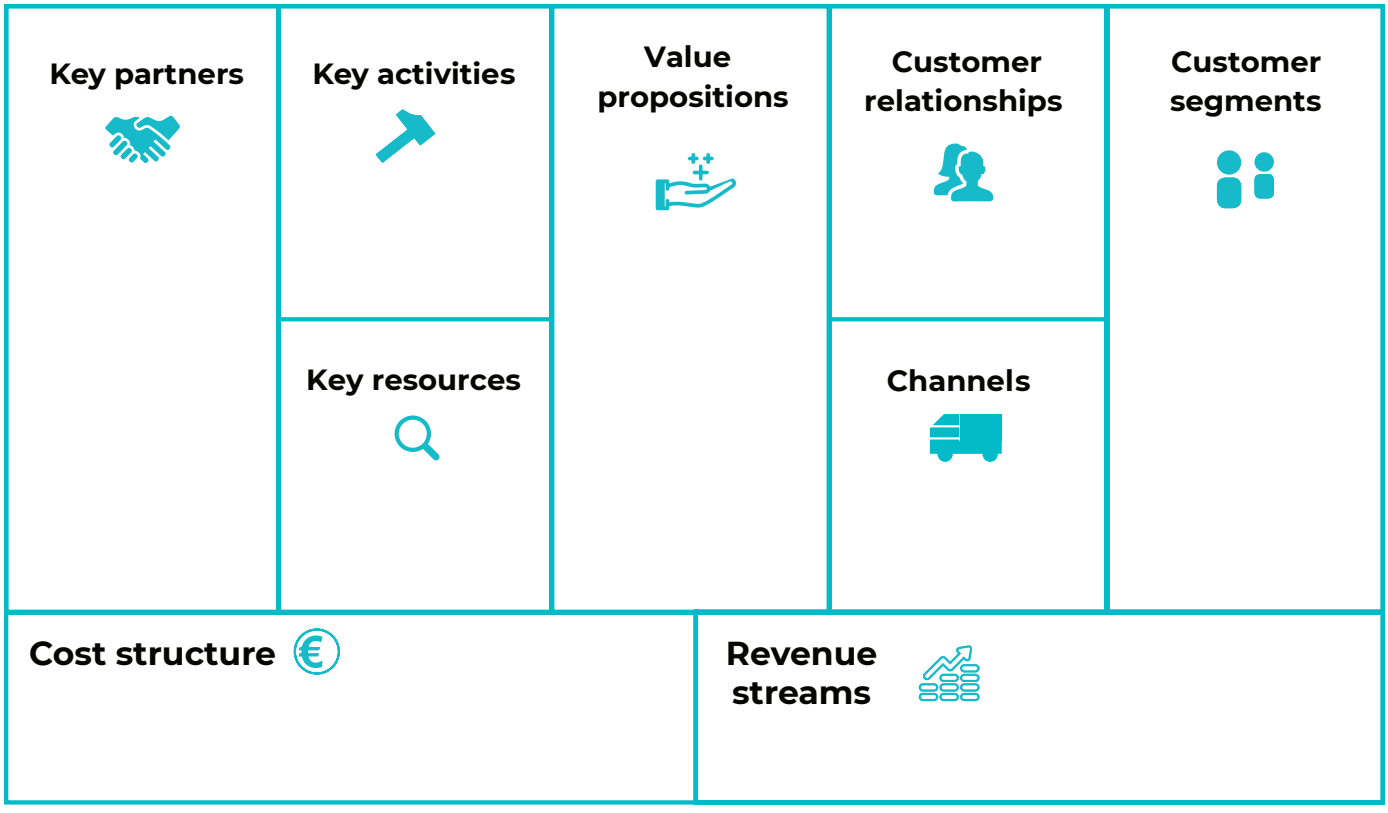


Figure T3-1: Business Model Canvas

Since the use of the BMC is so widespread, there are numerous examples of business models available online that use the Canvas structure. Although the BMC is more geared towards linear business models (firms that create goods and services, push them out and sell them to customers) it also facilitates development of more networked business models, where platforms or collectives allow users to create and consume value – which is becoming the predominant model in current online societies.

Exercise T3-1

To get a first idea of the BMC, start with the first key elements of the canvas.
- Select a business and products that is NOT circular at the moment
- Discuss and define the following elements for your business:

The Value proposition: Based on your vision, what is your mission, main programmes and brand.
The key Activities: What activities will your business focus on?
And what Channels, communication, distribution, sales, will you use?

Fill these in in bullet points in the Canvas.

Adaptations of BMC for Circular economy
There have been many adaptations of the Canvas to accommodate better the use for other than commercial companies in a linear model. One adaptation focusing specifically on Circular Economy is the Framework of the Circular Business Model Canvas (Lewandowski, 2016).

This canvas is extended and adjusted to the circular economy version of the business model canvas. It has 11 components; however, one component encompasses three sub-components.

Those components allow the designing of a business model according to the principles of circular economy, and consists of:

1) Value propositions offered by circular products enabling product-life extension, product-service system, digital services, and/or collaborative consumption. Moreover, this component comprises the incentives and benefits offered to the customers for bringing back used products

2) Customer segments - directly linked with value proposition component. Value proposition design depicts the fit between value proposition and circular customer segments

3) Channels - circular channels are possibly digitized through selling virtual value proposition and delivering it also online, selling via virtual channels, and communicating with customers online

4) Customer relationships - underlying production on order and/or what customers decide, and social-marketing strategies and relationships with community partners when new circular/recycling systems are implemented.

5) Revenue streams—relying on the value propositions and comprising payments for a circular product or service, or payments for delivered availability, usage, or performance related to the product-based service offered. Revenues may also pertain to the value of resources retrieved from material loops.

6) Key resources—choosing suppliers offering better-performing materials, virtualization of materials, resources allowing to regenerate and restore natural capital, and/or the resources obtained from customers or third parties meant to circulate in material loops (preferably closed)

7) Key activities—focused on increasing performance through good housekeeping, better process control, equipment modification and technology changes, sharing and virtualization, and on improving the design of the product, to make it ready for material loops and becoming more eco-friendly. Key activities might also comprise lobbying

8) Key partnerships—based on choosing and cooperating with partners, along the value chain and supply chain, which support the circular economy

9) Cost structure—reflecting financial changes made in other components of Circular BMC, including the value of incentives for customers. Special evaluation criteria and accounting principles must be applied to this component

10) Take-Back system—the design of the take-back management system including channels and customer relations related to this system

11) Adoption factors—transition towards circular business model must be supported by various organizational capabilities and external factors

Exercise T3-2

Now redefine the business and product you have chosen in exercise T3-1 and formulate a (more) circular version of it.

10) Revisit the same elements of the BMC and note the differences in these elements with the non-circular version

(2) Identify and formulate the key topics for the additional elements (10) – Take-back system – and (11) - Adoption Factors – of the Circular Business Model cf. Lewandowski.

Circular Business Modelling

A different approach for circular business models is taken in the work of Jonker et al (2018). Based on the principles of (1) organizing and closing the loops (2) maximizing the use of functionality and reusability, their circular business model (CBM) has 7 elements:

1. Closed-loop recycling schemes: Organising closed-loop recycling schemes so that products, parts or raw materials can be reused multiple times is key to circular entrepreneurship.

2. Value creation: A circular business model aims to create value on multiple fronts, such as socially, ecologically and financially.

3. Strategy: A successful circular business requires a strategy that focuses on efficient handling of raw materials and collaboration in creating closed-loop value chains.

4. Organisation: Jointly organising multiple value creation is a prerequisite for a circular business model. The organisation set-up has to allow for this.

5. Revenue model: Circular businesses require a suitable earnings model, such as the product-as-a-service approach.

6. Partners: Circular business models are only possible if other parties are prepared to collaborate in closing recycling loops.

7. Impacts: The results of multiple value creation – in other words, more than just the revenues – must be visible and measurable – this could also be CO2 reduction or eco-efficiency gains.

Next to this, four contextual factors complement the model: (1) the market for the CBM, (2) the capacity of the partners to invest (3) the flexibility in the area of legislation, finances and technology and (4) the influence of the partners to organize the transition towards the CBM.

Exercise T3-3

An example for the CBM (Jonker) will be provided.

After reading this, for the circular business and product that you have chosen, formulate key attention points for each of the 7 elements of the CBM model (Jonker). Also check the four contextual factors of the model and formulate how these can facilitate the transition towards the CBM. Module Programme Two modules of 3 hours each, hence the following programme is suggested.

Module Programme
Two modules of 3 hours each, hence the following programme is suggested.

HOURS	TOPIC
Block 1 1h	Lecture: Business modelling – the basics of the BMC and Circular Business Modelling
1h	Exercise T3-1
1h	Exercise T3-2
Block 2 1h	Lecture: Circular Business Modelling (Jonker 2018)
1h	Examples of Circular Business Models (from Organising for the Circular Economy, 2018)
1h	Exercise T3-3

Key Actions
- Mapping the key elements of the BMC
- In addition, formulate additional elements for more circular BMCs
- Mapping the key elements of the CBM (Jonker)

Methods and Tools
Business Model Canvas
Circular Business Model Lewandowski
Circular Business Model Jonker

References
J. Jonker, I. Kothman, N. Faber en N. Montenegro Navarro (eds.) (2018) Organising for the Circular Economy – A Workbook.

A. Osterwalder, Yves Pigneur, Alan Smith, Business Model Generation (2010), Wiley.

M. Lewandowski (2016) Designing the Business Models for Circular Economy—Towards the Conceptual Framework. Sustainability.

EXAMPLE COURSE SCHEDULE	DAY 1	DAY 2	DAY 3			DAY 4			DAY 5
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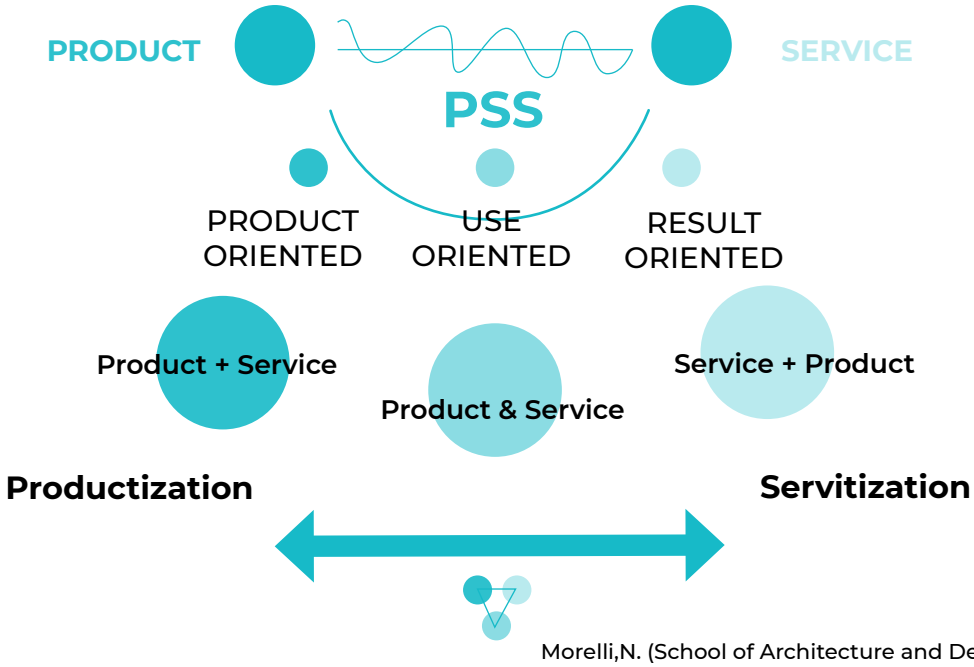
T4. Product-service design

Product–service systems (PSS) have great potential to promote the circular economy and sustainability. The importance of associating social values with sustainable PSS is crucial because social actors, including stakeholders, institutions, and communities are the key to organizational innovation and behaviour change.

Learning outcomes
Participants will be able to ... 1. reflect on the main characteristics of product-service design 2. identify types of product-service systems 3. name the main barriers and carriers for moving from products to product-service systems or services 4. identify service design opportunities for an existing product 5. design a sustainable product-service system or service.

Related Topics
Behaviour, customer journey, digitalisation, functional service economy, interaction, product ownership, productservice systems, sharing, service blueprint, service experience, service systems, sustainable product-service systems, systems mapping, touchpoints, user needs, value proposition Product-Service Systems

What is Product/Service System?
A PSS can be defined as a combination of products and services integrated into a system and networks to meet customer needs. This definition shows three main factors of PSS, namely products, services, and satisfaction. Generally, products are considered as physical and marketable properties (ownership) while services are regarded as intangible activities (access) (see figure T4-1).



Morelli,N. (School of Architecture and Design, Aalborg University) Product service - systems, a perspective shift for designers: a case study - The design of a telecentse. Des. Stud, January, 2003

Figure T4-1: Product-service systems.

Three types of PSS
Product-oriented PSS; Products are sold to the user, but additional services are considered as added value that enhances product sales.

This extra services may be: a maintenance/repair contract, a financing scheme or the supply of consumables, a take-back agreement when the product reaches its end of life and lastly advice and consultancy, in relation to the product sold, the provider gives advice on its most efficient use.

Use-oriented PSS; take services as the main solutions, where customers enjoy the functionality of products and pay for the use rather than the ownership.

- Product lease: the product does not shift in ownership. The provider has ownership, and is also often responsible for maintenance, repair and control. The lessee pays a regular fee for the use of the product; in this case normally he/she has unlimited and individual access to the leased product.

- Product renting/sharing: the product in general is owned by a provider, who is also responsible for maintenance, repair and control. The user pays for the use of the product. The main difference to product leasing is, however, that the user does not have unlimited and individual access; others can use the product at other times. The same product is sequentially used by different users.

- Product pooling: This greatly resembles product renting or sharing. However, here there is a simultaneous use of the product.

Result-oriented PSS; where customers enjoy the result of services rather than the product ownership. Activity management/outsourcing: a part of an activity of a company is outsourced to a third party. Outsourcing contracts include performance indicators to control the quality of the outsourced service.

- Pay per service unit: The PSS still has a fairly common product as a basis, but the user no longer buys the product, only the output of the product according to the level of use.

- Functional result: the provider agrees with the client the delivery of a result. This category is used, in contrast to activity management / outsourcing, for a functional result in rather abstract terms, which is not directly related to a specific technological system. The provider is, in principle, completely free as to how to deliver the result.

Methodology for PSS design
STEP 1 - Exploring opportunities: identification and analysis of an existing reference system.

The first activity is to identify existing production-consumption reference systems in which the company is active or expects to be active in the future. To do this, it´s essential to describe the functional unit , e.g. for a washing machine producer this might be “cleaning clothes”. Then, the list of elements of the reference system and description of its boundaries.

Then the most relevant actors in the reference system have to be identified, e.g. product manufacturers, suppliers, customers, retailers, etc. with their own interest in the system.

Suggested tools: Stakeholders Identification, Drawing a System Map, Sustainability SWOT (Strength-Weakness- Opportunities-Threats)

STEP 2 - PSS idea generation and selection of the most promising concepts.

The goal of the idea generation should be to solve the identified problems, take the opportunities and satisfy the identified consumer demands. The important elements that have to be generated to get an overview about the new concepts are:

- Short description of the new PSS concept.
- System map that describes the PSS from the consumer's point of view.
- Network of key actors and how it is organised.
- Revenue model: how is the cash flow through the system, who pays whom for what.
- Key material parts of the system, the material infrastructure, technology used.
- Key immaterial (service) parts of the system, organisation, information etc.

After generating a number of new PSS concepts, the task is now to select the most promising ones.

Suggested tools: Innovation Concept Card

STEP 3 - Detailing selected PSS concepts or PSS design

The chosen PSS concept(s) from step 2 are elaborated and detailed further. To detail the new PSS concept, include the following important considerations for the design of PSS:

- Relation of material product and immaterial service
- Co-operation and partnership
- Organisation
- Consumer relation
- User interface
- Financial Structure

STEP 4 - Evaluation of the detailed concepts and testing if possible
Once the new PSS solution has been detailed and the implications are much clearer than in the previous phases it is time to do a final sustainability check, before it is decided to realise the solution and launch it on the market.

Suggested tools: Qualitative Assessment Existing Product/System

STEP 5 - Planning implementation It is the moment to do a list of specifications for PSS implementation and finally the Business Suggested tools: Business Plan for the new PSS (see T3, Business Models)

Barriers for PSS

For companies

- An Eco-efficient PSS strategy is more complex to be managed than the traditional way of delivering products alone. It needs to implement changes in corporate culture and organisation in order to support a more systemic innovation and service-oriented business.
- Since PSSs determine the changing of systems and sources of gaining profit, this could deter producers from employing this concept (PSSs in fact require medium-long term investments and are connected with uncertainties about cash flows)
- The difficulty of quantifying the savings arising from PSS in economic and environmental terms, in order to market the innovation to stakeholders both inside and outside the company, or to the company's strategic partners.

For customers

- The main barrier is the cultural shift necessary to value an ownerless way of having a satisfaction fulfilled, as opposed to owning a product.
- Solutions based on sharing and access contradict the old but sometimes still dominant norm of ownership and requires new customer's habits and behaviour.
- Product ownership not only provides function to private users, but also status, image and a sense of control.
- The lack of knowledge about life cycle costs, which makes it difficult for a user to understand the economic advantages of ownerless based solutions.

Even when well-designed, some PSS concepts could generate unwanted side effects, usually referred to as rebound effects , i.e. counterproductive effects that "eat up" the intended positive sustainability effects, maybe by inefficient use or unsustainable changes in consumer behaviour etc. Nevertheless, PSS development certainly presents a potential for generating win-win solutions, which promote economic, environmental and social benefits.

PSS potential for Circular Economy

PSS is considered as a potential enabler for Circular Economy. "A PSS offers the opportunity to decouple economic success from material consumption and hence reduce the environmental impact of economic activity". (Baines et al., 2007) To turn linear production model into the circular flow, long-term collaboration among manufacturers, suppliers, clients, and other stakeholders have to be built.

PSS has an important role by creating these networks and also to use service strategies to replace product ownership and reduce the waste of materials and resources. Schemes such as product sharing, renting, and leasing are common ways to facilitate sustainable production and consumption and foster the dematerialisation .

Exercise T4-1

Service Flip Increasingly, companies are shifting from selling only a product to turning that product into a service. Do you need an office, or just a place to get work done? Do you need to buy a new set of clothes, or have access to a neverending wardrobe? It starts with understanding the underlying user need and thinking more creatively about how they can be met.

Download the Service Flip worksheet (at circulardesignguide.com), and start by identifying the core needs the three product examples are trying to meet: a dvd player, a washing machine, and clothes. (The core need of a car, for example, might be "get me from point A to point B." It's not about owning the vehicle necessarily, but providing mobility whenever someone needs it.)

Steps:

1. Now brainstorm other ways to meet those needs, that go beyond having to own that individual product. For each of the three examples, try to come up with a few ideas.
2. For the last box, flesh out what the new service experience might look like for each. (For mobility the solution might be car sharing–enabled perhaps by an online platform, GPS technology and maybe even driverless cars.)
3. For the last box, flesh out what the new service experience might look like for each. (For mobility the solution might be car sharing–enabled perhaps by an online platform, GPS technology and maybe even driverless cars.)
4. Now, do steps 1-3 with your own product, starting with the core needs you're trying to meet, a few ideas around how to solve for these in a new way, and a description of a service model approach that could be beneficial for users and producers.
5. To wrap up, ask yourself: if you were to offer a service, what systems would need to be in place? Which partners would you need to support this change? What feedback or data would be important to have (and which technologies might you rely on to do it)? Could the data be of benefit to others (e.g. might someone want to buy it)?

Exercise T4-2 - PSS Stakeholders Identification

Stakeholders have to be identified and then the relation between them have to be drawn.

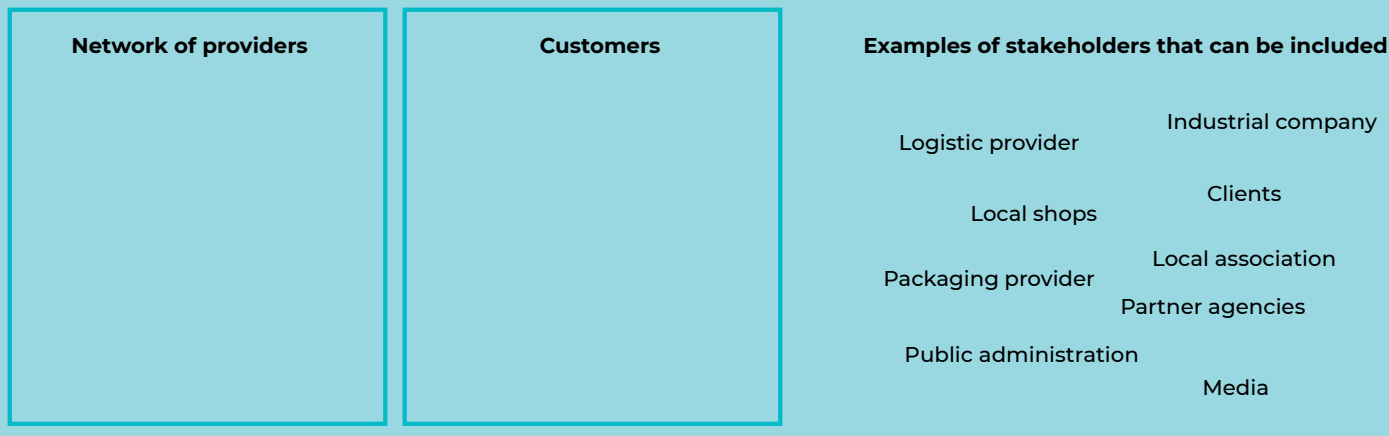


Figure T4-2: Stakeholders Map for PSS

Exercise T4-3 - Make a PSS System Map

The system map is a visual description of the service technical organization: the different actors involved, their mutual links and the flows of materials, energy, information and money through the system. It provides a complete and clear overview of the PSS. It helps to identify potential failure points, to identify the role and level of participation of customers and to clarify what customers should see or come in touch with. It stresses the areas of interactions between different actors and how the money flows through the system. This way, it is very helpful to support system re-design processes and can be also used for communicating the designed solution. An example is given below. Use the same approach to draw your PSS system map.

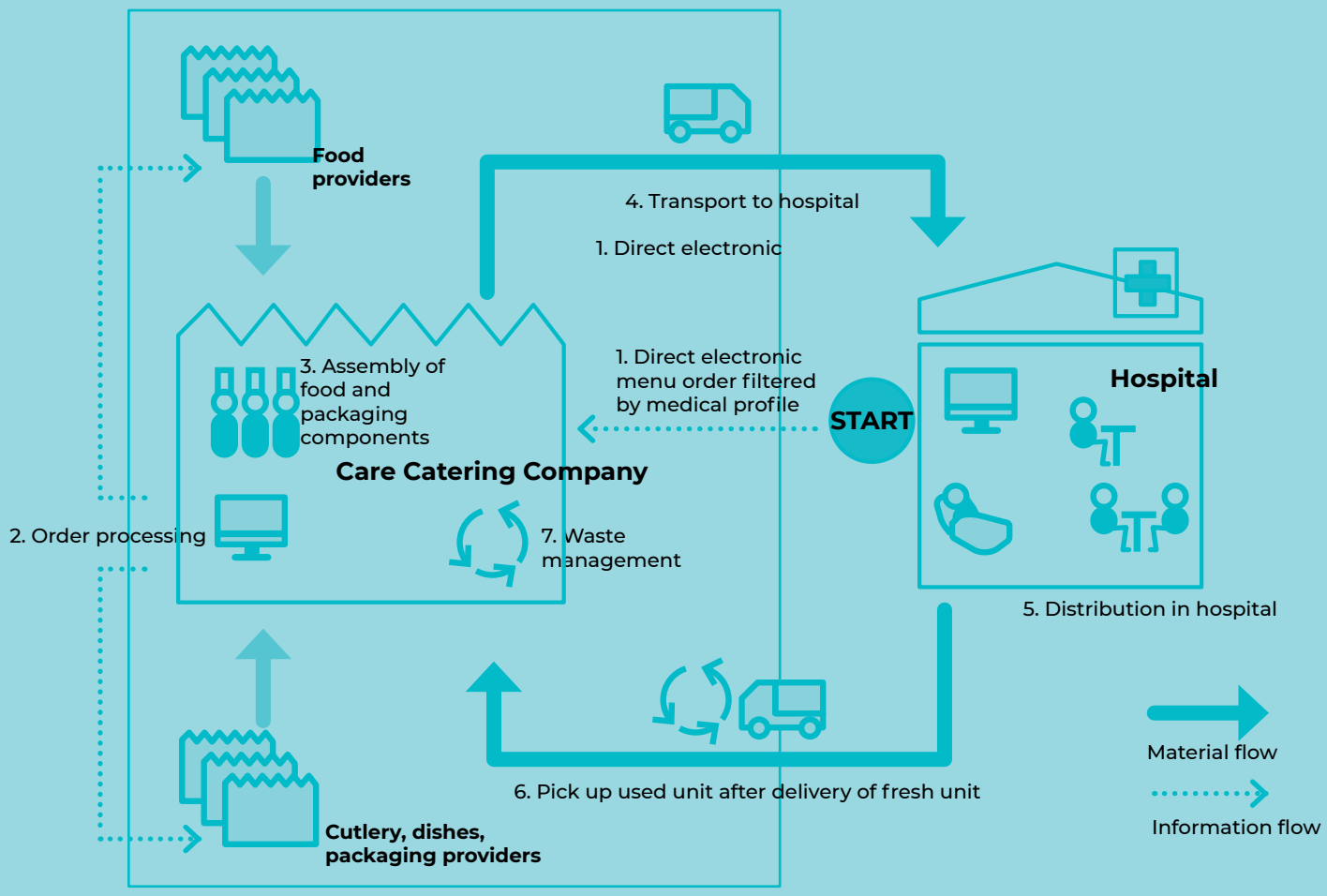


Figure T4-3. Food delivery solutions. Jegou and Joore (ed) 2014, page 51.

Qualitative Assessment Existing Product/System

To orientate system design process towards sustainable solutions (environmental, socio-ethical, economic), a set of qualitative checklist for each of the Cycle Design strategies are given. For each of the criteria it is then possible to define the relative priority: HIGH = H, MEDIUM = M; LOW = L; NO = N and draw a spiderweb (see figure T4-4)

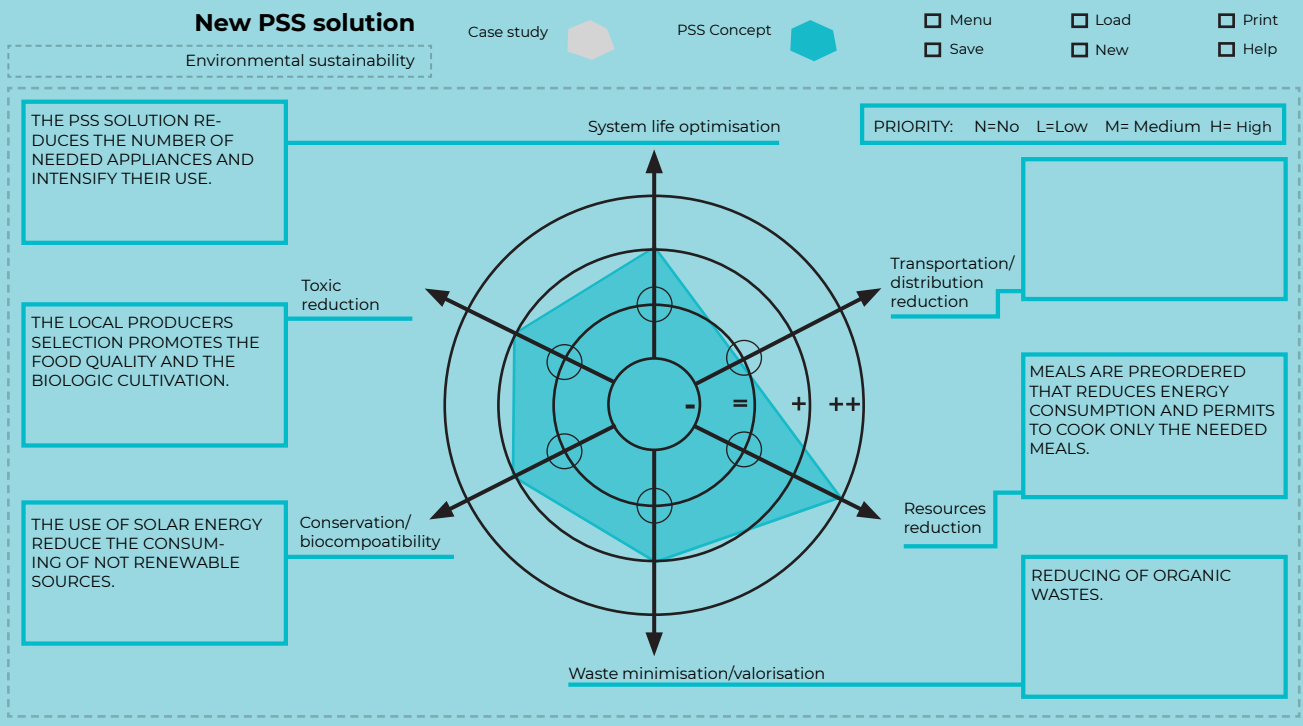


Figure T4-4: PSS solution Spiderweb

Course programme
Two modules of 3 hours each, hence the following programme is suggested.

HOURS	TOPIC
Block 1 1h	Lecture: PSS
1h	Exercise T4-1
1h	Exercise T4-2
Block 2 1h	Lecture: PSS Design
1h	Exercise T4-3
1h	Lecture on PSS Assessment with short small group exercise

EXAMPLE COURSE SCHEDULE	DAY 1	DAY 2	DAY 3			DAY 4			DAY 5
	INTRODUCTION MODULES	GENERAL MODULES	TRACK MODULES			TRACK MODULES			GENERAL MODULES
			SOCIETY	STRATEGY	TECHNOLOGY	SOCIETY	STRATEGY	TECHNOLOGY	
30min	Opening	Warm up	Track intro	Track intro	Track intro	Track intro	Track intro	Track intro	Warm up
1:30h	**Circular economy (I-1)**	Systems Thinking **(G1-1)**	Change & Transition **(T1-1)**	Business Model Design **(T3-1)**	**Material Flows & Production (T5-1)**	Change & Transition **(T1-2)**	Business Model Design **(T3-2)**	**Material Flows & Production (T5-2)**	Systems Thinking **(G1-2)**
1:30h		Stakeholders & Collaboration **(G2-1)**							Stakeholders & Collaboration **(G2-1)**
30min	Lunch	Lunch	Lunch	Lunch	Lunch	Lunch	Lunch	Lunch	Lunch
1:30h	Design for Circular Economy **(I-2)**	Policy, Legislation & Standardization **(G3-1)**	Social Design **(T2-1)**	Product-Service design **(T4-1)**	Product Design **(T6-1)**	Social Design **(T2-2)**	Product-Service design **(T4-2)**	Product Design **(T6-2)**	Policy, Legislation & Standardization **(G3-2)**
1:30h		Life Cycles, Assessment & Evaluation **(G4-1)**							Life Cycles, Assessment & Evaluation **(G4-2)**
1h	Discussion	Wrap-Up & Track Overview	Wrap-Up	Wrap-Up	Wrap-Up	Wrap-Up	Wrap-Up	Wrap-Up	CLOSING DRINKS

T5. Material flows and production

Central to the circular economy concept is the notion that the value of materials and products is kept as high as possible for as long as possible. This helps to minimize the need for the input of new material and energy, thereby reducing environmental pressure linked to the lifecycle of products, from resource extraction, through production and use to end-of-life. This module focuses on material flows and production in Circular Economy, and introduces several approaches to improve the Circularity of Material Flows & Production.

Learning outcomes
Participants will be able to...
1. Understand the basics of material flows in relation to circular design
2. Explain value creation in circular systems through closed-loops
3. Understand the basics of closed-loop system and open loop material recycling
4. Explain how to 'close-the-loop' by their material choices
5. Assess the applicability of circular design principles in an existing production line

Related Topics
Material cycles, maintenance, repair, reuse, remanufacturing, recycling and cascading, closed-loop recycling, openloop recycling, biodegradable, by-products, feedstock, Industrial Ecology, Sharing Economy, Cradle to Cradle, endof- life, end-of-use.

Introduction
Central to the circular economy concept is the notion that the value of materials and products is kept as high as possible for as long as possible. This helps to minimise the need for the input of new material and energy, thereby reducing environmental pressure linked to the lifecycle of products, from resource extraction, through production and use to end-of-life.

1. Material Flows

Material flows refer to the movement of materials which enter a system as resources and exist the system as outputs and pass to other systems. In a circular economy, material flows are made up of biological materials, which can dissolve in ecological cycles and technical materials which are inorganic materials and cannot biodegrade. These two material groups go through two separate material cycles namely technical and biological cycles. As you have studied before in I1 - Circular Economy module, in the butterfly diagram, these two separate cycles are illustrated as the wings of the butterfly. In a circular economy, products, components and materials continuously flow through value circles in other words they are looped. In the next section, we will discuss the loops in a circular economy.

2. Closed-Loop Manufacturing

The circular economy offers various ways of potential value creation through closed loops. A closed loop system refers to a production and manufacturing model which eliminates waste and regenerates value by circulating materials in the system and directing them to different circular setups. Whereas in the open loop system materials eventually are excluded from the system and become waste. So, how does the closed loop system eliminate waste? It involves reverse flow of materials back to the system such as repair, reuse, remanufacture, and recycling well as forward flows of materials for production (Schenkel, Caniëls, Krikke, & van der Laan, 2015).

Circular strategies
Repair refers to the act of restoring a damaged, faulty or out of order object to working order. This can be done by replacing parts, fixing parts to solve the problems that disturb the usual ways a product is used. On the other hand, maintenance includes the actions to keep a product in working order before the breakdown. Cleaning, lubricating and polishing are examples of maintenance acts which help prolonging the use-life of an object.

The most profitable value creation in a circular economy can be achieved through smaller loops such as maintenance, repair, and reuse. Reuse simply means using something again. In today's linear economy, reuse takes place through different channels such as second-hand shops or charity shops, online platforms such as eBay and Gumtree. Some mobile applications such as Letgo and Facebook groups are also popular to sell and buy used items.

Remanufacturing is not same as reuse or repair. It is an industrial process of returning a used product into new or better-than-new condition and

including the warranty. Aircraft components and automotive parts are some of the most commonly remanufactured product categories.

Recycling is the outer loop and should be considered as the last option because various processes that uses energy are required for recycling. The recycling process starts with collecting recyclables, sorting, cleaning and then converting them to recycled materials. After the converting process the materials go through a manufacturing process to create new products. The new products are then transported to the market and purchased by customers.

Another value creating opportunity in a circular system is cascading products repetitively from a higher to a lower value use, components or materials across different categories. It is an effective way to increase productivity by reusing and recycling the cascading material instead of valuable raw material resources. As you can see in Figure T5-1, the end-of-use apparel is transformed into stuffing for upholstered furniture and, later, it is transformed into fibre which is used as insulation material for houses (Ellen MacArthur Foundation, 2012). Some of these transformations of textiles can be repeated. When it is no longer possible to apply these steps due to the quality of the fibre, the final step could be the anaerobic digestion for cellulose-based textiles houses (Ellen MacArthur Foundation, 2012).

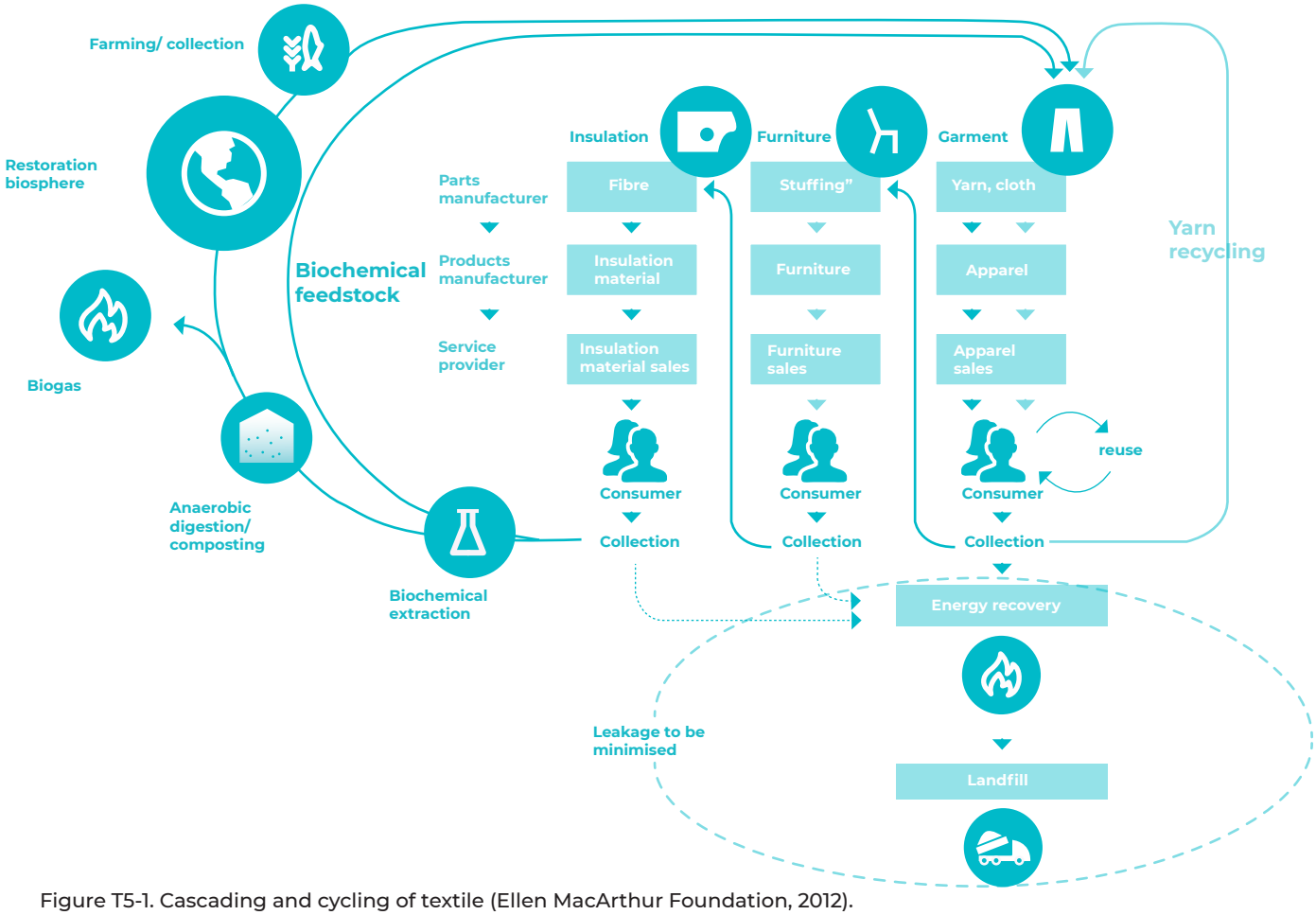


Figure T5-1. Cascading and cycling of textile (Ellen MacArthur Foundation, 2012).

Another value creating opportunity in a circular system is cascading products, components or materials across different categories. It is an effective way to increase productivity by reusing and recycling the cascading material instead of valuable raw material resources. As you can see in Figure X, transforming the construction material timber into chipboard and, later, into wood pellets which are used as fuels for electric power plants, homes, and other applications, can be given as an example for cascading materials.

Key Objectives of Value Creation in a Circular Economy
Two main objectives of value creation in a circular economy are to keep products in circulation for longer and use tighter inner loops. Keeping products, components, and materials in use longer within the circular system can be achieved by spending more time within a cycle and/or by going through the cycles multiple times. Extending the lifespan of a sofa from five to ten years can be given as an example to the former case and remanufacturing a cartridge for a printer, not one time but multiple times can be an example for the latter.

Tighter circles generally result in larger savings in terms of energy, materials, labour, etc. As it can be seen from the Ellen MacArthur Foundation's system diagram (Figure X), the inner circle of the circular system is maintenance and repair. As we discussed above, that is why recycling and remanufacturing can be a source of value creation if repair is no longer feasible.

3. Closed-Loop Recycling versus Open-Loop Recycling

It is significant to understand differences between the open-loop and closed-loop material recycling systems to be able to choose the most suitable one for manufacturing circular materials and products. In a closed-loop recycling, the material is recycled and reutilised in the same product category. An example of this would be recovered corrugated containers which are used in the production of the same corrugated containers (Gaudreault, 2012). The open-loop recycling system indicates that the recycled material is reused as raw material for other types of products. For example, in the pulp and paper sector, 90% of printing and writing paper is used as a raw material to produce other paper products such as boxboard and tissue (Gaudreault, 2012). The open-loop recycling is often regarded as worse than closed-loop recycling. However, this judgment must be made based on the environmental benefits of each recycling type which depend on complex variables.

Exercise T5-1 - Mapping the material flows

For this exercise, you are asked to map the material flows of a product of your choice with the purpose of (1) Identifying the possibilities of making the material flows in your industry circular (2) identifying the challenges of transitioning the linear material flows toward circular ones.

Here are the steps of this exercise:
1. Divide into groups of 3-5 people.
2. In your group choose a product and write it on the worksheet.
3. List up to 5 materials that enter and exit the system throughout your product's lifecycle.
4. On the diagram, map each material's flow in the system with different colour.
5. Discuss: Are they linear flows or circular flows? How can you turn the linear flows into circular ones? identify the requirements and main challenges for this transition and write them down on the worksheet.
6. Present your process and findings to other groups.

4. Challenges of Achieving Circular Material Flows

High up-front costs: Transitioning to a circular manufacturing system and switching to circular materials require high up-front investments. These costs include transforming a company's business model, altering the product design, purchasing new machinery, building new distribution arrangements, etc.

Choosing the right material: Choosing the right material is a complex task especially because some products are made from various types of materials, each with different chemical composition. The key goal of choosing circular materials is to eliminate negative health and environmental implications. Where the material comes from, how it is extracted in other words the feedstock selection is also another important aspect of choosing circular materials. For example, biological materials sourced from renewable resources or derived from waste such as food waste or agricultural by-products could be good choices for circular products. Similarly, technical materials that are derived from waste of another industrial process with a properly defined waste stream can be given as examples of circular materials.

Complex supply chain: This challenge is closely related to the previous one. It is a significant challenge to manage the supply chain. In the current global system, for some of the products the material extraction, manufacturing processes and the consumption take place in different countries. Reorganizing this entire network for a circular system will take time and effort.

A completely closed loop system: As we discussed above the unclear chemical composition of materials, complex supply chain and manufacturing system are affected by various economic, technical and social factors. As a result of this complexity, some experts argue that it is challenging to achieve a completely closed loop system.

5. Approaches to Improve the Circularity of Material Flows & Production

Industrial Ecology
Industrial ecology studies material and energy flows in an industrial system attempts to move from its linear nature to a closed-loop approach and eliminate by-products and waste. It is a system-based multidisciplinary framework focused on identifying strategies to reduce the environmental impacts of industrial processes, from material extraction through to product disposal (Thomas, 1997). The waste and by-products of other industries are utilised as inputs into its own processes. Within the industrial ecology concept, the production processes are designed in accordance with local ecological constraints and shaped in a way that they perform as close to living systems as possible. Industrial ecology ranges from purely industrial ecosystems to purely natural ecosystems with a range of hybrid industrial/natural ecosystems in between.

Manufacturing Service improvement through Performance / Sharing Economy

Manufacturing service improvement means identifying areas to work within the industrial system, across their supply chain, and with the stakeholders to shift from a traditional purchase transaction to a service model. The performance economy refers to an economy where most of the value is provided by services, and the majority of jobs are in service activities (Stahel, 1997). Through most of the past century, the success of the linear economy is measured by throughput and profit. The declining resource prices relative to labour costs have supported the economic growth in advanced economies. In fact, this success has resulted from using natural resources, especially energy, to reduce labour costs. Accordingly, using products or materials has not been a priority. Whereas the performance economy is based on optimising the use of products and services and management of existing wealth (Stahel, 1997). The competitiveness in this system can be achieved through a functional service economy in which users pay per unit of service they receive, and service providers reduce the resource flows and this, of course, will increase their profits by decreasing their material and energy costs (Stahel, 2008).

Cradle to Cradle

The biological and technical material flows in the circular economy mentioned in Section 1 are inspired by the nutrient groups in Cradle to Cradle concept. Similarly, each nutrient group has its own closed-loop cycles in an industrial or natural system. Cradle-to-cradle is a practical design framework focuses on developing products and systems that aim effectiveness in terms of positive impact, which fundamentally differentiates it from the traditional design focus on reducing negative impacts. Durability is not the only strategy when designing and producing products. Products and components are designed for continuous recovery through disassembly, upgrade and reutilisation of the nutrients depending on their use period.

6. End-of-Life or End-of-Use

The current linear economy produces an increasing amount of waste and entails significant resource losses. Over two and a half billion tonnes of waste are generated annually in the EU, according to Eurostat Data (Eurostat, 2016). According to the European Union's Road Map, it would take the equivalent of more than two planets to sustain humanity by 2050 if we continue to consume resources at the current pace. The circular economy changes the current understanding of the end of life of products by employing renewable energy and eliminating the use of toxic chemicals. Products do not have end-of-life in a circular economy, they have end-of-use. After their use-life ends, they get reused repetitively in cycles. The current end-of-life management of products mainly consists of traditional waste collection and a limited percentage of material recovery. In order to accelerate the move towards a circular economy, the available end-of-use scenarios should be transformed into advanced strategies which ensure the value regeneration through circulation of products, components, and materials.

Exercise T5-2 - Re-design and make it circular

For this exercise, you are asked to individually redesign the product that you have chosen in the previous exercise considering the requirements and challenges that you have identified. Here are the steps of this exercise:

1. Each group member gets a worksheet. The worksheet of "mapping the material flows exercise" stays in the middle of the group members so that everyone can see it.
2. Look at the approaches to improve the circularity of material flows & production that were discussed during the lecture. Individually choose and circle one or more of them and apply them in your new product that you will develop in the next step.
3. Individually generate ideas and re-design the product considering the requirements and challenges that you have identified. Sketch your idea on the worksheet. The aim is to make the material flows circular.
4. Define your idea with 2-3 sentences.
5. Present your idea to your group and get feedback.
6. Vote and choose the best idea considering circularity and implementation.

Module programme
Two modules of 3 hours each, hence the following programme is suggested.

HOURS	TOPIC
Block 1 1h	Lecture: Material Flows and Closed-Loop Manufacturing
1h	Lecture: Value Creation in a Circular Economy
1h	Exercise 1: Mapping the material flows
Block 2 1h	Lecture: Challenges of Achieving Circular Material Flows
1h	Lecture: Approaches to Improve the Circularity of Material Flows & Production
1h	Exercise 2: Re-design and make it circular

Key Actions
- Familiarise yourself with the concepts of material cycles and approaches that focus on circular material flows & production.
- Identify the possibilities of making the material flows in your industry circular.
- Identify the challenges of achieving circular material flows for your product.
- Generate value creation ideas in circular systems through closed-loops

Methods and Tools

- - Material Wise (Circular Design Project). Link: http://circulardesigneurope.eu/oer/material-wise/
- IDEO Circular Design Guide- Understand Circular Flows Link: https://www.circulardesignguide.com/post/loops
- IDEO Circular Design Guide - Smart Material Choices link: https://www.circulardesignguide.com/post/materials
- The Cradle to Cradle certified products resource link: https://www.c2ccertified.org/products/registry/search&category=materials_for_product_designers

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EXAMPLE COURSE SCHEDULE	DAY 1	DAY 2	DAY 3			DAY 4			DAY 5
	INTRODUCTION MODULES	GENERAL MODULES	TRACK MODULES			TRACK MODULES			GENERAL MODULES
			SOCIETY	STRATEGY	TECHNOLOGY	SOCIETY	STRATEGY	TECHNOLOGY	
30min	Opening	Warm up	Track intro	Track intro	Track intro	Track intro	Track intro	Track intro	Warm up
1:30h	**Circular economy (I-1)**	Systems Thinking **(G1-1)**	Change & Transition **(T1-1)**	Business Model Design **(T3-1)**	Material Flows & Production **(T5-1)**	Change & Transition **(T1-2)**	Business Model Design **(T3-2)**	Material Flows & Production **(T5-2)**	Systems Thinking **(G1-2)**
1:30h		Stakeholders & Collaboration **(G2-1)**							Stakeholders & Collaboration **(G2-1)**
30min	Lunch	Lunch	Lunch	Lunch	Lunch	Lunch	Lunch	Lunch	Lunch
1:30h	Design for Circular Economy **(I-2)**	Policy, Legislation & Standardization **(G3-1)**	Social Design **(T2-1)**	Product-Service design **(T4-1)**	**Product Design (T6-1)**	Social Design **(T2-2)**	Product-Service design **(T4-2)**	**Product Design (T6-2)**	Policy, Legislation & Standardization **(G3-2)**
1:30h		Life Cycles, Assessment & Evaluation **(G4-1)**							Life Cycles, Assessment & Evaluation **(G4-2)**
1h	Discussion	Wrap-Up & Track Overview	Wrap-Up	Wrap-Up	Wrap-Up	Wrap-Up	Wrap-Up	Wrap-Up	CLOSING DRINKS

T6. Product design

This module focuses on product design for value recapture in Circular Economy, and introduces several strategies to re-imagine sustainable products.

Learning outcomes
Participants will be able to...
1. Explain the main principles for circular design in the product design context
2. Work towards developing realistic strategies for circular product design
3. Access existing methods and tools for circular product design
4. Apply the methods and tools for circular product design
5. Assess the applicability of circular design principles for an existing product.

Related topics
Adaptability, attachment, compatibility, disassembly, durability, maintenance, prevention, product lifetime extension, reassembly, recycling, reduce, refurbishing, refuse, reliability, remanufacturing, remarketing, repair, repurposing, rethink, reuse, standardisation, trust, upgradability

Longevity vs. Ephemerality
Designing products for the circular economy requires a deeper understanding of the perceived lifespan of said products. Although the logical approach would be eliminating short-lived products (e.g. through designing reusable alternatives, creating product-service systems, etc.), this may not be possible for the product design project at hand. Such an understanding from the very beginning enables planning for value recapture throughout the design process.

For example, an electronic device - or at least some parts of it - might become technologically obsolete due to certain advancements. If such a product is designed for value recapture, it might be possible to upgrade the device through part replacement, reuse of parts and components, or recycling non-renewable materials. Another example can be about food packaging, and their single-use life. Ice cream cone is a good example of how to serve food, as it is consumed with the commodity (i.e. ice cream). All these are completely different from the products which we expect to last, like white appliances.

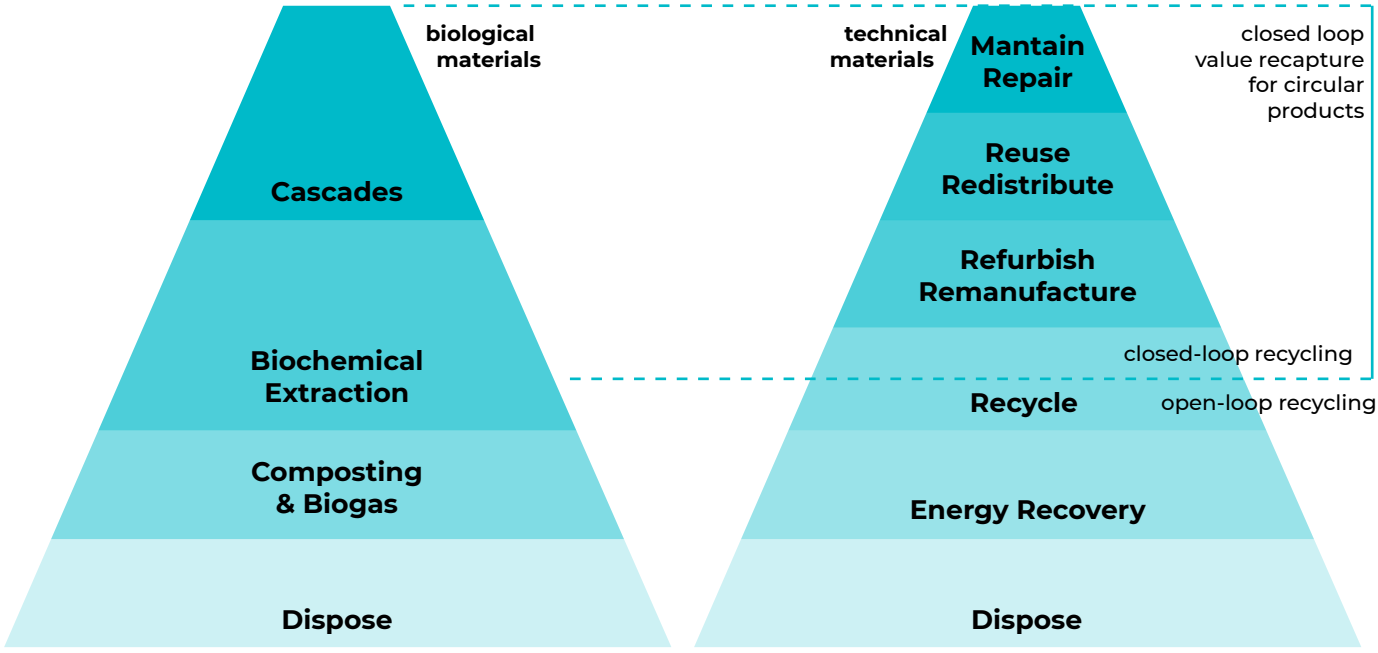

Figure T6-1. Value recapture hierarchy for designers

Longevity and ephemerality should be weighed against each other to ensure the best strategy from a socioecological perspective, ensuring the least possible leakage to the biosphere (see the butterfly diagram in I1 - Circular Economy) and empowering people through value recapture.

Figure T6-1 presents a value recapture hierarchy inspired by the 'waste pyramid' and showcases the strategies need to be taken for biological and technical materials separately. Closed-loop value recapture happens on the upper part of the pyramid, ensuring the utmost recovery for businesses.

Disposal is placed at the lowest section of both pyramids indicating the least desirable strategy with no possibility of recovery of any kind of value.

Throughout this Professional Development Course, these circular economy strategies have been presented many times and ways of implementing them are showcased through numerous examples. However, on the product design level, realizing these strategies require careful, informed decisions for each part, component, production technique, assembly step and post-use. This module introduces certain aspects to consider throughout the design process, whether you are designing for longevity or for ephemerality.

Exercise T6-1 - Exploring realistic end-of-life scenarios for your product
This exercise involves understanding which aspects of your product are short-lived, which are long-lived, and what leads to the disposal of your product. Through examining realistic end-of-life scenarios, you can identify areas of intervention for your design process. On a piece of paper, create a table similar to Table X. Write down reasons for disposal, when they happen after purchase and which parts or components are related to them.

Table T6-1. Example of the exercise table, for smartphones (this list is representational and can be expanded)

#	Reason for disposal	When	Parts / Components
1	Buying a better alternative	One year	Processor, Camera Software, Screen
2	Screen cracked, too expensive to replace	When the phone is dropped	Screen
3	Battery life dropped, too expensive to replace	Three years	Battery
4	Slowed down	Two years	Software
5	Too many scratches, dents, etc. on the exterior	Two years	Outer shell, material

Considerations for Designing Products in a Circular Economy
A number of examples of circular designed products are given below when discussing the various considerations. These examples can be found as case studies on circulardesigneurope.eu

Durability & Attachment
This consideration revolves around the possibility of making products last long, not only through durability of its materials and construction but also through users' attachment and trust towards them. The materials used to manufacture products have the properties to outlast their actual use-time, which begs the question of why people discard them and how can we design products that would last.

Aesthetics, or changing perception of it through trends, fashion, and so on, is a driver for premature discarding of fully operational / functional products. While there have always been discussions on 'timeless' designs and their aesthetic properties being unaffected by ephemeral concepts e.g. fashion, achieving timelessness in product design is a challenge and mostly inapplicable for many product types currently in use.

While luxury items, e.g. certain watches, furniture, etc. can achieve such aesthetic superiority, there are many more products used repeatedly in daily life which will not.

Another concept on aesthetic durability is aging gracefully, which acknowledges the fact that, even if a product remains perfectly functional, its exterior will be subject to wear, tear and simply aging. The degradation of materials is one constant which needs to be examined, explored and exploited to sustain the value of products over time.

While the aesthetic durability of products is an important factor to prevent their disposal, users should be motivated to keep-using them. Personalization comes forth as a consideration, through the involvement of users into the design and production processes fully or partially to create products they need, want, desire. Halfway designs are a good example of how users can be partially involved into these process, e.g. Do-hit chair by Droog Design. Users' further involvement is also discussed in G-2 Co-creation and Collaboration module.

Ease of Maintenance and Repair
Maintenance and repair are at the top of value recapture hierarchy as they ensure the continued use of products. In current business models, this refers to the availability and accessibility of maintenance and repair services provided by businesses themselves or associated stakeholders, as well as ensuring that these processes are easy to perform by design, with little to no risk of service staff damaging the products throughout these processes. For more complex products, e.g. cars, scheduled servicing to perform professional maintenance is important to prevent any foreseeable break-down.

For less complex products, however, user maintenance is an important aspect to include from the very beginning of the design process. Products, in

their current widespread forms, conceal the maintenance need and require feedback mechanisms to ensure the visibility of the maintenance need. The feedback does not need to be invasive or high-tech, and can be as simple as making it visible, like Bora water-filter vacuum cleaner by Arnica which makes the need for cleaning the water and HEPA filter through see through compartments. However, the visibility of the maintenance need should be supported by the ease of user maintenance, so that the maintenance processes do not cause harm to the product functionality and can be performed easily and correctly by users.

When product breakdowns occur, users' challenge is generally the cost and duration of the professional repair services. As an alternative, businesses can explore user repair options for their products. This requires an overhaul of the design for dis- and re-assembly by non-professionals, as well as clear instructions for diagnosis and repair, and accessibility to spare parts and necessary tools . E.g. Fairphone is a good example of enabling user repair, in addition to responsible material sourcing.

Upgrading & Adapting
In order to keep-using the overall product, some aspects of it may need upgrading for several reasons, like advances in technology, transition to improved energy efficiency, changing needs and preferences, and so on. Generally, only some parts of an overall product is required to change, however the design and manufacturing decisions of products generally do not allow such upgrades. The black box nature of modern products require the disposal of the old and acquisition of the new products with every change in needs, preferences and technology. The most common upgrading practices are visible in software-based technologies, like smartphones, in which the general software is updated to include new features and performance improvements. Also, new features can be added or unused features can be deleted through e.g. improved features and performance, and the whole experience can be personalized through additional digital components.

The challenge for product design, however, is upgrading the physical parts and components to introduce overall improvements or features according to changing needs and preferences of the user and motivate them to continue using the products. This requires modularity of parts for replacing them with improved versions, adding new parts for additional features, and removing parts if they are no longer used. While new or different parts can be produced and provided by the businesses themselves, they can also be provided by third-parties through shared properties, e.g. *connectors in PhoneBloks example*.

Reuse & Second-use
At this stage of product life-cycle, either the user decided not to use a product anymore or the functional lifespan of the product has ended. For the former, the product can still be used by another user and still holds value to be exchanged in e.g. second hand markets. At this stage, the product can be refurbished to attain any lost value and is provided to its next user. Similarly products can be remanufactured to the original specifications, using reused, repaired and new parts, restoring its added value. There is also the possibility of reusing parts and components of a discarded product to manufacture

different products. Short-circuit kitchen appliances project is a good example of this, which reuses functioning electrical parts of old kitchen appliances to produce different new ones.

While reusing products, parts and components to recapture their added value is important, it may not always be possible for your product and parts, especially if they have a specific, short-term function as opposed to long-term durability of their materials. It might be useful to consider a secondary function for it and design those parts with a second-use scenario. Heineken beer bottles designed to be used as bricks is a good example of this.

Design for End-of-Life
For the final stage of value recapture, the end-of-life conditions of your product need to be considered. For the technical loops of Circular economy, this refers to the recycling of technical materials. For value recapture within your business i.e. closed-loop recycling , you should consider getting your products back at the end of their lives, dismantling them within your production lines and recycling valuable materials.

Alternatively, you can consider recycling other businesses' waste streams as raw materials for your products, i.e. industrial symbiosis . *Sea2See sunglasses* is a good example of this, as their frames are produced out of recycled fishing nets. While closed-loop recycling and industrial symbiosis ensures the best conditions for recycling the materials used in your products, these opportunities may not be feasible for your business. In those cases, you should consider existing local waste management facilities and their capabilities for open-loop recycling . For this, you have to be familiar with existing recycling opportunities, ensure that your products are disposed of the right way through informing and motivating users, and ease the dismantling of your product. *The Realist Toaster concept by Agency of Design* is a good example of this, as it includes pins for dismantling the whole toaster into parts, which are activated in a low-pressure chamber.

Exercise T6-2 - Redesigning your product for value recapture

In this exercise, you will develop value recapture ideas as an alternative to the realistic end-of-life scenarios you identified in Exercise 1. For each idea, you will identify challenges and opportunities for your business. You are expected to re-imagine your products with the value recapture strategies explained throughout this module. Suggestion: Form groups of four and use the brainwriting technique for the initial 30 minutes to generate ideas.

Module Programme
Two modules of 3 hours each, hence the following programme is suggested.

HOURS	TOPIC
Block 1	Lecture: Longevity vs. Ephemerality in Product Design
	Exercise 1: Exploring realistic end-of-life scenarios for your product
Block 2	Lecture: Considerations for Designing Products in Circular Economy - Part 1
	Lecture: Considerations for Designing Products in Circular Economy - Part 2
	Exercise 2: Redesigning your product for value recapture

Key Actions

- Familiarize yourself with the concepts of ephemerality and longevity, value recapture strategies, open and closed loops.
- Identify realistic end-of-life scenarios for your product. Use existing literature or field study on the topic if possible.
- Generate ideas in line with the value recapture strategies, as many as you can.
- Assess ideas and identify the ones with highest possible value recapture.

Methods and Tools

- Value Recapture Brainwriting (Circular Design Project). Link: http://circulardesigneurope.eu/oer/value-recapture-brainwriting/
- IDEO Circular Design Guide - Make Tools. Link: https://www.circulardesignguide.com/methods/make
- Design with Intent Toolkit (by Dan Lockton). Link: http://designwithintent.co.uk/

Literature

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