



Aalto University
School of Arts, Design
and Architecture

Design Approaches to Sustainable Consumption

**Session 3: Systemic design, sustainable Product-
Service-System (PSS) design and circular economy**

Tatu Marttila

17.1.2023 (13:15-17:00)

Agenda

- 13:15–13:45** Recap of first week & status of case work
- 13:45–14:30** System focus in design: From products to services and further
- 14:45–15:30** Sustainable Product-Service-System (PSS) design
- 15:30–16:30** Group exercise
- 16:30–16:45** Concluding session

Course and case work schedule

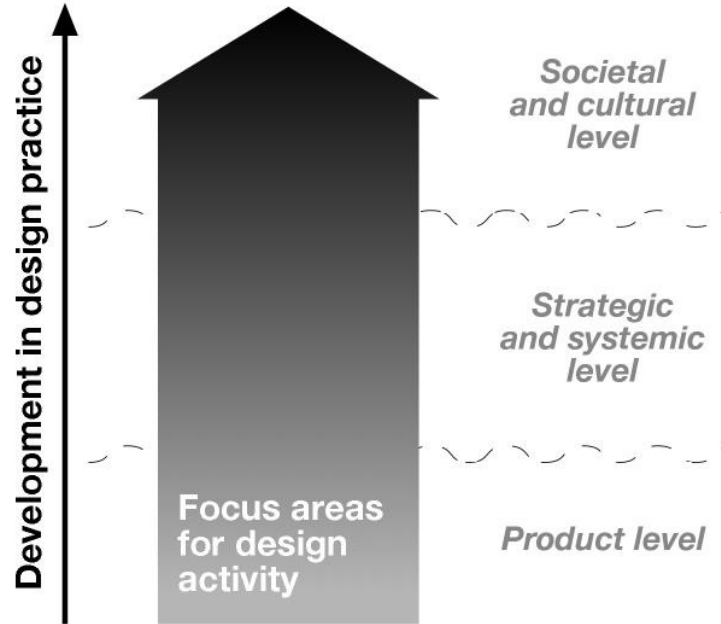
Working days	Tuesdays (13-17)	Thursdays (9:15-12)
Week 1 (10. & 12.1.)	Introduction to course; DfS introduction (F101)	Case introduction: Food system sustainability (Q201)
Week 2 (17. & 19.1.)	Systemic (PSS) design and circular economy (Q201)	Design for sufficiency (Q201)
Week 3 (24. & 26.1.)	Presenting case work ideas (F101)	Assessing and communicating sustainability impacts (Q201)
Week 4 (31.1. & 2.2.)	Negotiating food systems experiments (Q201)*	Scaling-up design ideas (Q201)*
Week 5 (7. & 9.2.)	One planet game session (L1–241, Puunjalostustekniikka 1)	Case work tutoring (Q101) <i>Concept poster by Friday!</i>
Week 6 (14. & 16.2.)	Final presentations (F101)	Summary discussion (Q101)

Recap of first week topics

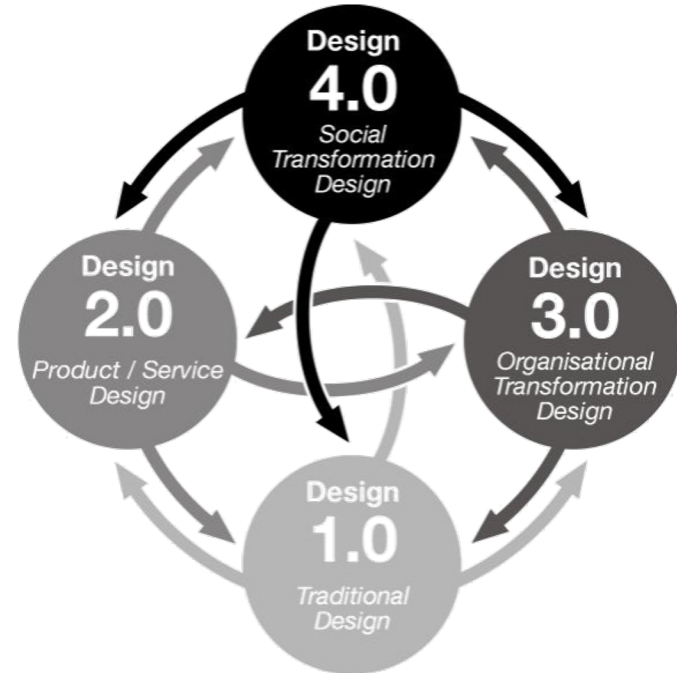


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Focus areas for sustainable design action



Source: Author



Source: Aminoff, et al. 2011;
GK VanPatter and Elizabeth Pastor, 2005

Strategies for Design for Sustainability

DfS approaches can be divided in **four levels of focus** according their relation to systemic and socio-technical emphases (Ceschin & Gaziulusoy, 2020):

1. Product innovation level:

- Green design
- Ecodesign
- Emotionally durable design
- Design for sustainable behaviour
- Cradle-to- Cradle design
- Biomimicry design
- Design for the Base of the Pyramid

2. Product-Service System innovation level:

- Product-Service System design

3. Spatio-Social innovation level:

- Design for Social Innovation
- Systemic Design

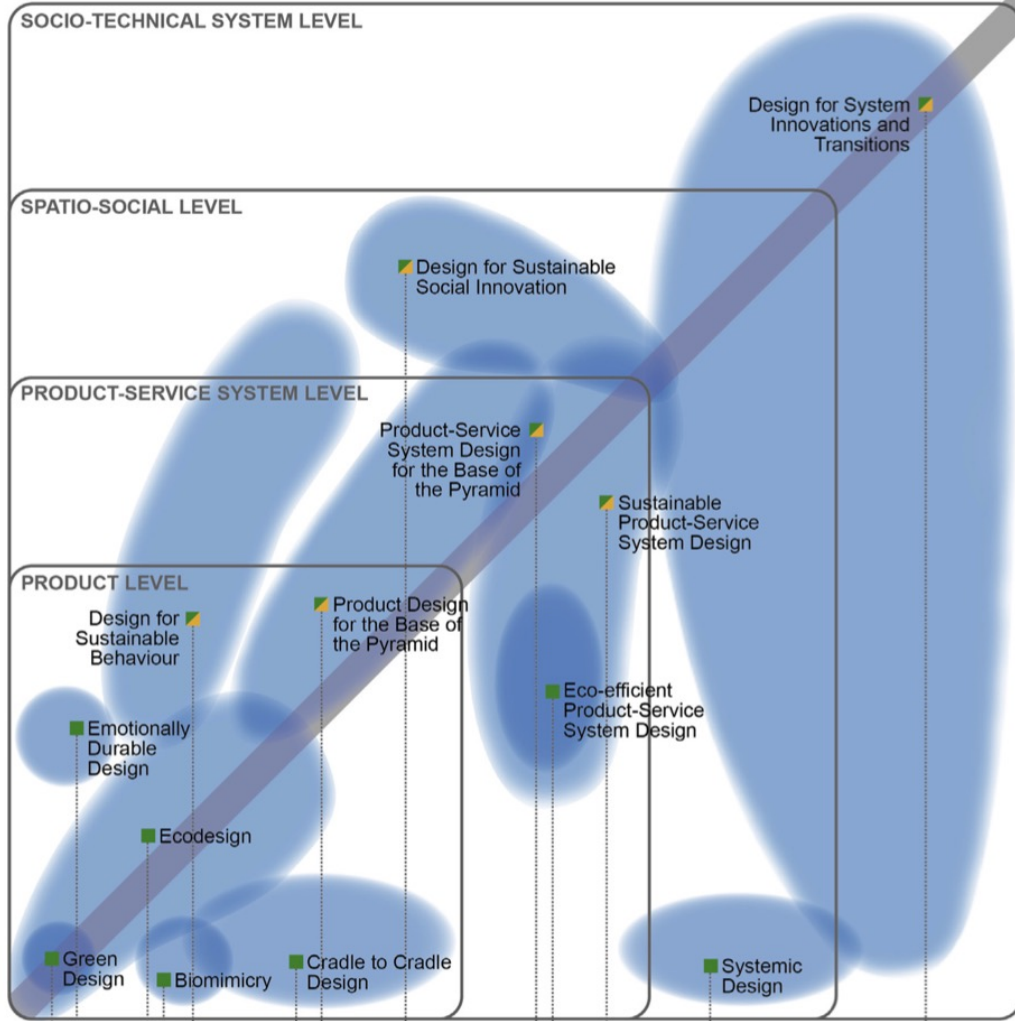
4. Socio-Technical System Innovation level:

- Design for System Innovations and Transitions

INSULAR

SYSTEMIC

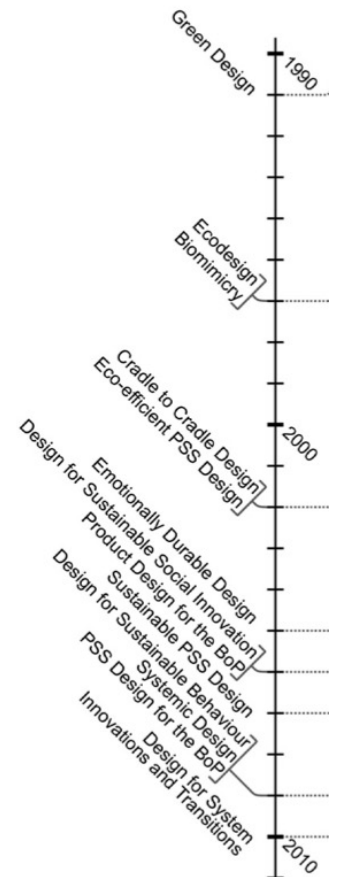
Increasingly
potentially
sustainable



TECHNOLOGY

PEOPLE

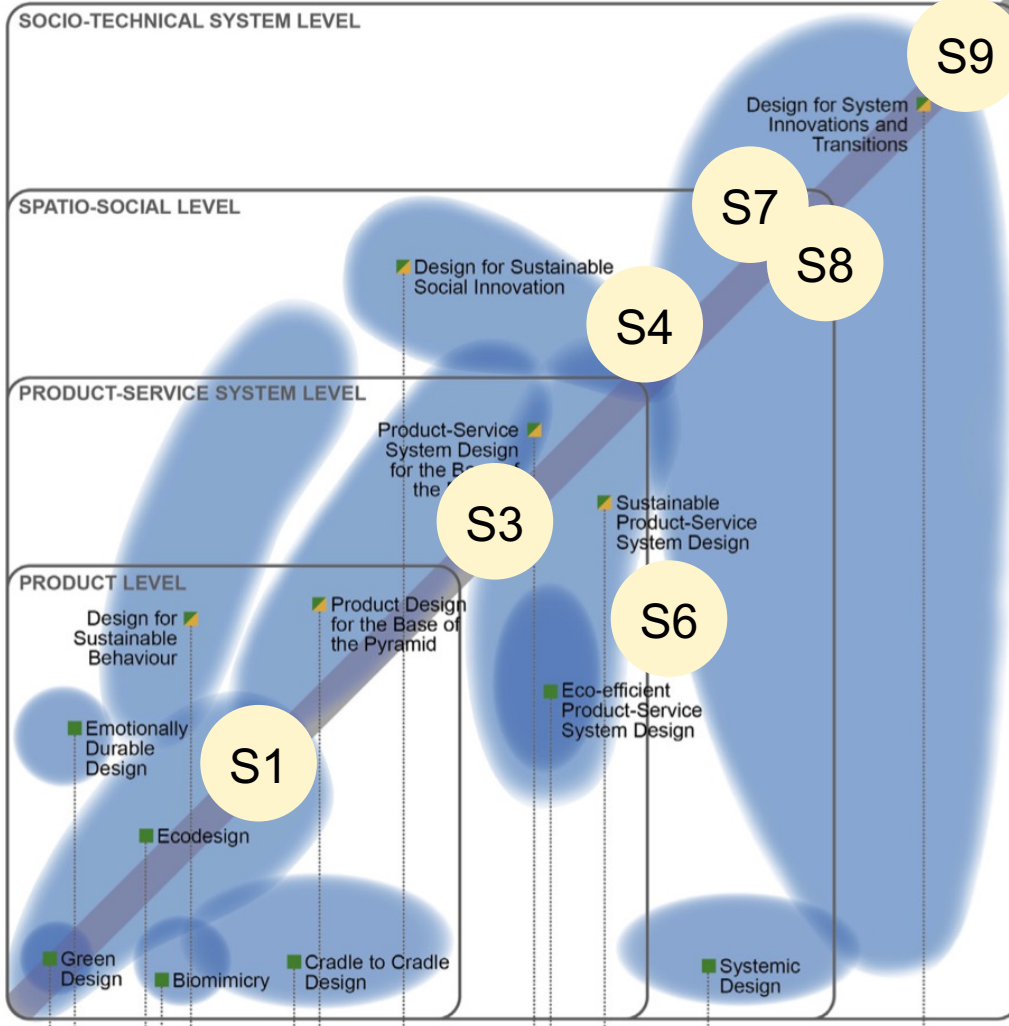
- Approach addressing the environmental and economic dimensions of sustainability
- ▣ Approach addressing the environmental, socio-ethical and economic dimensions of sustainability



A?

INSULAR

SYSTEMIC



Increasingly potentially more sustainable

PEOPLE

TECHNOLOGY

Lectures and sessions:

- S1. Introduction to DfS
- S2. Case work intro**
- S3. PSS design
- S4. Design for sufficiency
- S5. Idea presentations**
- S6. Sustainability assessment
- S7. Scaling-up
- S8. Changing consumption
- S9. One-planet game
- S10. Shared tutoring**
- S11. Final presentations**
- S12. Summary session

Green square: Approach addressing the environmental and economic dimensions of sustainability

Yellow square: Approach addressing the environmental, socio-ethical and economic dimensions of sustainability

Case work – steps so far...

- **Structure your schedule and group meetings beforehand; Agree on next steps and divide work**
- **Get familiar with material package in MyCourses**
- **Arrange a meeting with your tutor**
- **Perform rapid ideation, to come up with initial ideas for the idea presentation session**
- **Begin to prepare for idea presentations next Tuesday!**

- *How has the work started – status reports?*

System focus in design



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Sustainability as a holistic concept

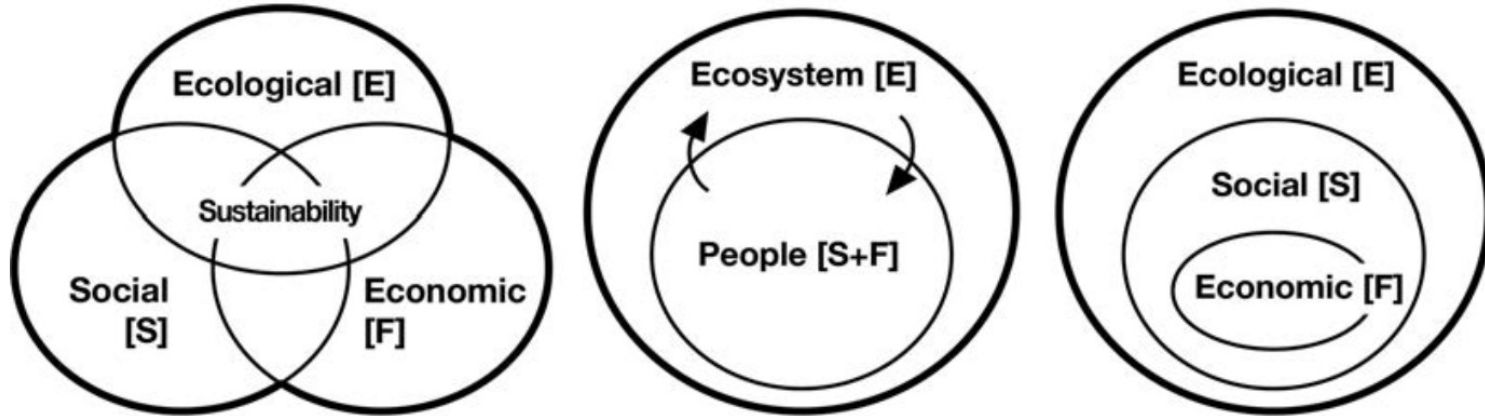


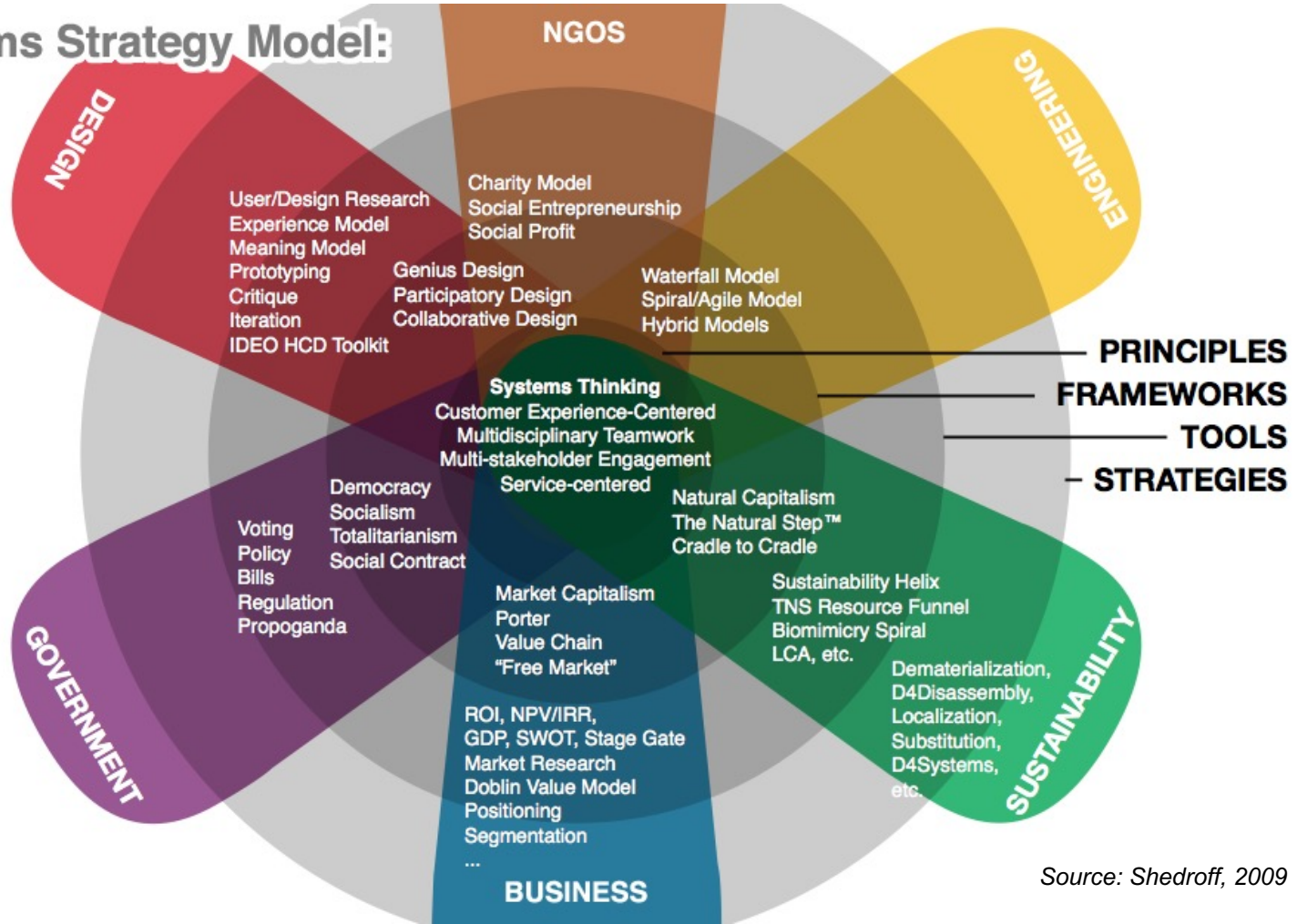
Figure 4. *Diagrams of sustainability: The interlocked circles model (on left), and the nested sustainability models.*

Sources: IUCN (1991); Willard (2005)

Sustainable Development Goals

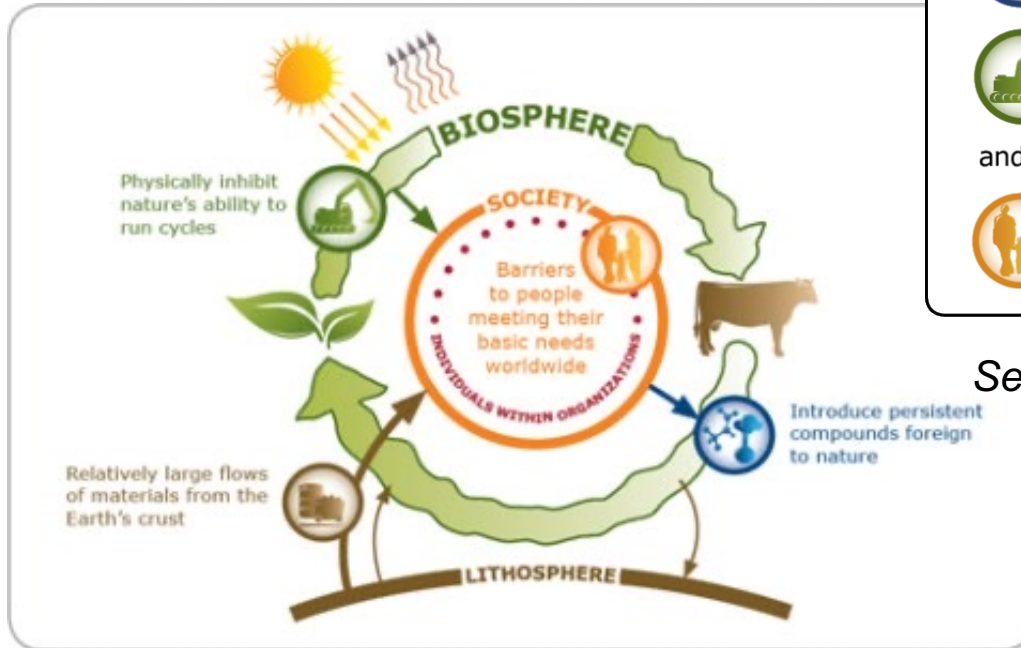
1 NO POVERTY 	2 NO HUNGER 	3 GOOD HEALTH 	4 QUALITY EDUCATION 	5 GENDER EQUALITY 	6 CLEAN WATER AND SANITATION 
7 RENEWABLE ENERGY 	8 GOOD JOBS AND ECONOMIC GROWTH 	9 INNOVATION AND INFRASTRUCTURE 	10 REDUCED INEQUALITIES 	11 SUSTAINABLE CITIES AND COMMUNITIES 	12 RESPONSIBLE CONSUMPTION 
13 CLIMATE ACTION 	14 LIFE BELOW WATER 	15 LIFE ON LAND 	16 PEACE AND JUSTICE 	17 PARTNERSHIPS FOR THE GOALS 	 THE GLOBAL GOALS For Sustainable Development

Systems Strategy Model:



Source: Shedroff, 2009

The Natural Step – principles for sustainable design



In a sustainable society, nature is not subject to systematically increasing...



...concentrations of substances extracted from the Earth's crust,



...concentrations of substances produced by society,



...degradation by physical means,

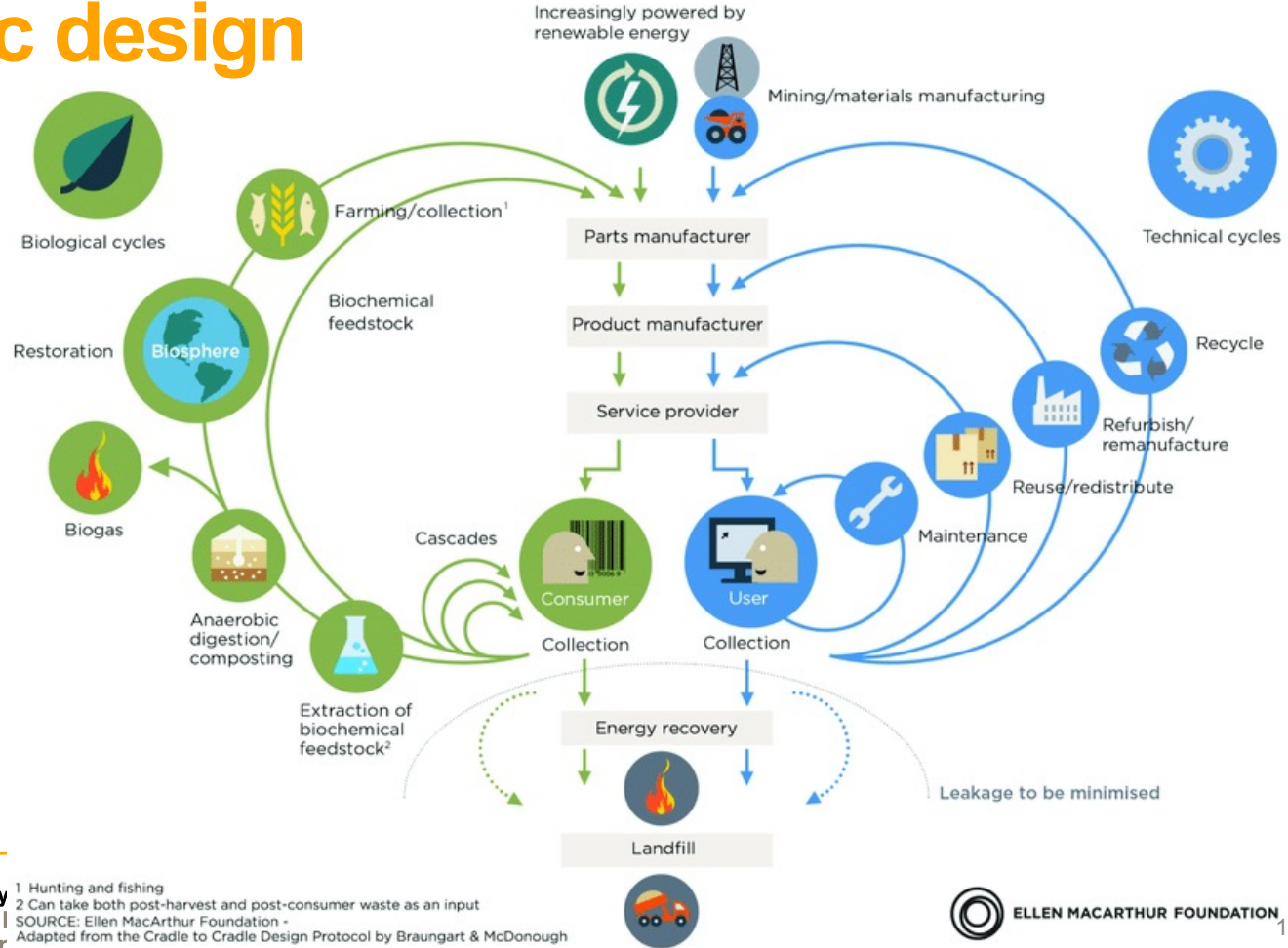
and, in that society...



...people are not subject to conditions that systematically undermine their capacity to meet their needs.

See: <https://thenaturalstep.org/approach/>

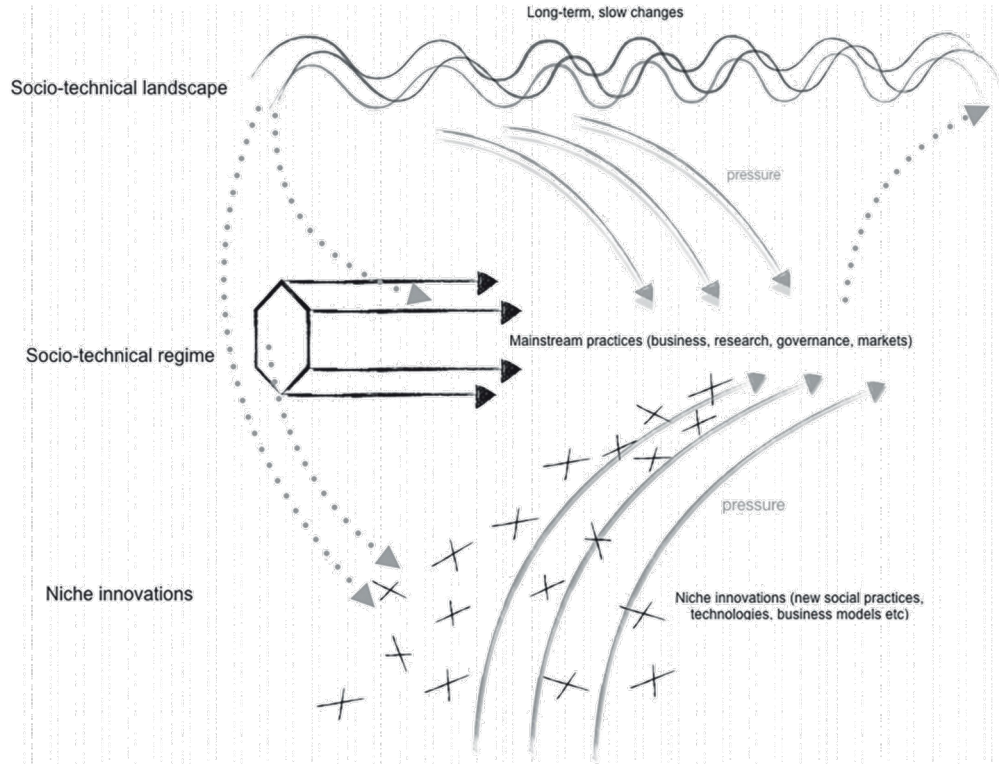
Circular economy & systemic design



Socio-technical systems and sustainability transitions

Transition Management (TM) methodology is based on a *multi-level perspective* on sustainability transitions within the socio-technical system context, with focus on:

- **Macro-level (landscape)**
- **Meso-level (regimes)**
- **Micro-level (niches)**



The dynamics of socio-technical change:

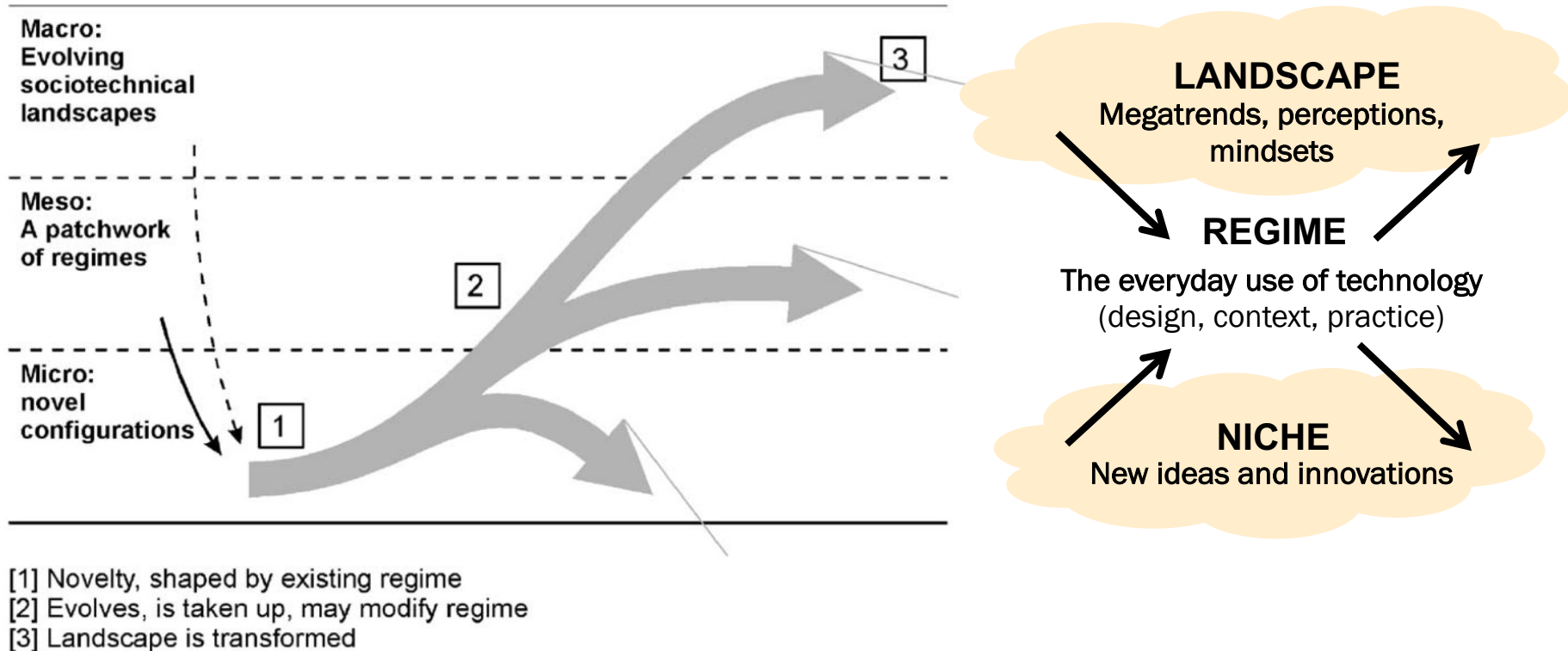


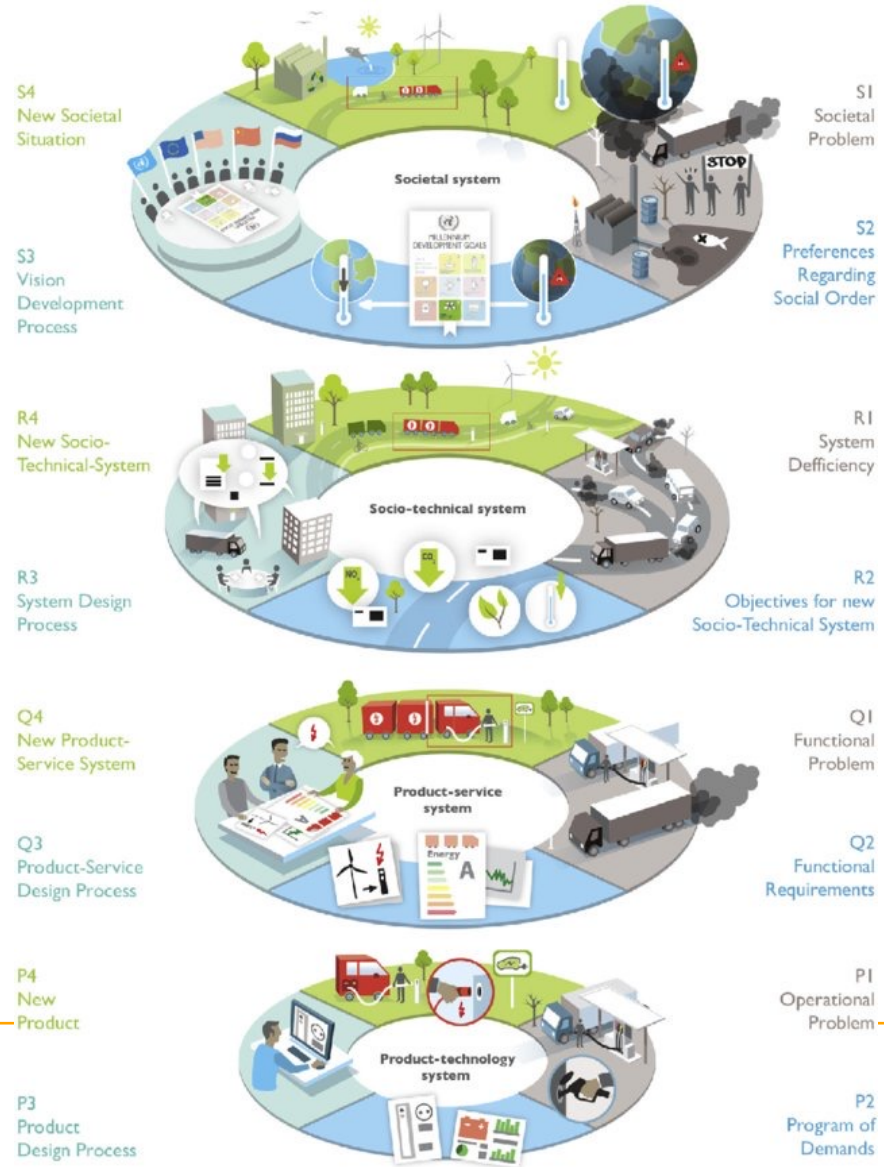
Fig. 4. The dynamics of sociotechnical change (Rip and Kemp, 1996; Kemp et al., 2001).

Multilevel focus for design

Multilevel perspective adapted to design:

“The role of designers is broadening, from the creators of physical arte-facts to the potential role of facilitators of complex societal change processes. To support the widening role of the designer, there is a need for a design supportive model.”

Multilevel Design Model (MDM) by Joore & Brezet (2014)



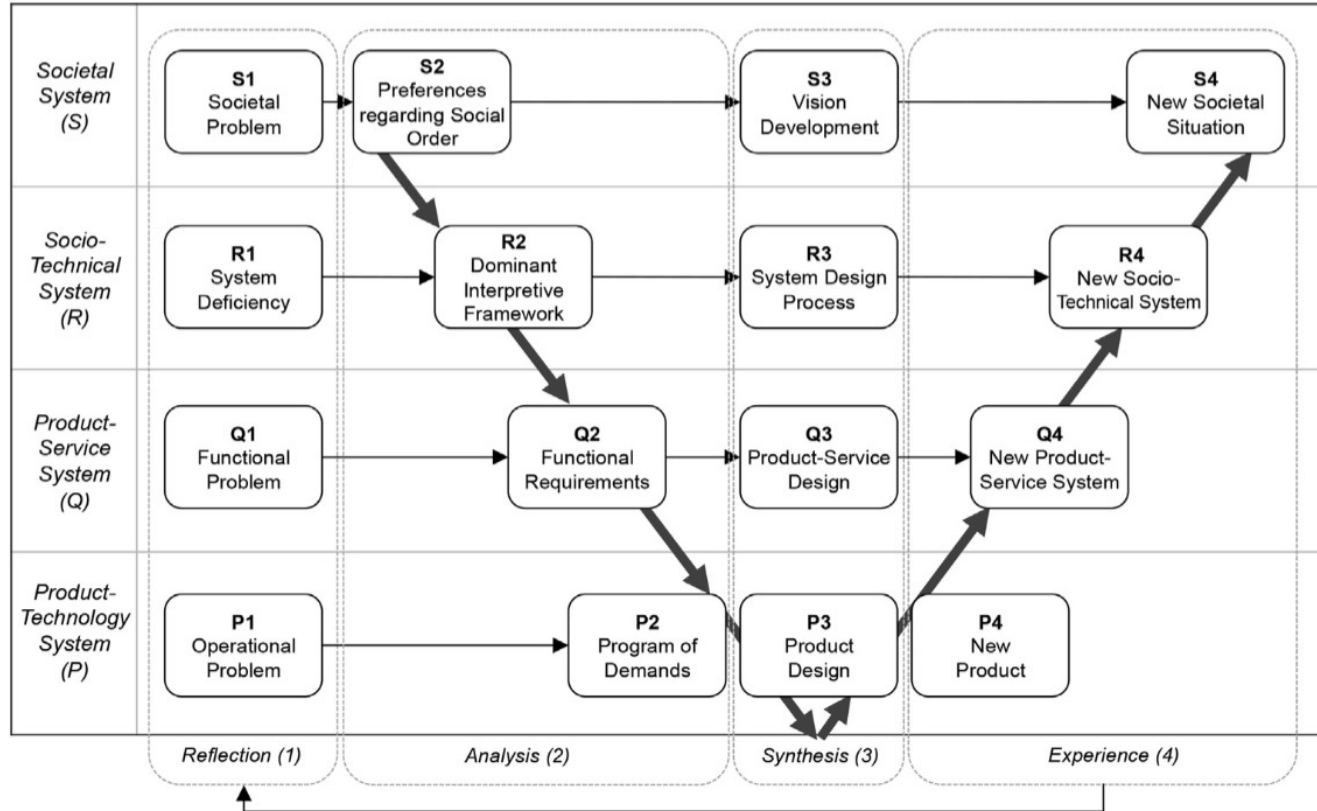
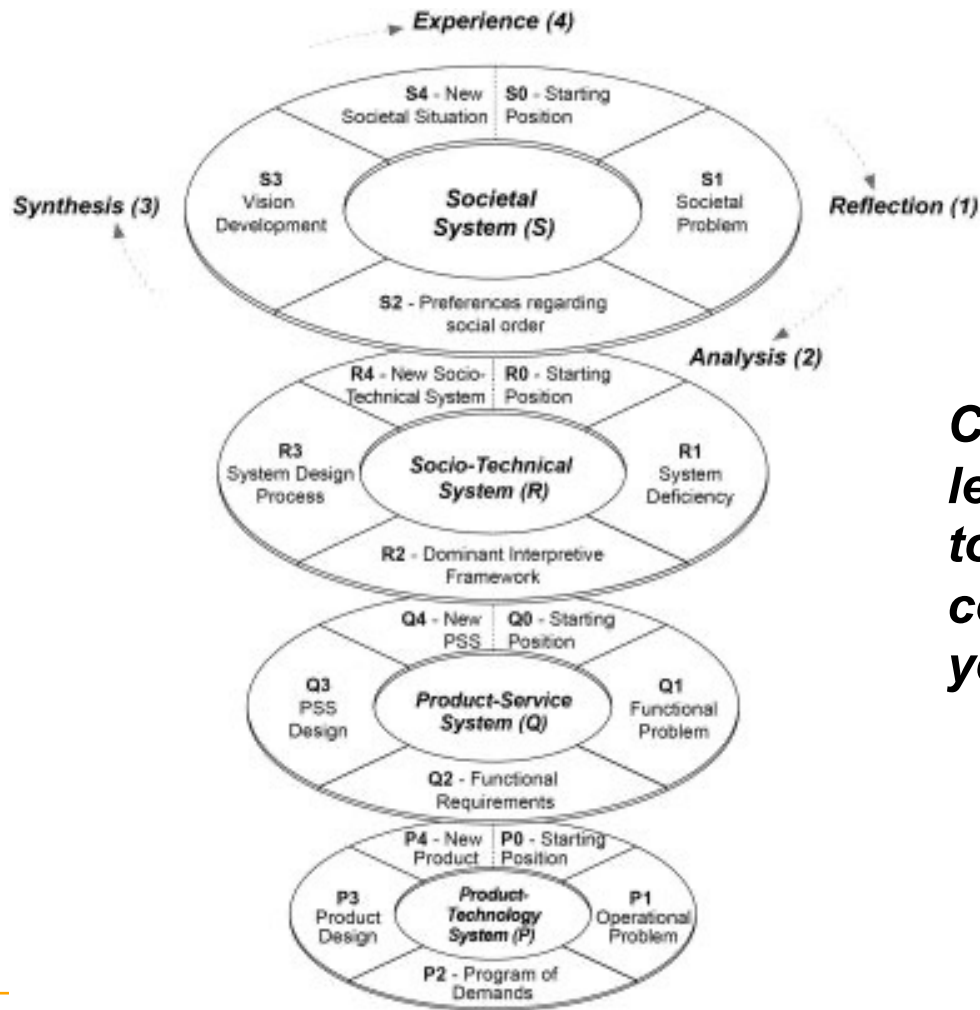


Fig. 2. Multilevel Design Model (Linear representation).



Consider all levels and how to align/ connect them in your design



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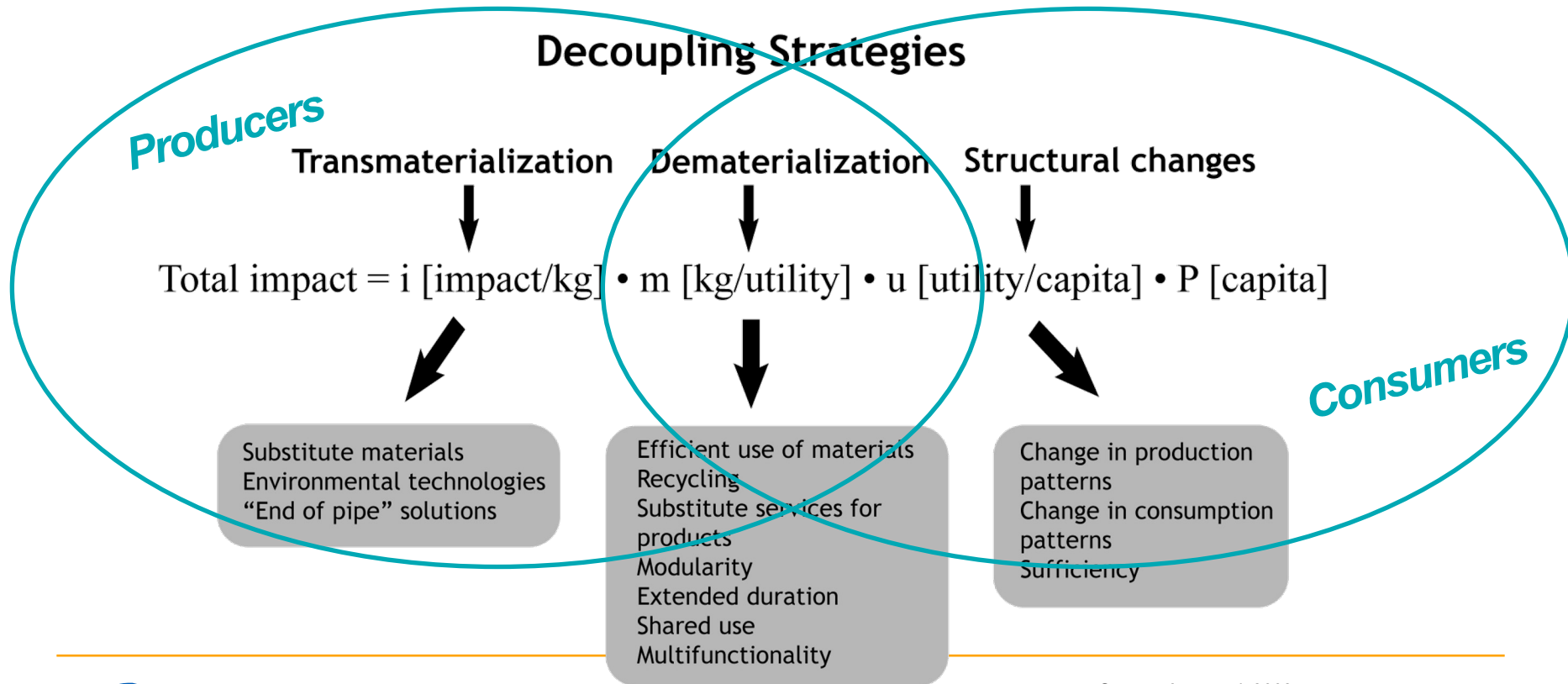
Joore & Brezet (2014). "A Multilevel Design Model – The Mutual Relationship between Product-Service System Development and Societal Change Processes"; As an optional reading in MyCourses!

From products to systems and services



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Strategies for Sustainable Consumption and Production



Product-Service System (PSS) Design for Sustainability

Based on the model of functional economy (Stahel, 1997), Product-Service System (PSS) Design considers products as interfaces to larger product-service systems, and moves the focus towards systemic efficiency in access to the services that products provide.

Endorsed also by the UNEP (2002), **sustainable PSS design considers alternative business and service models** that could provide improved sustainability by adjusting ownership and revenue models, and by adding more stakeholders to the process.

- *PSS enables systemic improvement and more efficient access to services that products offer*
- *PSS enables changes product ownership models; Offering access to services instead of products*
- *PSS adds value to stakeholder network; Potential co-governance in design, production and management*

Product-Service System (PSS) design

Products as artifacts offer interfaces to functions and services they provide. Product-Service System (PSS) design moves the focus of design action towards the whole system of service provision, and systemic efficiency and/or value addition within it.

- Assess impacts per service-unit rather than product
- Assess and enhance system sustainability

PSS design considers alternative business and service models that could provide improved sustainability by adjusting ownership and revenue models, and adding more stakeholders into the process.

- Changing product ownership: services instead of products
- Co-governance in design and management

Different types of PSS solutions

PSS design is a perspective to designing any product or service. However, there are different types of PSS depending on how and where the value is created.

- **Product oriented PSS** focuses mainly to extend the existing product-offering
- **Use oriented PSS** covers various models of leasing/sharing/pooling of products
- **Result oriented PSS** focuses to deliver a (novel) service with a ‘functional result’ (i.e., satisfy user need without product/material ownership)

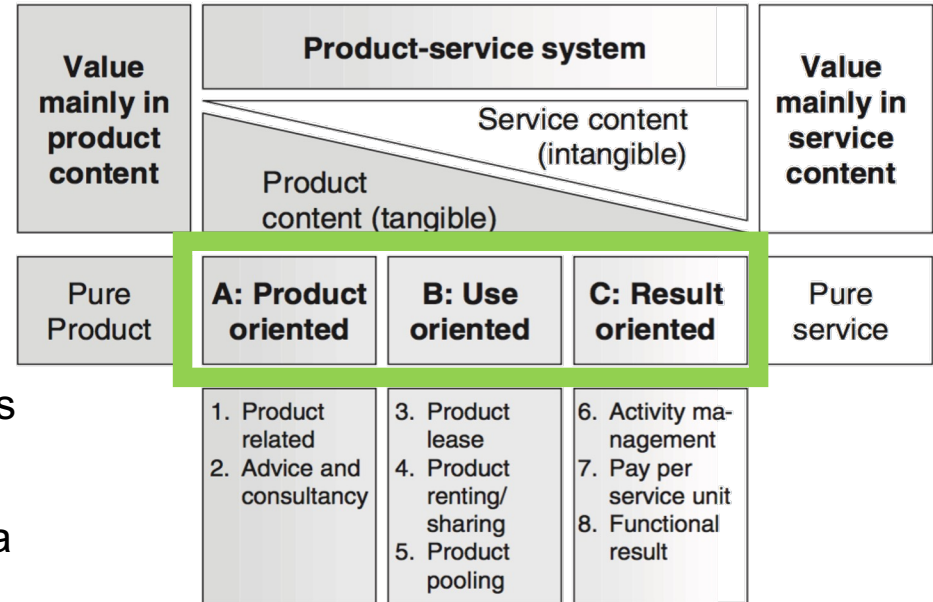


Figure 1. Main and subcategories of PSS

Sustainable Product-Service Systems

However: There are several types of PSS – not all PSS are sustainable!
(Tukker, A. 2004; Mont, O. 2001)

Three key elements in creating new, innovative, and sustainable PSS concepts:

- 1) Innovative stakeholders network;
- 2) A shift from selling products to selling results;
- 3) A change in product and resources ownership.

(Vezzoli, C. and Ceschin, F. 2008)

Switching from product sales to selling a functional result has most sustainability potential. Here, the provider agrees with the client the delivery of a result.
(Tukker, A. 2004)

Example: Selling office lighting in lux per meter (Philips) or clean air per cubic meter

Examples of PSS designs

Product oriented:

Use oriented:

Result oriented:

Examples of PSS designs

Product oriented:



Use oriented:

Result oriented:



Examples of PSS designs

Product oriented:



Use oriented:



couchsurfing

Result oriented:

Examples of PSS designs

Product oriented:

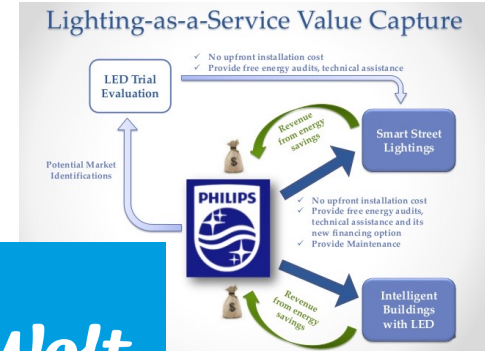


Use oriented:



couchsurfing

Result oriented:



Product-service system (PSS) for sustainable consumption

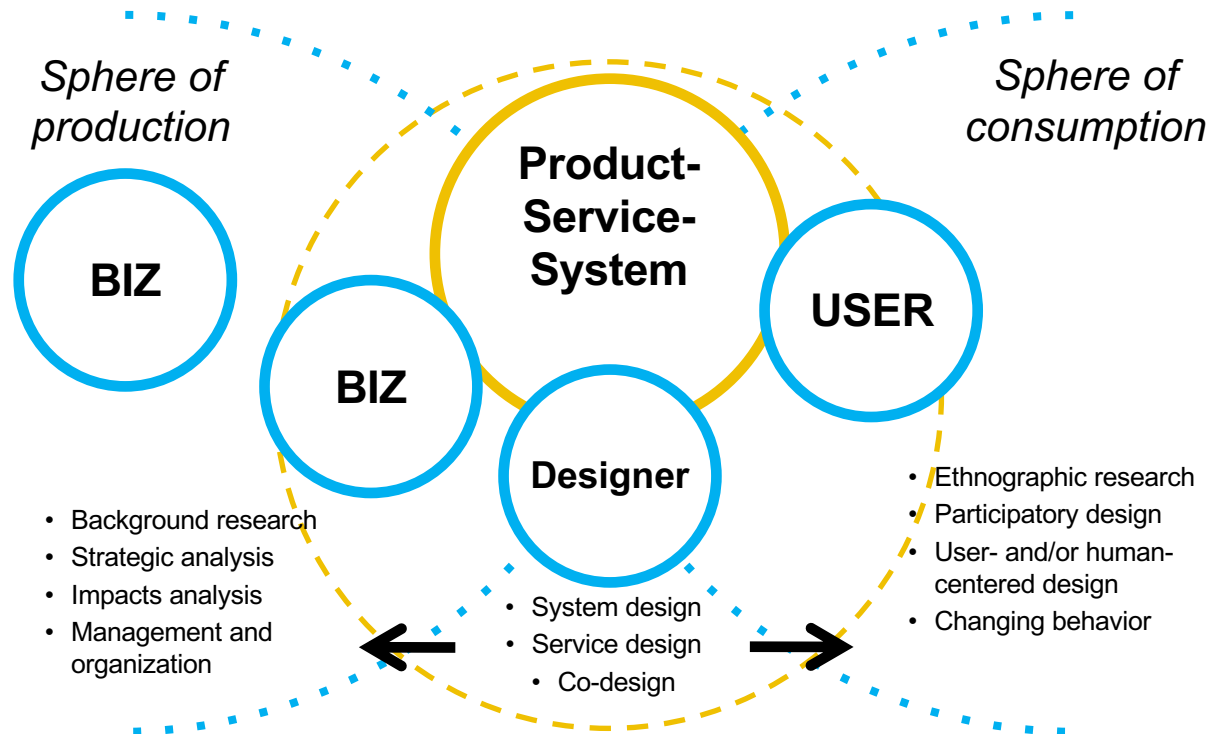
Products as 'service-producing machines'

- We do not need the products, but the services they provide!

Organise consumption differently

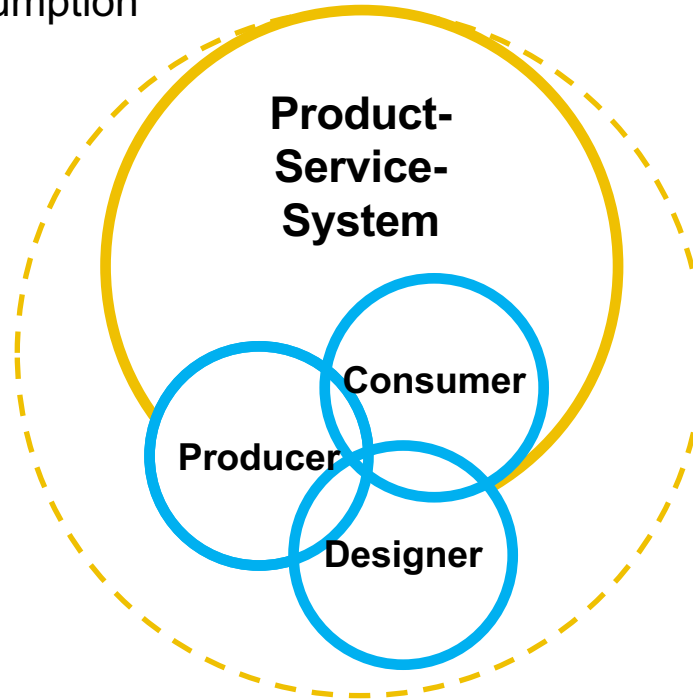
- 'Access-based consumption'
- Mobility-as-a-Service (MaaS)
- Energy performance contracts (EPC)
- Life-cycle costs models
- Service business,
- Service-orientation, 'servicizing'

Sphere of sustainable PSS design focus



Sphere of sustainable PSS design action

Sustainable consumption and production at the interplay of stakeholders:



Sustainable PSS:

- ✓ Functional results as a goal
- ✓ Expanded stakeholder network
- ✓ Sharing vision
- ✓ New roles for stakeholders
- ✓ Ownership into system processes and components

Sustainable PSS design – what & why?

WHAT & WHY:

- What is the demand? What is being offered & why?
- Strategic analysis & Exploring opportunities
- Existing research, checklists, “facts”
- Understanding the surrounding system; System mapping
- Identifying the potential (remember “low hanging fruits”)
- Environmental, socio-ethical and economic potential & needs
- What are the driving motivations, and how are they communicated?
- How to prioritize trade-offs?

Sustainable PSS design – how & who?

HOW & WHO:

- What is the improvement? What new stakeholder interactions can be created? What is the added value?
- Exploring opportunities; System ideation, development and design
- What is the offering to stakeholders (or system functions)?
- Who are the main actors? Who are the other stakeholders?
- What are the interactions? System & stakeholder mapping...
- What are the system boundaries (primary & secondary)
- How is the design process set up?
- How is communication set up?

Sustainable PSS design – test & iterate!

TEST & ITERATE:

- Take PSS concept in real life setting & testing
- System implementation and iteration
- Socio-technical experimenting
- Environmental, socio-ethical and economic assessment
- Communication between societal domains & actors
- Develop & iterate collaboratively with stakeholders!
- Scale up from experiment...

PSS design in Circular Economy



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Circular Economy (CE) as an economic model

Circular Economy (CE) as an economic model builds on the understanding that the linear material flows of global production and consumption systems cannot continue on their current trajectory. Instead, **more circular material systems are to be embraced** (see e.g., Brandão, M., et al. 2019).

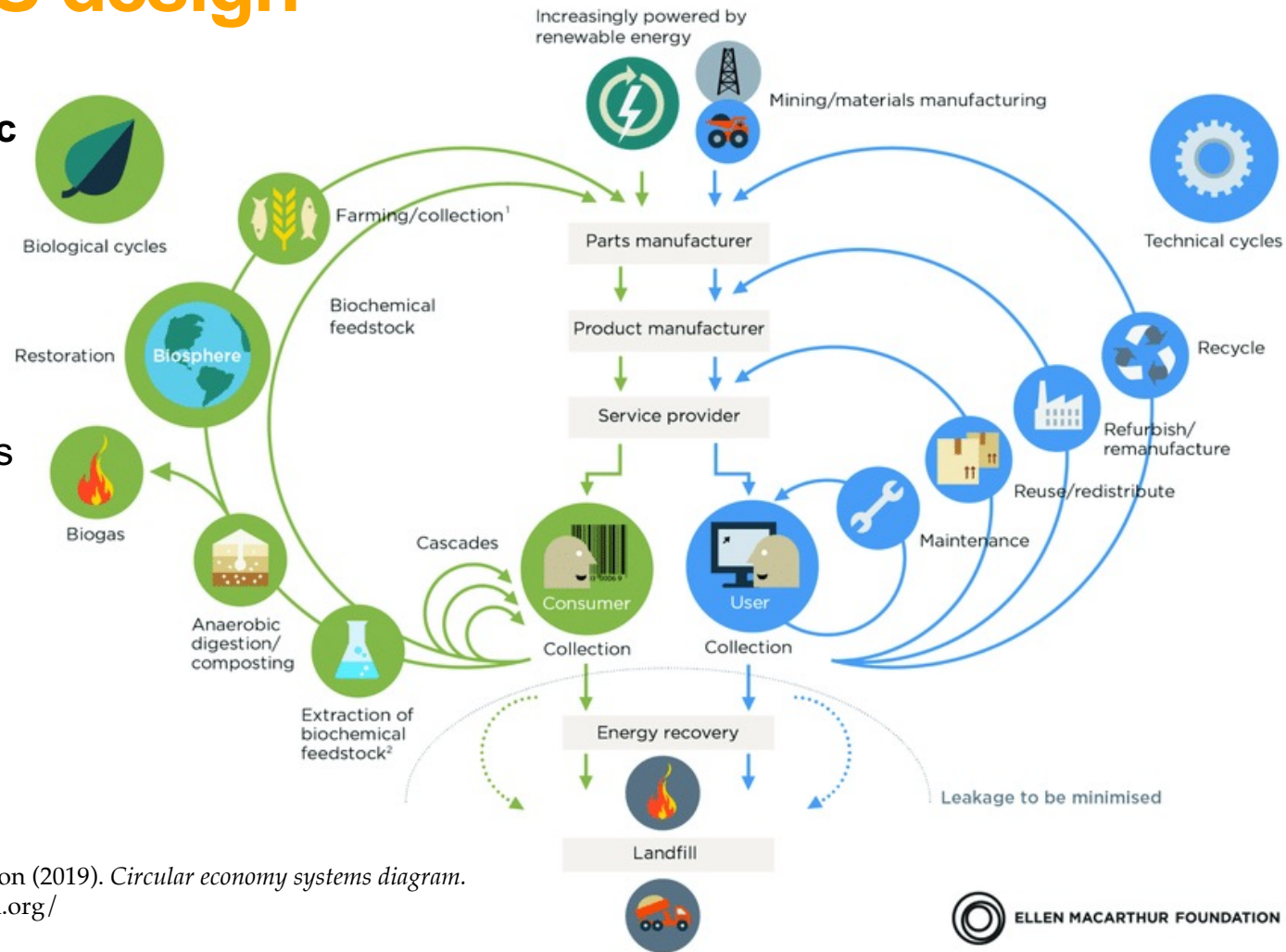
CE seeks changes especially in the way we use (organic and technological) raw materials in production and consumption. It connects to novel offerings and interactions in both **business-to-business (B2B)** and **business-to-consumer (B2C) service domain**, and also to support various actors the CE transition (e.g, research collaborations).

Also the EU has endorsed CE as a model in its Circular Economy Action Plan (CEAP; 2015), with emphasis on improving resource use and recycling, waste prevention, and promotion of more holistic design.

CE and PSS design

CE entails a systemic view, and focus on various organic and technological material cycles.

PSS design for CE thus seeks possibilities for **closing the loops** on various stages of the value chain, and more efficient, circular and extended use of products and materials.

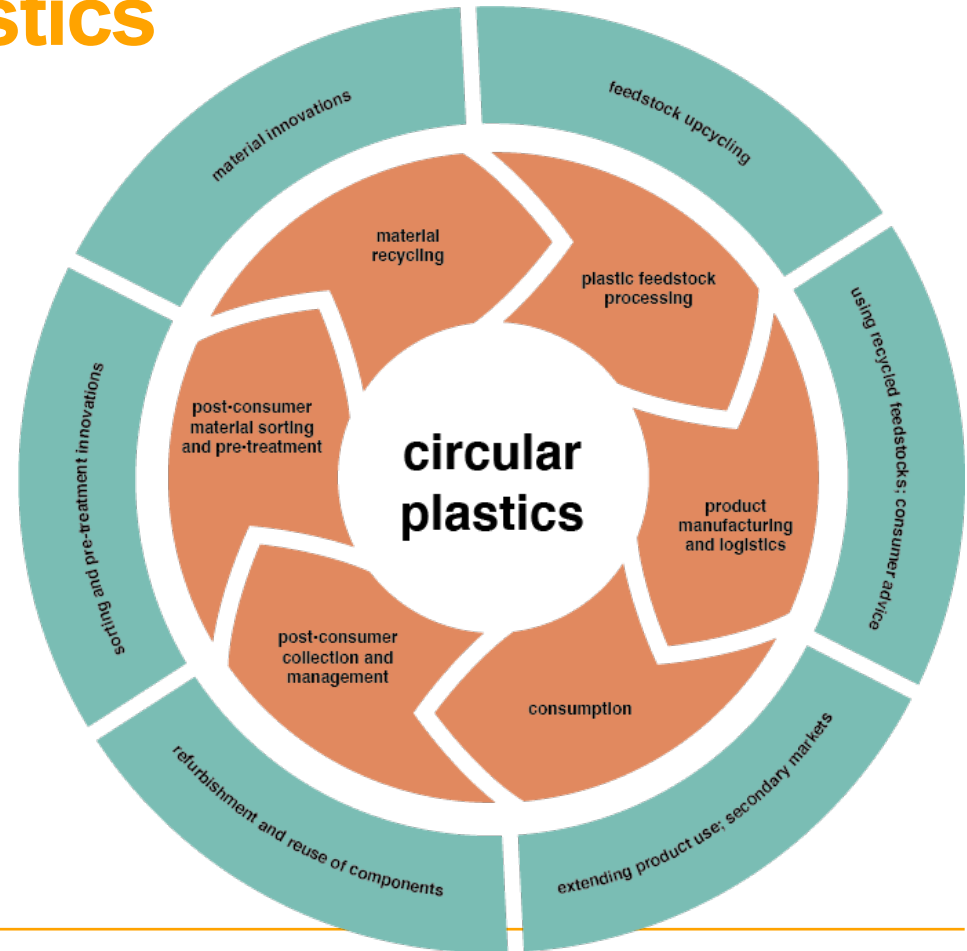


Source: Ellen MacArthur Foundation (2019). *Circular economy systems diagram*.
<https://ellenmacarthurfoundation.org/>

PSS for circular plastics

The EU promotes circular plastics for example with new packaging directives that require producers to collect and recycle plastics from packaging.

Several PSS opportunities can be identified in the circular plastics value chain, especially in B2B domain between recyclers and producers, as well as in B2C domain in relation to product-life extension, and efficient end-of-life services.

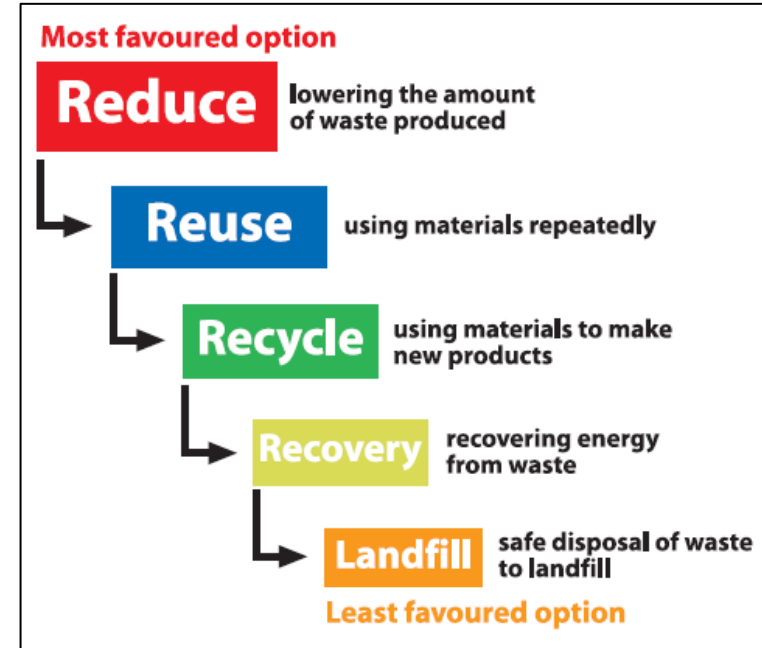


Example: Redesigning plastics by Ellen McCarthy Foundation

Our current economy employs a linear, take-make-dispose, model (resources are **taken** from the ground, **made** into products and then **thrown away**). This model has contributed to both the positive but also negative effects of plastic being everywhere.



But what if we had an economic model that was more 'circular', and kept products and materials cycling within the system for longer? This vision for a 'circular economy' aims to optimise value by increasing the lifecycle of materials and designing out waste, thereby decoupling growth from the consumption of finite resources.



Source: Ellen McCarthy Foundation: Redesigning plastics

PSS for food waste and bioplastics circularity

The EC Scientific Advice Mechanism (SAM) also promotes use of bioplastics in contexts where it is challenging to separate plastic from organic material (e.g., food system products).

Several PSS opportunities can again be raised along the material cycle, in B2C domain especially with recycling information, collection systems, and efficient end-of-life use, and in B2B domain in the form of improved use of waste side streams and sales of e.g., energy services



Focus areas for PSS design in CE context

PSS design seeks systemic efficiency, and CE moves focus to efficiency in material use and circularity, empowering changes in consumption and production. **Hence, the focus areas for PSS design in CE context can be as follows:**

- **Improved management of material flows:** PSS designs can offer ideas to both B2C and B2B to enhance material-use efficiency, recycling, and/or reuse of waste and side streams.
- **Services and strategies to extend product life:** To extend product- and material-life, both B2C and B2B, as well as community PSS solutions can be developed (e.g. repair, recycle).
- **Efficient end-of-life systems:** PSS offerings can also help in developing efficient take-back systems to support recycling especially in B2C but also in B2B domain.
- **Visibility to material circularity in consumption and production:** DfS and PSS design for CE is also communicating the urgency and need to change patterns of our material use.

PSS design process, tools and methods



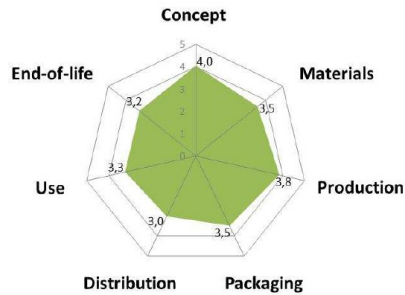
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The process and methods for PSS design

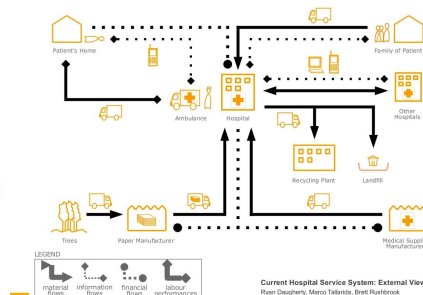
The PSS design process conforms to the conventional design process, starting from strategic analysis and opportunity exploration to ideation and system design, and to the further iteration and prototyping of the (PSS) design concept.

Methods and tools for PSS design cover various ecodesign and service design tools, and also the facilitation of strategic co-design and prototyping:

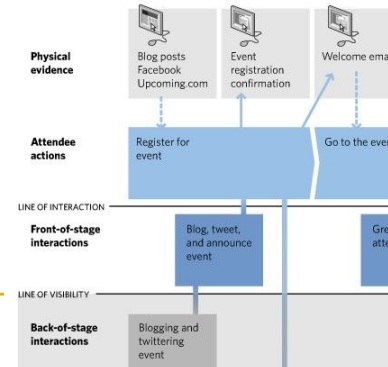
(Systemic) impact assessment



Stakeholder and system mapping



Service interaction blueprinting



Strategic co-design, collaborative prototyping



Sustainable PSS design process

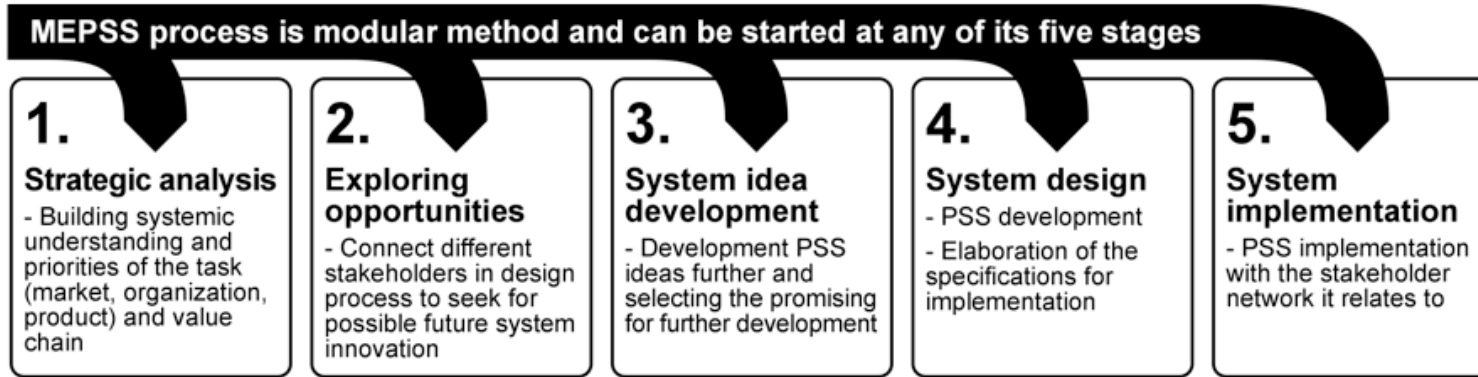


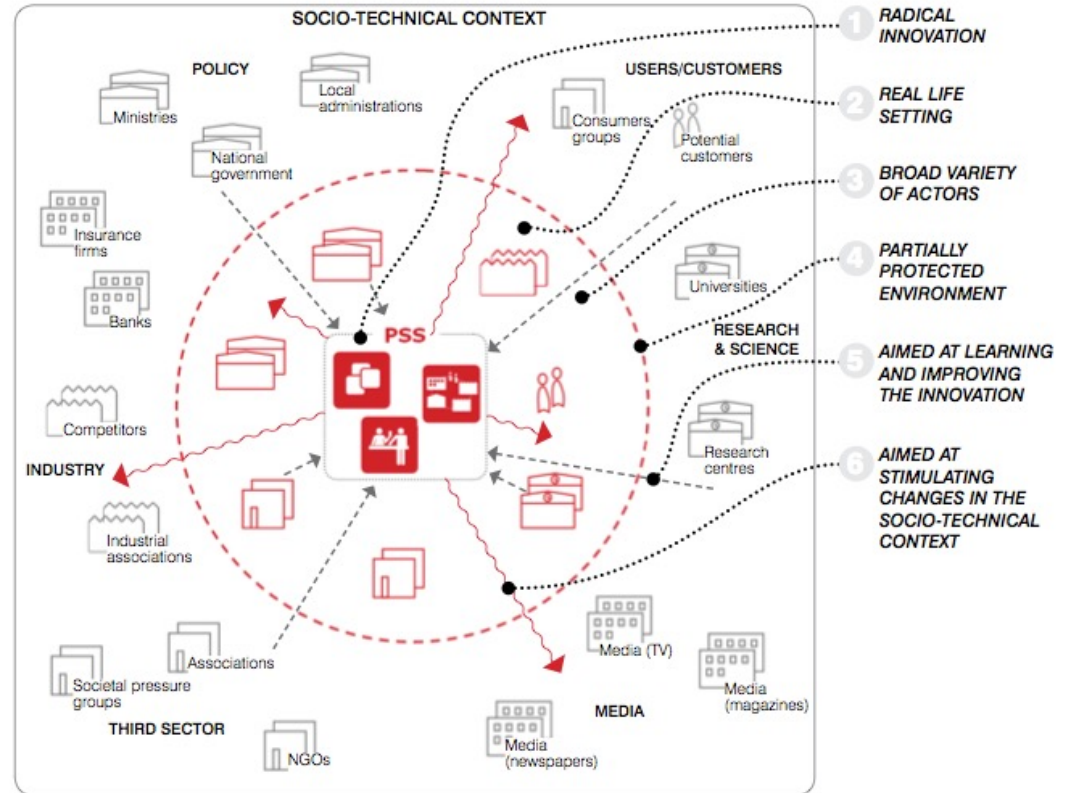
Figure 1. MEPSS design process and its five stages (based on Van Halen, C. et al. 2005; Vezzoli, C. 2007).

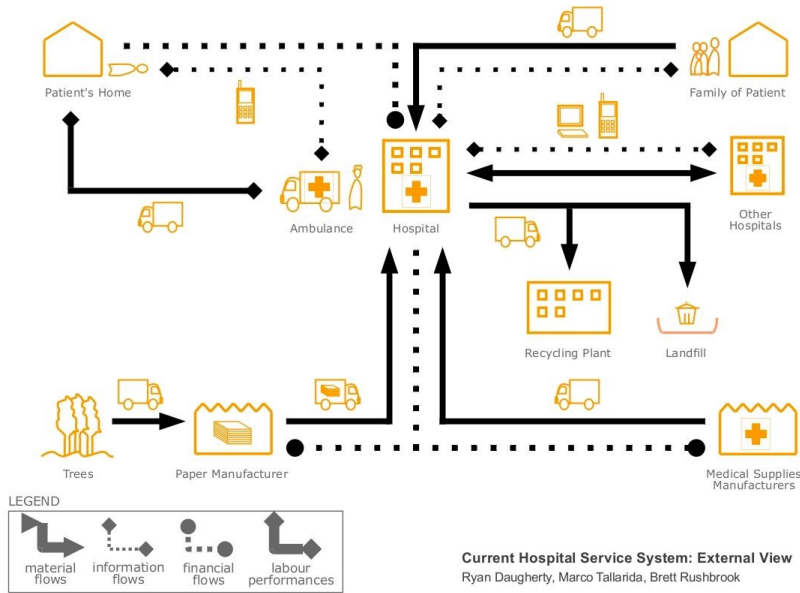
Communicating results

Designer as the match-maker

Design action can focus to:

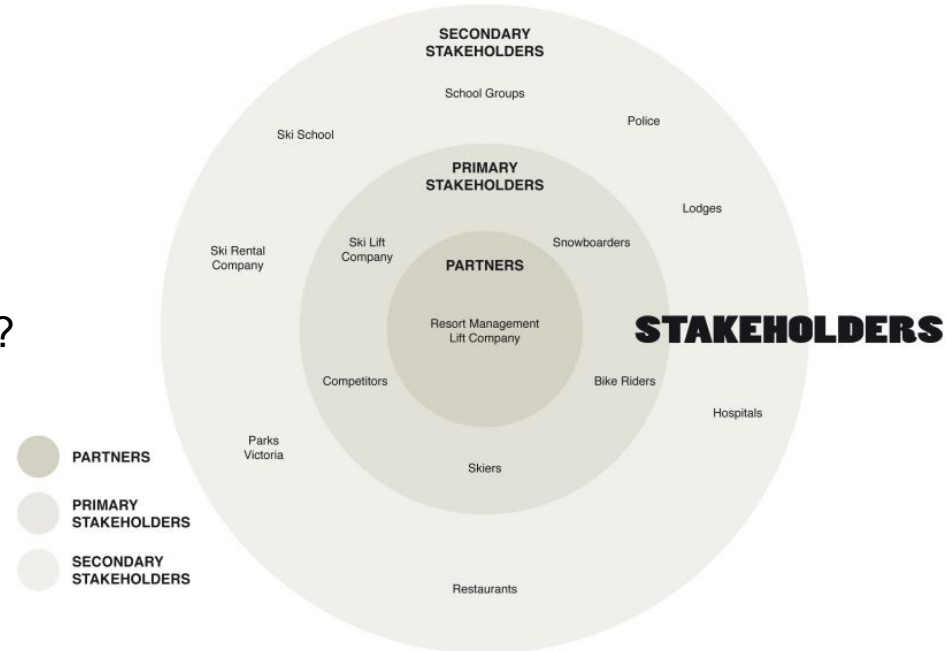
- Redesigning system interactions and connections
- Connecting new stakeholders within the problem context
- Communicating system interaction and value propositions





- How are interactions designed? Can they be redesigned?
- Can you introduce changes to your product system: increase sustainability through improved system or with a novel component with additional value?

- What is the core offering in your case? Can you expand the offering or redesign it?
- Who are the main stakeholders in your product-service system? Can you introduce new actors and interactions?



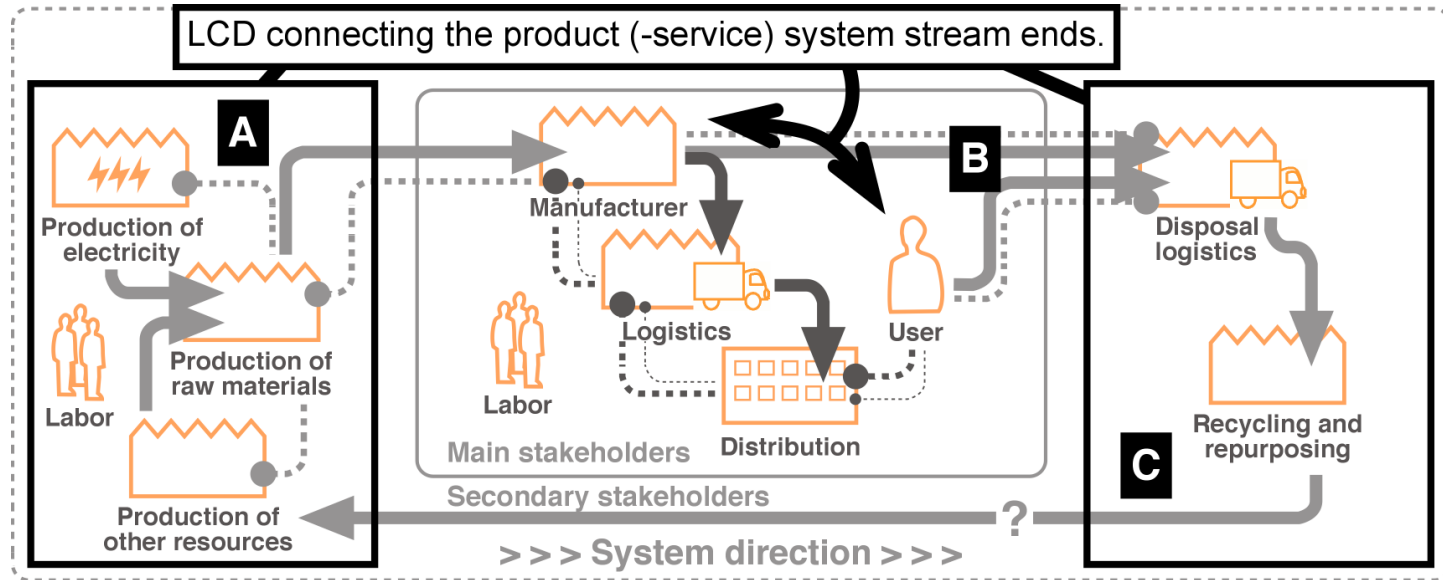
**Communicating
the offering from
user perspective:**



Part of the detailed Offering Diagram that visualises the whole offering

Offering Diagram showing the basic and added-value functions of the design idea

Communicating production system and system of use, and novel stakeholder & system interactions:



Source: Author, 2014

Communicating business value:









The Business Model Canvas

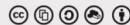
Designed for:

Designed by:

Date:

Version:

<p>Key Partners </p> <p>Who are our Key Partners? Who are our key suppliers? Which Key Resources are we acquiring from partners? Which Key Activities do partners perform?</p> <p>DEFINITION FOR PARTNERSHIPS Optimization and innovation Reduction of risk and uncertainty Acquisition of particular resources and activities</p>	<p>Key Activities </p> <p>What Key Activities do our Value Propositions require? Our Distribution Channels? Customer Relationships? Revenue streams?</p> <p>DEFINITION Production Problem Solving Platform/network</p>	<p>Value Propositions </p> <p>What value do we deliver to the customer? Which one of our customer's problems are we helping to solve? What bundles of products and services are we offering to each Customer Segment? Which customer needs are we satisfying?</p> <p>CHARACTERISTICS Newness Performance Customization "Getting the Job Done" Design Brand/status Price Risk Reduction Accessibility Convenience/Usability</p>	<p>Customer Relationships </p> <p>What type of relationship does each of our Customer Segments expect us to establish and maintain with them? Which ones have we established? How are they integrated with the rest of our Business Model? How costly are they?</p> <p>EXAMPLES Personal assistance Dedicated Personal Assistance Self Service Automated Services Communities Co-creation</p>	<p>Customer Segments </p> <p>For whom are we creating value? Who are our most important customers?</p> <p>EXAMPLES Mass Market Niche Market Segmented Demographic Multi-sided Platform</p>
	<p>Key Resources </p> <p>What Key Resources do our Value Propositions require? Our Distribution Channels? Customer Relationships? Revenue Streams?</p> <p>TYPES OF RESOURCES Physical Intellectual (brand patents, copyrights, data) Human Financial</p>		<p>Channels </p> <p>Through which Channels do our Customer Segments want to be reached? How are we reaching them now? How are our Channels integrated? Which ones work best? Which ones are most cost-efficient? How are we integrating them with customer routines?</p> <p>CHANNEL PHASES 1. Awareness How do we raise awareness about our company's products and services? 2. Evaluation How do we help customers evaluate our organization's value Proposition? 3. Purchase How do we allow customers to purchase specific products and services? 4. Delivery How do we deliver a value Proposition to customers? 5. After sales How do we provide post-purchase customer support?</p>	
<p>Cost Structure </p> <p>What are the most important costs inherent in our business model? Which Key Resources are most expensive? Which Key Activities are most expensive?</p> <p>IS YOUR BUSINESS MODEL Cost Driven (lowest cost structure, low price value proposition, maximum automation, extensive outsourcing) Value Based (focused on value creation, premium value proposition)</p> <p>SAMPLE CHARACTERISTICS Fixed Costs (salaries, rents, utilities) Variable costs Economies of scale Economies of scope</p>	<p>Revenue Streams </p> <p>For what value are our customers really willing to pay? For what do they currently pay? How are they currently paying? How would they prefer to pay? How much does each Revenue Stream contribute to overall revenues?</p> <table border="0"> <tr> <td>FIXED Asset sale Usage fee Subscription Fees Licensing Franchise fees Advertising</td> <td>RECURRING REVENUE List Price Product/Service dependent Customer segment dependent Income dependent</td> <td>ONCE-OFF REVENUE Negotiation (Bargaining) Yield Management Real-time Market</td> </tr> </table>	FIXED Asset sale Usage fee Subscription Fees Licensing Franchise fees Advertising	RECURRING REVENUE List Price Product/Service dependent Customer segment dependent Income dependent	ONCE-OFF REVENUE Negotiation (Bargaining) Yield Management Real-time Market
FIXED Asset sale Usage fee Subscription Fees Licensing Franchise fees Advertising	RECURRING REVENUE List Price Product/Service dependent Customer segment dependent Income dependent	ONCE-OFF REVENUE Negotiation (Bargaining) Yield Management Real-time Market		



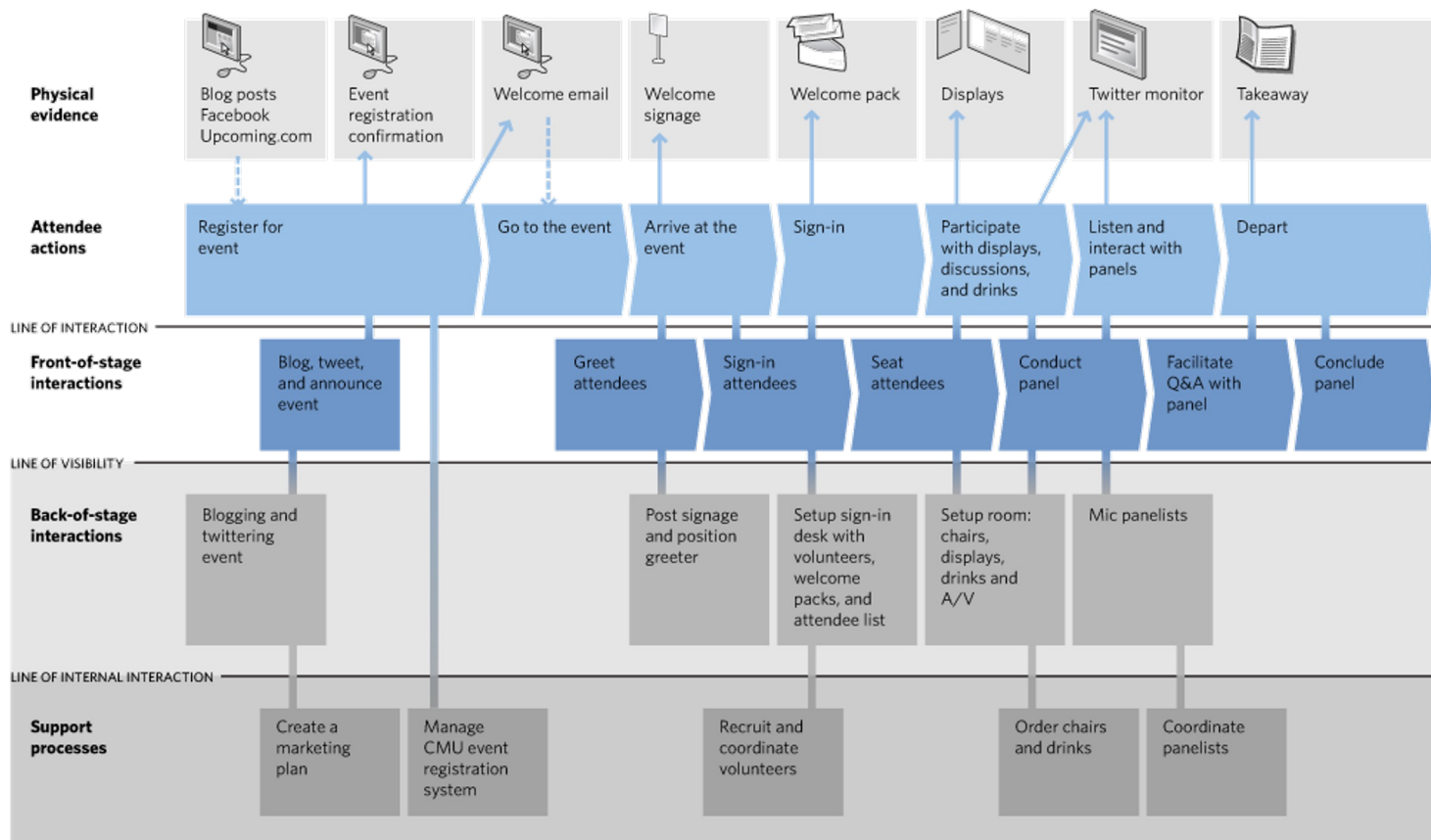
DESIGNED BY: Business Model Foundry AG
The makers of Business Model Generation and Strategyzer

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Communicating 'service blueprint':

Service Blueprint for Seeing Tomorrow's Services Panel

find out more: <http://upcoming.yahoo.com/event/1768041>





Brandon Schauer, Adaptive Path

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Communicating system interactions with storyboards:

SOLUTION	> database to register information	> menu formulation software	> menu formulation software	> order management system
		> communication system	> communication system	> appliances

USER ROLE	>users decide which ingredients the University kitchens has to order	>users order the weekly menu		
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	Service action 1	Service action 2	Service action 3	Service action 4
LINE OF INTERACTION				

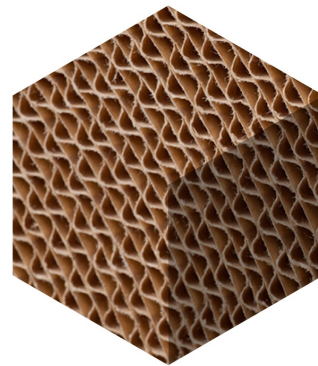
Representative of students chooses the weekly menus, basing on local producers disponibility

Students, using internet, communicate their weekly menu and the place where they will eat. The system return them a code/ticket

SYSTEM ROLE	>local producers cooperative gives information to university on products disponibility	>central kitchen receive orders and prepare the requested meals
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Not forgetting new material and texhcnical innovations!



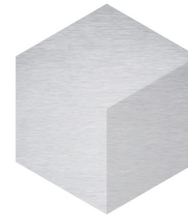
35.5%
Corrugate



17.9%
Plastic



9.1%
Bleached
paper



12.3%
Steel



9.6%
Unbleached
paper



6.1%
Wood



7.4%
Glass



2.2%
Aluminium

Summary

Some examples of sustainable PSS: Services for mobility, food systems, and products

Car leasing service: no ownership or maintenance, guaranteed access with monthly fee

Food delivery service: online service with 3rd party delivery

Repair service by mail: ability to repair selected product via mail

B2B offerings: sustainability improvements (e.g., efficient energy, transport) as services



VS.

Car sharing and peer-repair service: platform for peer-sharing and repairing vehicles

Community kitchen: a place for community to gather around food

Open repair workshop: a supported workshop for repair and tool rentals

B2B collaborations: gather into networks to create platforms for peer-service and development

...Remember a critical perspective in considering sustainability improvements!

Summary of session topics

- **Product-Service System (PSS) design focuses** to restructure stakeholder roles and interactions to increase the systemic efficiency in delivering a 'functional offering' (i.r., access to a selected service)
- **Types of PSS** range from product oriented, to use oriented, and to result oriented solutions
- **In the CE context, PSS design emphasis** is on efficiency in material use and circularity, and in extending product life, promote sharing, and providing efficient end-of-life systems.
- **Not all PSS designs are sustainable:** sustainability transition in production and consumption calls for further restructuring of the producer and consumer roles
- **Remember a critical perspective** in considering sustainability improvements!

Next steps to continue work...

To continue with the topic, you may think of PSS-type of examples for further assessment:

- Consider e.g., main sectors of consumption: Food services, mobility, housing, energy, but also products (e.g., clothing, IT-products), tourism, etc.
- What are the possible changes to system and stakeholder network, and how that adds value?
- Are there changes in ownership? Who ensures product longevity and efficient end-of-life?
- Continue to discuss potential improvements; You can support work with system and stakeholder mapping and service blueprinting

Supplementary readings on sustainable PSS design (open access book):

Vezzoli, C., B. Garcia Parra, & C. Kohtala (2021). *Designing Sustainability for All – The Design of Sustainable Product-Service Systems Applied to Distributed Economies*. Springer.

<https://link.springer.com/book/10.1007/978-3-030-66300-1>

Group activity

Group activity

Working in case groups, ~30 minutes:

- **Can you think of out a real-world example of a PSS solution, or ideate a new one for your focus case**
- Focus either food and your own case theme (or pick some other theme)
- What is the core (product/service) offering in your case? Are there additional offerings?
- Is it product-, use-, or result-oriented?
- Who are the main stakeholders (actors) and interactions in the system? How are interactions designed?
- You can use a paper canvas if necessary (e.g., for visualizing system map)

Example PSS orientations

Product-oriented:

- Online supplementary data
- Augmented reality solutions
- Improved recyclability of packaging

Use-oriented:

- Organic food cycle
- Car-sharing
- Leasing tools

Result-oriented:

- App for leftover restaurant food services
- Online food services

This week sessions: Topics & readings

Tuesday (17.1.):
Systemic (PSS) design and circular economy

Lecture reading:

- Ceschin & Gaziulusoy (2020) Design for Sustainability, Chapter 7: Product-service system design for sustainability (in MyCourses)
- Supplementary reading (if you feel like it): Chapter 10: Systemic design; Joore & Brezet (2014) Multilevel perspective in design (in MyCourses)

Remember to begin to reflect on weekly topics and progress in your learning diary!

Thursday (19.1.):
Design for sufficiency

Guest: Mikko Jalas

Lecture reading:

- Ceschin & Gaziulusoy (2020) Design for Sustainability, Chapter 9: Social innovation
- Supplementary readings: Jungell-Michelsson, J., & Heikkurinen, P. (2022). Sufficiency: A systematic literature review. Ecological Economics, 195, 107380. (please note that, unless specifically interested, you can skip the methodology section of the systematic literature review)

Thank you!



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