

## **Slowing and narrowing resource flows as part of circular economy business strategies**

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### **Abstract**

Circular economy is currently getting a lot of attention among businesses as environmental strategy, because it is said to be restorative and regenerative by design.

However, circular economy is not without shortcomings as strategy for sustainable development. A circular economy with main focus on closing material flows through recycling has limited value for both businesses and society. In order to contribute to substantial reductions in resource consumption, then it is necessary to understand the dynamics of the present linear economy and the speed and volume of the resource flows by questioning what we produce and why products lose value to their users and become waste. Additionally, a narrowing and slowing of the resource flows are also on the agenda as part of a circular economy. The paper is analyzing to what extent it is a practice, a challenge or a potential for businesses to slow down resource flows by prolonging the product lifetime and narrowing the resource flows by optimizing and reducing the use of materials.

Three redesign processes with focus on redesign of services, redesign of value chain relations and redesign of the internal business organization have been investigated within a Danish research project based on cooperation with 20 businesses about analyses of potentials and barriers to circular economy as part of their business strategies. In 11 of the businesses initiatives were identified or developed aiming at prolonging product life time and reducing the amount of necessary products. These cases covered clothes with long product life time and product repair and of drinking water equipment, prolonging lifetime of a rescue product by instructing the users in better product use and offering product take-back, long product life time and considerations about product take-back and refurbishment of furniture, use of roof-top windows for re-purposing and multi-purposing of buildings and thereby increasing lifetime and use of buildings, developing leasing and product-service-system for furniture for schools, use of second quality grade vegetables, and increasing resource effectiveness of textile service through optimization of speed and size of the textile flow.

### **1. Introduction**

Initiatives to develop alternative economic models to the linear ‘take-make-dispose’ model are emerging. Circular economy is currently getting a lot of attention, because of promises about an industrial system that is restorative by design [1]. There are several examples of both businesses and cities that have developed circular economy strategies.

Not least due to the challenges of closing material flows in the globalized production and consumption system, it is necessary - as background for development of circular economy strategies - to understand the dynamics of the present linear economy by addressing:

- What are the dynamics co-shaping the patterns and volume of production and consumption?
- When and why products lose value to their users and become waste?
- How can businesses contribute to narrowing and slowing of the resource flows?

Alternative social and economic models addressing the sustainability challenges have been discussed since the Brundtland report was published in 1987, including the concepts industrial ecology and cradle-to-cradle. Ellen MacArthur Foundation [1] refers to these and other “schools of thought” as inspiration for the description of circular economy as “restorative and regenerative by design”, and aiming at keeping products, components, and materials at highest utility and value at all times and based on the following three principles [1]:

- Preserve and enhance natural capital by controlling finite stocks and balancing renewable resource flows
- Optimize resource yields by circulating products, components, and materials at the highest utility at all times in both technical and biological cycles
- Foster system effectiveness by revealing and designing out negative externalities

Business strategies for circular economy are for finite (non-renewable) resources described as (see for example [1]):

- Maintaining products
- Reusing and redistributing products
- Refurbishing and remanufacturing products
- Recycling components and materials from products

For renewable resources, the strategies are described as cascading use of waste materials and recycling as feedstock and energy resource.

EU’s circular economy package from December 2015 [2] draws upon the analyses of the Ellen MacArthur Foundation. The European Commission focuses on increasing resource efficiency by closing material loops, and thereby maintaining the value of products, materials and resources in the economy for as long as possible and minimizing waste generation [2].

A conceptual framework has also been developed by Bocken et al [3] who describe circular economy through the three principles of slowing, narrowing and closing resource flows:

- Slowing resource loops: Through the design of long-life goods and product-life extension the utilization period of products is extended and/or intensified, resulting in a slowdown of the flow of resources
- Narrowing resource flows: Increasing resource efficiency by using fewer resources per product.
- Closing resource loops: Through recycling, the loop between post-use and production is closed, resulting in a circular flow of resources

An analysis by EEB [4] shows the low efficiency in recycling of materials and components. Therefore, circular economy efforts based on slowing resources flows – e.g. prolonged life time of products - and narrowing resource flows by using less resources or fewer products enable a bigger increase in resource effectiveness than just closing resource flows through recycling. This implies that circular economy strategies of businesses, who want to contribute to substantial reductions of resource extraction and consumption, should include focus on slowing and narrowing resource flows.

The attention to what is produced would for example imply an emphasis on the types of food which is produced before focusing on reducing food waste. This is a different understanding compared to for example the focus on reducing and utilizing food waste in Ellen MacArthur Foundation’s analyses of circular economy in Denmark [5]. Since closing resource flows only is one of strategies for increasing resource effectiveness the term ‘circular economy’ could be seen as misleading and strategies for higher resource effectiveness or slow economy would be a better term.

The paper presents experiences with slowing and narrowing resource flows in a research project at Aalborg University – Sustainable Production 3.0 – which aims at mapping and developing experiences with and methods for circular economy in businesses through cooperation with 20 businesses in Denmark with different size, product and service area and geographical location.

In the project the concept of so-called ‘circular economy journeys’ was developed. The approach to development of circular economy strategies in the project is based on:

- An environmental and organizational mapping in life cycle perspective of the business
- Analyses of potentials and barriers for circular economy through three types of re-design processes:  
1) Re-design of the provided services; 2) Re-design of value chains up-stream and down-stream and  
3) Internal organizational redesign of the business organization
- Impact on environmental aspects and impacts

The project findings are systematized and disseminated to other businesses, business associations, business service centers, consultants, waste management companies, authorities and university lecturers through networking, practical guidelines and case reports in cooperation with two regional sustainable business networks.

## **2. Theoretical background**

The Sustainable Production 3.0 project builds upon theories about:

- Network relations of a business, including forces that shape the competition which the business is part of [6,7]
- The interactions between product and service design and users’ social practices with a product or a service [8]
- Aspects which shape the capability of a business to explore and exploit knowledge about environmental problems and solutions [9]

According to Jørgensen and Forman [6] a business is part of five types of networks:

- *The value chain* is the flow of capital and information from cradle to grave, and the product chain is the resource flows downstream and upstream, between suppliers, customers and users.
- *The innovation network* focuses on the development of new processes, products and services and can include other parts of the value chain, consultants, universities and other types of knowledge institutions.
- *The regulatory networks* include public authorities from the local to the international level, but also civil society organizations that directly or indirectly address how businesses should or ought to act.
- *The local networks* consist of the different local supplies of natural resources, infrastructure, staff, local governmental regulation etc. along the value chain

The concept of ‘script’ and ‘de-script’ is used as framework for understanding the interactions between design of products and services and users’ social practices in relation to those products and services [8]. The script focuses on the roles ascribed to a product, services, users, societal infrastructures, etc. during innovation processes. The script can be seen as those intentions that a developer consciously or unconsciously builds (‘inscribes’) into a technology, product, service, etc. through the material shape, the functions, the user guidelines etc. This includes the future roles, which surrounding infrastructures are supposed to have.

Whether the script afterwards actually is accepted by the imagined users through their de-scription of the script and whether a stable practice is developing, depends on the script, the type of technology, the alternatives, the user and the social context. Akrich [8] calls those interactions 'negotiations' between the inscribed possibilities and limitations that the script gives the user. The interactions take place within the economic, knowledge, technical etc. resources which the user has access to when shaping the practice with a product or service. A product is called 'hard' if the users cannot change the practice with the product, even if they feel restricted in the shaping of their practices. A product is called 'soft' if the users can shape their own practices. The so-called 'prescription' refers to the room for user action, which the script allows.

Lenox and Ehrenfeld [9] distinguish between a business' capability to collect knowledge about environmental problems and solutions (exploration of knowledge) and the business' capacity to translating this knowledge into guidelines for example product design (exploitation of knowledge).

### **3. Environmental and organizational mapping of baseline**

As a starting point in the 'circular economy journey' of a business, an initial mapping of the social and material relations of the business is made in order to give the researchers and the business some common knowledge about the business and provide a base for development of ideas for circular economy which might be analyzed as part of a 'journey'. The circular economy principles like in [2,3] can inspire reflections about potentials and barriers to circular economy but the reflections need to be contextualized and situated within the specific business and its capabilities and strategic plans. The environmental mapping in life cycle perspective can be done through a so-called MECO-screening (Materials, Energy, Chemicals, Others) based on a description and assessment of the following aspects of the products and services of a business [10] – both as a baseline and as an assessment of proposed changes in products and services:

- M: Materials, including whether the materials are scarce, non-renewable or renewable
- E: Energy, including whether the energy sources are fossil or renewable
- C: Chemicals, including aspects of environmental toxicology (e.g. risks of carcinogen, reproductive, allergic and neuro-toxic impact) and eco-toxicology (e.g. risks related to persistence and bio-accumulation)
- O: Other aspects, like land use, biodiversity, occupational health and safety (OHS)), etc.

A MECO-screening can be done by filling out a table with data for each type of product.

The environmental mapping includes speed, size and circularity of resource flows and a comparison of expected vs actual user practices:

- The extent of use of recycled resources as raw material
- The recyclability of the discarded product, including how pure or clean the resources are and whether they contain hazardous materials, including actual recycling
- The speed and the size of the resource flows, including:
  - Whether and how there is focus on informing users about the right use of the product (through labelling, user manuals etc.)
  - Whether knowledge is collected about the actual use of the products (de-scription), and how this use corresponds to the imagined use (script) and whether and how knowledge from maintenance, service and repair of the products are available and applied in the business trying to obtain longer product life time

By combining Jørgensen's and Forman's business network relations [6] and Porter's five forces [7], the following aspects were discussed as part of the initial organizational mapping together with a business in the project:

- Aspects of power and learning in relation to suppliers, customers, and users and the role of environmental concerns
- The roles of environmental concerns in innovation
- Competitors' environmental strategies
- Threats from new (more environmental friendly) varieties of competing products and services entering the market
- Relations to existing and future environmental regulation – locally, nationally and internationally
- Relations to citizens and non-governmental organizations – locally, nationally and internationally

#### **4. Development of options for analyses of potentials and barriers to higher resource effectiveness**

After the initial mapping, potentials and barriers to higher resource effectiveness are discussed between the business and the researchers. Initial options have several times in the research project been developed inspired by a print-out of a circular economy diagram from [1]. The diagram shows the possibilities of maintaining products, reusing and redistributing products, refurbishing and remanufacturing products, and recycling components and materials from products. For renewable resources the diagram shows the possibilities of cascading use of waste materials and recycling as feedstock and energy resource. Our experience is that such a diagram can initiate reflections about possibilities for slowing, narrowing or closing resource flows which afterwards have been analyzed by the business; several times in combination with researcher analyses or student projects at Aalborg University.

As part of the analyses the need for three types of re-design processes is considered:

- 1) Re-design of the provided services, considering necessary changes in the roles of products, users, service, infrastructure, etc.
- 2) Re-design of the value chain relations up-stream to suppliers and down-stream to customers and users
- 3) Redesign of internal business organization considering necessary changes in tasks, competences, structures and technologies related to 1) and 2)

Some of the developed options for higher resource effectiveness in the businesses have been inspired by considerations about present or future strategic choices, which a business is facing, and where resource effectiveness could be considered together with these choices, either as a further argument or as a concern in order not to reduce resource effectiveness. Examples of such strategic considerations in case businesses are:

- Whether a public procurement model from another country could be implemented in Denmark and could imply higher resource effectiveness
  - The analysis included interviews with a number of stakeholders from executive management, line management and procurement in the public sector in order to identify the different actors' preferences in relation to an investment model and a service system model based on procurement of number of analyses
- Whether a subscription model for an environmental technology product could enable re-use of the product instead of the dominating single-use of the product
  - The analysis showed a need for more knowledge about the present user practices and of the possibilities and barriers to re-use of the product
- Whether customers' increasing focus on Total Cost of Ownership (TOC) of machines and facilities as part of a procurement process can enable higher resource effectiveness in the use of the machines and facilities

- The analysis showed the need for further analysis of the resource flows in an existing customer's facility and some of this customer's important final users in order to get more information about potentials and barriers to slowing or narrowing resource flows

## 5. Slowing and narrowing as circular economy strategy

In 11 of the 20 businesses initiatives were identified or developed aiming at prolonging product life time and reducing the amount of necessary products. These cases are shown in Table 1 and covered:

- Three clothes manufacturers with long product life time and one of these with product repair,
- Drinking water equipment with long product life time and possibilities for own product repair,
- Prolonging lifetime of a rescue product by instructing the users in better product use and offering product take-back,
- Long product life time and considerations about product take-back and refurbishment of furniture,
- Use of roof-top windows for re-purposing and multi-purposing of buildings and thereby increasing lifetime and use of buildings,
- Developing leasing and product-service-system for furniture for schools,
- Use of second quality grade vegetables for other food products,
- One textile service company increasing resource effectiveness of textile service through optimization of speed and size of the textile flow and one textile service company considering to do so.

In 8 of the 11 businesses initiatives for slowing and narrowing resource flows were already part of the business strategy, although not exposed as such by the business. In two businesses the strategy was under development and in one business the researchers developed initiatives for slowing and narrowing together with the business. Our experiences show that researchers can be important in identifying *existing* business strategies building upon slowing and/or narrowing of resource flows and in developing options and strategies for slowing and narrowing together with a business.

In the three clothes manufacturers and one of the furniture manufacturers the business strategy is based on a high quality and high price market segment. In the other cases the slowing and narrowing were part of a business strategy based on an average quality and price level.

*Table 1. Initiatives identified or developed aiming at prolonging product life time and/or reducing the amount of necessary products*

| Slowing and/or narrowing | Product and business type     | Business model and conditions   | Slowing and narrowing resource flows – potentials and achievements |
|--------------------------|-------------------------------|---|--|
| Slowing                  | Clothes manufacturer start-up | High quality<br>Outsourced manufacturing  | Design for long life-time<br>Repair kits available for free        |
| Slowing                  | Clothes manufacturer start-up | High quality<br>Manufacturing new products of recycled raw material<br>Outsourced manufacturing | Long product life time<br>Product sale with take-back or leasing   |

|           |  |   |  |
|-----------|--|---|--|
| Slowing   | SME clothes manufacturer                 | High quality organic cotton<br>Design for long durability<br>Outsourced manufacturing | Considering to offer product repair to consumers   |
| Slowing   | Furniture manufacturer                   | High quality<br>Long time warranty  | Design for long life-time<br>Considering product take back and refurbishment   |
| Slowing   | Manufacturer of drinking water equipment | Design for long life-time   | Easy to repair and available spare parts prolong life time<br>Remanufacturing of used equipment                                    |
| Narrowing | Food and agriculture business            | Technical demands for uniform raw material shape                                      | Use of second quality grade vegetables for processed food reduces waste from quality and technical constraints                     |
| Narrowing | Professional laundry and textile service | Textile service   | Labelling of clothes with chip reduces necessary amount of working clothes for workplaces  |
| Narrowing | Professional laundry and textile service | Textile service   | Optimisation of size of textile flow by changing pricing model to include a price for renting and a price for washing textiles     |
| Slowing   | Building component manufacturer          | Focused on increased use of daylight in buildings through roof-top windows            | Re-purposing and multi-purposing of buildings with roof-top windows increase life time and intensity of building use               |
| Narrowing |  |   |  |
| Slowing   | School furniture manufacturer            | Design for long life-time<br>Flexible use as concept                                  | New leasing and product-service-system for public procurement enable longer product life time and re-use                           |
| Narrowing |  |   |  |
| Slowing   | Environmental technology manufacturer    | Mainly single-use of flooding prevention product due to conditions during rescue work | Prolonged product life time by instructing users in better product use. New business models based on leasing or product take-back. |
| Narrowing |  |   | Product re-use and re-manufacturing  |

## 6. Case: developing business strategy for slowing and narrowing

A circular economy journey in one of the case businesses, where a strategy for longer product life time was developed together with the business is presented in the following. In this case the business model of an environmental technology product was changed from a single-use product to re-use of the product through the cooperation between the business and the researchers. The three re-design processes, which enabled this change, are shown in Table 2.

Close cooperation between researchers, university students, the business and interviews and co-design sessions with different actors were important in the identification and development of the possibilities for reuse and recycling into implementable concepts. The changed business model can be seen as co-created by the business and the researchers, students and users. The environmental assessment of the changed business model was based on a comparison of the benefits of product re-use with the impact from cleaning the used product and necessary changes of parts of the product.

Similar dialogues with customers and final users were important in several other cases in order to collect knowledge about the actual user practices and compare them with the expected practices and thereby identify options for e.g. increased resource effectiveness based on increased product life time. Furthermore, such dialogues have been important in considerations about changes in public procurement models and change in products.

*Table 2. Case: Developing strategy for longer product life time.*

| Types of re-design   | Changes through re-design  |
|--|--|
| Re-design of provided services considering changes in roles of products, users, service, infrastructure, etc.: | <ul style="list-style-type: none"> <li>• Business offers to take back product after use instead of product is discarded by customer</li> <li>• Users informed about how to empty used product so that the product can be re-used</li> <li>• Product is re-used after cleaning or refurbishment</li> <li>• Customers buying re-used products are informed that products might be dirty but have same quality as new products</li> </ul> |
| Re-design of value chain relations up-stream and down-stream:  | <ul style="list-style-type: none"> <li>• Customers are offered discount with next purchase of product if they return used products instead of disposing them</li> </ul>  |
| Redesign of internal business organization:  | <ul style="list-style-type: none"> <li>• New tasks introduced: Disassembly, refurbishment and cleaning of used products</li> <li>• Development of information for customers about prices and quality of re-used products</li> </ul>  |

## 7. Conclusion

Circular economy is not without shortcomings as strategy for sustainable development. A circular economy with main focus on closing material flows through recycling has limited value for both businesses and society. In order to contribute to substantial reductions in resource consumption, then it is necessary to understand the dynamics of the present linear economy and the speed and volume of the resource flows by questioning what we produce and why products lose value to their users and become waste.

The paper has analysed to what extent it is a practice, a challenge or a potential for businesses to slow down resource flows by prolonging the product lifetime and narrowing the resource flows by optimizing and reducing the use of materials. In 11 of the businesses initiatives were identified or developed aiming at prolonging product life time and reducing the amount of necessary products. The experiences from the project shows that

- "Circularity" is a unique socio-material combination of slowing, narrowing and closing material flows
- Slowing and narrowing already developed by some companies: circular start-ups and existing businesses
- Slowing and narrowing are in some cases based on a high price/ high quality strategy – but in some cases this strategy is part of a business, which compete about average price and average quality



- Researchers can identify existing slowing and narrowing practices and initiate and support development of such initiatives
- If a business develops knowledge about user practices: potential for CE strategies for prolonged product life time and more effective product use
- Businesses can develop dialogue with public authorities about public procurement enabling slowing and narrowing, but it is a challenge whether the public customer is able and willing to change from a public investment to subscription to a service

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