

TRANSITIONING TO THE CIRCULAR ECONOMY: WHAT DOES IT TAKE TO GO FROM EFFICIENCY TO EFFECTIVENESS?

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If the manufacturing world had its own dictionary and each year celebrated 'newcomer phrase of the year', the past 2-3 years would have seen 'Circular Economy' as a clear candidate for a place in the listings of new vocabulary. Alongside the United Nations' 'Sustainable Development Goals (SDGs)' and the now well matured mantra of 'Resource Efficiency & Cleaner Production', the notion of transitioning from a take-make-use-waste (or linear) economy to a whole new circular mind-set is a notion that has taken hold within the Danish society. Circular economy is a concept that is based on the notion where the highest value possible is striven for, by consumption of the fewest possible resources, whether these should be reused, recycled or shared between numerous users. And Denmark is by no means alone in this development, as the number of countries developing strategies towards a circular economy grows, month for month.

Danish manufacturing companies are generally well advanced with respect to sustainability, but even though Denmark is one of the absolute highest performers in various global sustainability indexes, it is clear that we need to focus on 'sustainable production and consumption', which is Denmark's greatest challenge amongst the 17 SDGs.

One of the most compelling promises of the Circular Economy concept is the opportunity to make significant savings (and even earnings) for the company, via a radical change in the relationship between value creation and resource consumption. "But who or what loses out?" one may ask oneself. The answer to that question is that the so-called 'structural waste' ought to be the only loser. Structural waste is basically waste that is caused by inherent ineffectiveness within or across value systems due to bad design, sub-optimal processes, out-dated laws, or sheer lack of motivation or insight, on the receiver's or the provider's side. The idea with the Circular Economy is to focus on providing the highest value possible from the provider to the receiver of a product or service, whilst minimising the amount of resources consumed along the way.

SOUNDS LIKE THE OLDEN DAYS?

If the notion of the Circular Economy awakens stories from one's parents or grandparents, about how life was, when they were children and resources were scarce, well there is some shadow of truth in such an analogy. The differences today are that we are more than double the human population on the earth than when the folks from the previous generation or two were our age. The human population has never been as wealthy and affluent and therefore we've never consumed as many resources per capita as we do today. As a species, we're also bigger (taller and/or broader) and therefore heavier than we ever were before. Resources are actually becoming scarce! So yes, some of the olden day principles of frugality, efficiency and effectiveness are just as relevant and applicable today as they were in the stories that our grandparents could tell us, with some measure of nostalgia and pride.

But something else is different today too, in comparison to 'back then'. The 20% richest of the world's population, who are consuming 80% of the world's resources have become so used to convenience and instant availability of very cheap goods, that the 'good old' exercises in saving and

preserving no longer are enough. If we are to stand a chance of achieving the goal of responsible consumption and production and if we are to preserve some resources for the generations after us, we need to find solutions that are at least as attractive and easy to adopt as our current 'click and buy' society offers.

NEW VALUE PRODUCTION FORMS ARE THE KEY

The good news is that the digital, connected and post-modern economy that we live in today can provide part of the answer to achieving the opportunities of resource efficiency, if we just reframe our way of delivering value and consuming goods. More than ever before, we are used to fulfilling our needs via alternative means than traditional production forms. We increasingly see the convenience of instant access to services and the freedom of non-ownership of products. We are more willing to share goods with others, if the benefits are befitting. And we're actually more conscious than ever about the need to invest on behalf of future generations, not just for immediate savings and convenience.

In industry, initiatives such as 'Industry 4.0' and the 'digital factory' contributory factors in the achievement of thorough production optimisation processes. Sensory technologies and IoT solutions contribute to effectivity boosts of both production facilities and to an ever-increasing extent, to certain product types. And within full scale production facilities, examples of both post-production and post-consumer remanufacturing and other loop-closing initiatives are on the increase. Good ecology is more and more viewed as an equal to good economy.

PUTTING IT ALL INTO SYSTEM

Arguably the largest proponent in the world of the Circular Economy is the Ellen MacArthur Foundation (EMF) - a UK-based NGO, established with the purpose of promoting and disseminating knowledge about the opportunities that lie in cutting structural waste, in favour of increased value per resource consumed. Not simply playing on words, EMF urges us to move away from the rather more established notion of 'resource efficiency' in favour of thinking in terms of 'resource effectiveness' instead. The adage states that resource efficiency is 'doing less bad' by cutting down on resource usage, whereas resource effectiveness is about 'doing more good', by squeezing as much value-add out of the resources we utilise in our products and then ensuring that the resources circulate as many times as possible. In reality, the two notions of efficiency and effectiveness are not too far from each other (indeed in Danish, it's the same word, effektivitet!), but the provocation of the dichotomy is a healthy reminder to change our mindset.

It can all sound quite compelling, to increase savings and earnings by cutting inherent and structural waste. The past 2-3 years have seen many examples and shining stories of how it's achieved, in a number of cases from a number of industries and various economic and societal contexts. But how to learn from the good examples, in order to create a home-grown success inside one's own company? How to spot the potential and get new ideas, in our own production facility? How to initiate such a transition from linear to circular business model? And maybe most importantly of all, how to understand whether or not everything we make circular is necessarily more sustainable, at the end of the day?

The answer to the above questions is what is currently driving a number of companies that have made the decision to venture into investigating the potential of making the shift to Circular Economy

practice. In answer to this large interest, many research agencies, funds and innovation-promoting organisations (both nationally, regionally and not least at an EU level) have been actively supporting the creation and development of knowledge in the area of Circular Economy, over the past couple of years.

A NORDIC EXAMPLE: THE CIRCit PROJECT

The research community is of course also playing a large role in the development of knowledge and growth in this area. Researchers have a drive to understand how to contribute, through methods and tools, to the support of a sustainable transition to Circular Economy. One such research project is the CIRCit project, a Nordic project, supported by the 'Nordic Green Growth Initiative' and running in all five of the Nordic countries.

Led by the Technical University of Denmark (DTU)*, CIRCit offers six views to Circular Economy support, seen from a company viewpoint. The project engages production companies from the five Nordic countries and invites them to choose two or more of the six CE-views, after which an engagement between the researchers and the companies results in a co-development of new methods to integrate the circular economy mind-set into the businesses. The six views (manifested within the project as 'work packages'), follow the value creation and deliver process for a company and are therefore of direct use and relevance to the collaborating companies. The six Circular Economy views (described in the following section) can be applied in combination or one at a time.

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The CIRCit consortium consists of five partners: DTU (DK), RISE (S), Innovation Center Iceland (Is), Technology Industries Finland (F) and NTNU (N). The Principal Investigator for CIRCit is Professor Tim C. McAlone.

CIRCit is a Nordic research project aiming to increase the proficiency of the Nordic Industry towards Circular Economy, so as to increase competitiveness in the short, medium and long-term. It is part of the Nordic Green Growth Research and Innovation Programme, funded by NordForsk, Nordic Energy Research and Nordic Innovation.

Circular business models: If the Circular Economy is to provide a significant benefit for the manufacturing company (that may lead to a disruption of traditional transaction-based manufacturing and sales), then a focus on the business model is imperative. The main reason to address the strategic layers of the company with regards Circular Economy are to identify alternative ways of doing business that are fitting to the company's position in the value chain; already developed products and services to develop best practice cases; and to develop promising new offerings and value propositions that achieve strategic goals for circular economy.

Development of circular products: Here the focus is on conceptualising, developing, validating and implementing more 'circular-ready' products, by means of a product circularity indicator and circular design guidelines, for the early-stages of the product development. The idea being that product developers will need to train new competencies to understand the most optimal design decisions and trade-offs to make, in order to produce the most circular-optimal solutions.

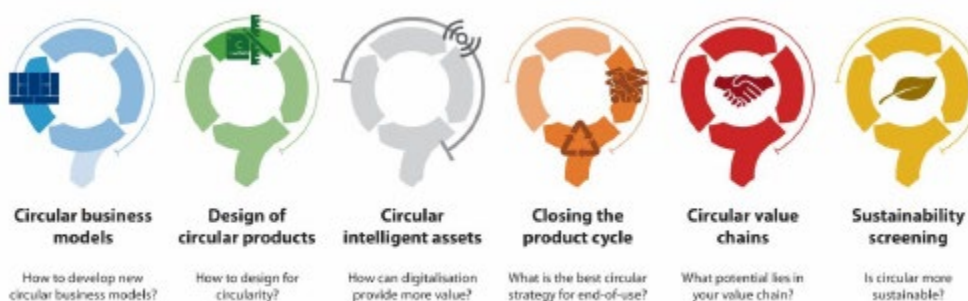
Circular product operation via digital intelligence: What to do when the product reaches the customer? Well, never before have we had quite so many possibilities to support the product during use and at the same time to learn from it (if we have the access and the permission to use its operations data). More and more examples in established industry sectors are beginning to arise, regarding new business ventures (e.g. 'engine health monitoring' of ship motors or truck engines), which are using digital technology as the core to their substance. But we are just at the beginning of the journey, regarding optimal and innovative use of digital technology for the optimisation of products' use and efficiency.

Closing the product cycle: One thing is to design and develop products via a circularity indicator and related guidelines. A whole other question is how to deal with the components, products and systems that are out in the market already? Companies need support to identify the best strategy for products that have completed their first, second and third active life cycles (shall we remanufacture, repair, reuse, recycle, refurbish, etc.?). And this should be worked out for all products that are manufactured and sold, based on insight into the products' technical, market and sustainability characteristics.

Cross-sectorial vertical collaboration in value chains: Much of the innovation potential that lies in taking a Circular Economy approach can be unlocked by focusing on the trinity of: value proposition (through innovative and sustainable business models); value creation (through sustainable product/service development); and sustainable value delivery (by means of new value chain configurations). By working together within and across value chains, companies can unlock the innovation potential of sustainability, ensuring long-term competitiveness. Opportunities lie in the creation of new (and maybe unconventional) partnerships within and across value chains, which can help manufacturers to decouple value creation from resource consumption.

Sustainability Screening for Circular Economy: One thing is to design business models and products according to a circularity recipe, and to manufacture, operate and later 'retire' such products within closed loops. But the question for all companies should also be as to whether the closing of the loop is always the best idea, seen from a business-, environmental- and a social perspective? There is a need to support industry with indicators that enable the evaluation of the potential sustainability impact of circular solutions, in order to make an overall judgement as to whether the proposed change is better or worse than the solution that the company currently operates.

Figure 1: The CIRCit project's six views on circular economy



NORDIC INDUSTRY AT THE FOREFRONT

The CIRCit project is engaging the Nordic industry through these six knowledge-based viewpoints on circular economy, in approach that both directly guides and supports the industry partners through their own development processes, whilst also contributing to the researchers' development, validation and evaluation of new methods and tools, which will later be made generically available, towards the end of the project. Of the 15 companies with which CIRCit is engaging from across the five Nordic countries, Finnish Konecranes has engaged on activities to develop their business models, understand their sustainability potential and achieve further optimisation of the operations of their heavy industry cranes. Swedish producer of coffee machines and related equipment for restaurants and cafés, 3TEMP/PLAE2TECH, has identified a host of new opportunities to be gained by seeing business from a completely new perspective, plus new potential value chain collaborations. Danish Danelec Marine has calculated the business case for new circular economy related initiatives and is ready to measure the benefits of new data analytical approaches. And Icelandic manufacturer of prostheses, Össur, is pairing the insights from circular product development and approaches to closing the product cycle, so as to address circularity both at the front end of their innovation process and to ensure maximum 'end-of-use' optimisation.

The CIRCit project is just half way through its own life cycle and the company engagements continue. At the same time, new insights, rich methods and novel case stories are being created, all of which are intended to lead the way towards circularity in the Nordic industry. With the methods and tools from the CIRCit project and the direct industrial insight that is being created through the tight collaboration between industry and the researchers, the goal is to provide a step change in the way that companies view value creation. The necessary decoupling of value creation from resource consumption is the mantra that is driving the research. And it's this mantra that should enable our growing and increasingly affluent population to thrive, through a better distribution of resources and an increase in the amount of value created per unit of resource consumed.