Complexity Approach to

Basic Materials

1. Overview

- Overview
- Push Factors
- The Linear Model
- Solutions Overview
- Disruption

2. Analysis

- The Materials Economy
- Pre-Modern Economy
- The Industrial Model
- 21st Century
- Today’s Challenges

3. Solutions

- Solutions Overview
- Complex Business Models
- Innovative Disruption
- Vectors Of Change
- Resource Platform
- Nonlinear Cycles
- Materials As-a-Service
- Life-cycle Management

Overview

The basic materials sector is a category of companies engaged in the discovery, development, and processing of raw materials. This basic materials economic sector consists of companies engaged in the extraction and primary refinement of chemicals, metals, nonmetallic and construction materials; forest, wood, and paper products; and containers and packaging products. These raw materials provide basic physical structure, they are the building blocks of manufacturing and construction of all kind.

An industrial age set of solutions for the extraction and provision of basic materials within a linear model is increasingly reaching its limits of operation, due to on the one hand the rapid expansion of the global middle class of consumers and on the other a finite limit of available resources. The most recent figures from 2011 reveal that the world on aggregate extracted over 16 trillion metric tons of mineral raw materials from the Earth's crust. We currently extract an equivalent of 1.5 planets' worth of resources every year including forests, land, metals and minerals, while generating a vast amount of waste product. Following the current trajectory, it is estimated that we may need more than two planets' worth of materials by 2050.

Section 1l Overview

Push Factors

Although it should be noted that there remains many different opinions on the availability of natural resources. This question of availability of future resources is a complex one involving many interacting variables, many of which are unknown. Thus, we should be cautious in making exact projections about specific materials. But what we can say is that this macro set of limitations will have a systemic restructuring effect on the nature of the materials industry over the coming decades. In a world with increasingly constrained resources and environmental challenges, the balance of supply and demand will shift for many commodities. This will have a profound effect across the basic materials value chain.

Added to this are a number of other factors including political turmoil, price volatility, changes in markets and production applications and increased environmental protection to name just a few of the many aspects that influence the supply of raw materials. Major economic trends such as demographic change, urbanization and globalization necessitate a need for continuous innovation to reduce the consumption of natural resources. An outcome to this is that companies already face the challenge of growing their business and creating customer value in the face of supply price volatility, environmental concerns, and possible resource availability scarcity.

Linear Model

This basic recognition to resource constraints has guided many to come to the conclusion that it is the linear model at the heart of industrial economies that is the primary limitation to the sustainable development of our global resource economy. The linear model of take, make and dispose, creates a direct correlation between economic development and resource consumption that results in this core set of constraints to the future development of the global economy - and in particular the emerging markets that are set to expand rapidly over the coming decades, as we approximately double the world's middle class of consumers within just a couple of decades.

Thus, the central challenge going forward for the resource economy (and a major driver of structural transformation) can be identified as the decoupling of economic development and resource consumption. Something that appears to be unprecedented in the economic development of industrialized nations.

"Recently, many companies have also begun to notice that this linear system increases their exposure to risks, most notably higher resource prices and supply disruptions. More and more businesses feel squeezed between rising and less predictable prices in resource markets on the one hand and high competition and stagnating demand for certain sectors on the other"

Towards the Circular Economy report

Solutions Overview

The solution to this challenge of decoupling growth from material throughput is becoming increasingly apparent. It involves a shift from a linear economic model to a nonlinear model, from a linear economy to a circular economy. A circular economy is grounded in the study of feedback loops within non-linear systems as exemplified by ecosystems. Through nonlinear processes of re-use, recycle and refurbish increased material consumption can be decoupled from their availability for usage.

Although the concept of a cyclical economy is relatively simple in the abstract. Its application will require a fundamental transformation of major economic sectors along a number of dimensions. A major outcome of shifting to a circular economy is the notion of optimizing systems rather than components. A shift from ownership and sale of discrete products to an as-a-service model, where the value is in the delivery of the function. The focus will shift to processes and the full life cycle of resources from cradle to grave.

This new economic model fundamentally requires a shift in focus from gross input and throughput toward instead looking at how those resources are used, distributed and exchanged within the system to enable their most effective usage. Value is here generated less by extracting and processing more "stuff" but increasingly opportunities will be built around helping people use and exchange their resources more effectively.


"We want our products to be a tree, everything that is falling down from the tree or being blown away is being used by microorganisms, plants, plant insects or what have you" - Stef Kranendijk, CEO Desso

Disruption

The transition to a circular economic model should be seen as offering vast opportunity. A new book "Waste to Wealth", demonstrates that a circular economy could deliver $4.5 trillion in revenue to a range of companies by 2030. When we combine new business model opportunities with new digital platforms we get the huge potential for innovative fast growing new enterprises. Innovative disruptive companies are already coordinating upstream and downstream activity to recover precious materials in the most cost-effective way, or even supplanting traditional materials completely.

There are new industry players already creating businesses around the market for secondary resources through recycling and recovery of materials. And as with all industries, the concept of creative destruction will apply, meaning that new business models will rise, at the expense of existing incumbents. The materials industry maybe one of the last to be truly affected by the digital disruption, but as the shift to a sustainable economic model increase and the internet of things is rolled out we should be expecting it.

The ideas of a circular economy are not new but with this new context of volatile and limited resources, changing consumer demand and information technology the time is now for businesses involved in the materials economy to expand into an evolved business model that is designed to take full advantage of these opportunities and ensure their relevance going forward.

"Initially, market disruption through circular business models was driven by startups. Now large multinationals are making serious moves as well. H&M collect garments in all stores to close the textile loop, BMW and Cisco Systems are extending the life of used products through refurbishment and resale, Philips offer "light as a service" to cities and municipal governments, Amazon.com textbooks as a service, Daimler's Car2Go (a car sharing service) had 600,000 customers in 2014 heading for $100 million in revenue and Wal-Mart is making a push into the $2 billion market for pre-owned video games through an in-store trade-in program" - Accenture Consulting

Section 2l Analysis

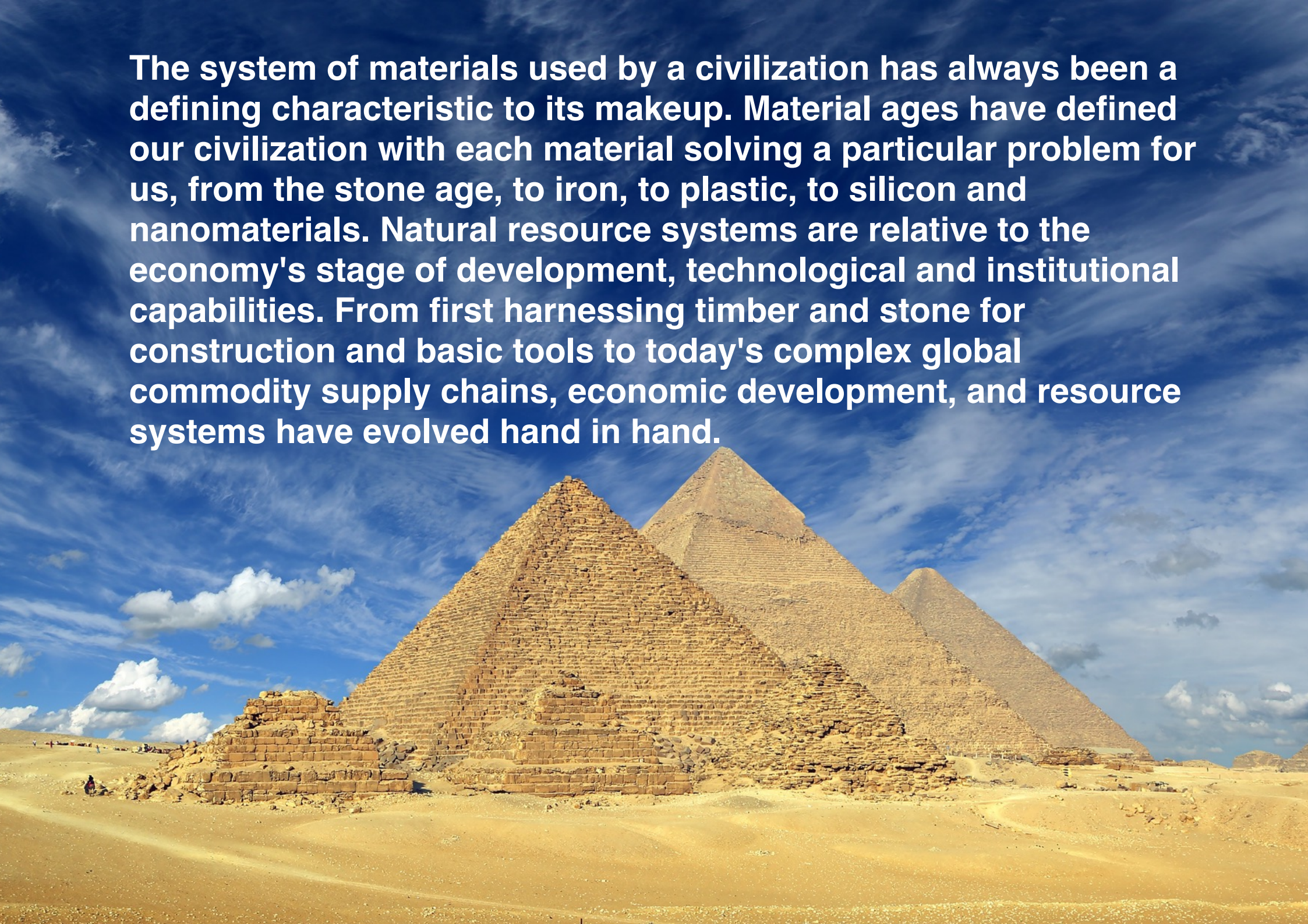
Understanding the Materials Economy

Raw materials are the minerals extracted from the natural environment for usage in the production of tangible products, these materials provide the physical structure to our engineered environment. The primary sector raw materials industry is a system for locating, accessing, extracting and processing raw materials from the natural environment into standardized commodity resources readily available for usage in secondary industrial activities.

Natural raw materials come in a wide variety of forms from metals such as zinc and iron too, petroleum to timber and serve a diverse set of functions across industry sectors, from structural functions in construction and machinery to electrical conductivity, insulation, lubrication, etc. The input, processing, utilization and disposal of materials through the economy can be best understood with reference to material flows analysis modeling. Materials flow analysis (MFA) helps us to quantify flows and stocks of materials or substances in a well-defined system.

With materials flow analysis models we can define the stocks and flows of materials within the industry and define various scales of analysis from the micro, of possibly a single company's product process, to that of a whole economy. In this way, we can gain insight into the full input material flow processes and outputs in order to understand how effectively that resource is being utilized and its effect on the environment. Understanding the full journey of a material across its life cycle process is central to understand it, how it is used and its core value proposition.

The efficiency of material usage would be the relationship between the value delivered by that material during this process relative to entropy produced; where entropy is a function of all of the waste product caused by that material, its negative effect on the environment, space is taken up in a landfill, emissions etc. Thus, efficiency should be understood as the actual value that the material delivers over its full life cycle, relative to the waste produced.


The system of materials used by a civilization has always been a defining characteristic to its makeup. Material ages have defined our civilization with each material solving a particular problem for us, from the stone age, to iron, to plastic, to silicon and nanomaterials. Natural resource systems are relative to the economy's stage of development, technological and institutional capabilities. From first harnessing timber and stone for construction and basic tools to today's complex global commodity supply chains, economic development, and resource systems have evolved hand in hand.

Premodern Economies

Preindustrial economies are subsistent in nature. Products exhibit a low level of material composition complexity, with a low level of throughput volume and materials processing. Economic activity represented a small enough influence on natural processes for materials to be easily reintegrated into natural cycles. The pre-modern materials economy was likewise relatively low in diversity between materials and how those materials were interconnected or bundled into manufactured items. The life cycle of a material was typically constrained to a local geographical area as preindustrial economies were subsistent in nature.

The Industrial Model

With the rise of industrial systems of economic organization and technology came much more sophisticated systems for the extraction, processing, and manufacturing of products that transformed our raw materials economy. A greater variety and volume of material came to be extracted through standardized mass extraction mining processes. Newly found knowledge within thermodynamics allowed for a more complex processing of these raw materials into steel and various fabrics. Innovations in engineering enabled the production of more complex artifacts that combined many materials into a single product.

Since the industrial revolution, the world's economy has been dependent upon a selective number of base metals that form the backbone to our economic development and are used in large quantities. Base metals including iron used to produce steel, copper used in electrical wiring, tin, lead, and zinc. With urbanization and the rise of the modern mass market system, the materials flow of industrialized nations was scaled up often to the scale of the national economy, and sometimes internationally.

Industrial age economic demands were small relative to the availability of natural resources, thus, it was possible to adopt a linear model in which resources were taken from the natural environment, used and then disposed of back to the environment, with limited environmental constraints the emphasis was on a gross throughput of resources. The focus for producers and suppliers was on optimizing the gross throughput to their section within the supply chain.

The 21st Century

During the 20th Century, the materials economy expanded, diversified and broadened to include every class of material, including ceramics, polymers, semiconductors, magnetic materials, medical implant materials. By the later half of the century, the advanced industrial economies were into the age of synthetic materials, as plastic exploded on to the materials scene, ultimately leading to the development of today's biological materials and nanomaterials. The rise of the high-tech industries placed a significant demand on rare earth metals and the wide variety of technology metals in the computers and smartphones that enable the information technology we depend on today.

Today our engineered environments are urban jungles of materials, they are a complex system of thousands of different materials extracted from around the planet, developed through sophisticated processing techniques, assembled within global supply chains and distributed to the end user. The global materials economy is now a complex system consisting of thousands or different resources that are interconnected in the making of millions of different products as they flow through a complex set of processes from extraction, processing and manufacturing to usage to disposal. A value chain consisting of many different interacting parties, from government regulators to mining companies, to commodity markets to manufacturers, retailers, consumers, and waste disposal providers.

Today's Challenges

Today there is widespread recognition and indicators that the scale and pace of expansion are reaching the limits of our traditional economic model. As many emerging economies around the world currently go through the process of industrialization that is leading to a rapid expansion in the size of the world's consuming class within a couple of decades. Within this context there is a clear need for a more sustainable model and the center of this nexus can be identified as a need to decouple economic development from resource consumption.

Throughout the modern era economic development has been a distinctly physical and material activity. Economic development has been essentially synonymous with inputting, processing and consuming more natural resources with an almost linear correlation between the two. In fact, historically for every 1 percent increase in GDP, resource usage has risen on average 0.4 percent.

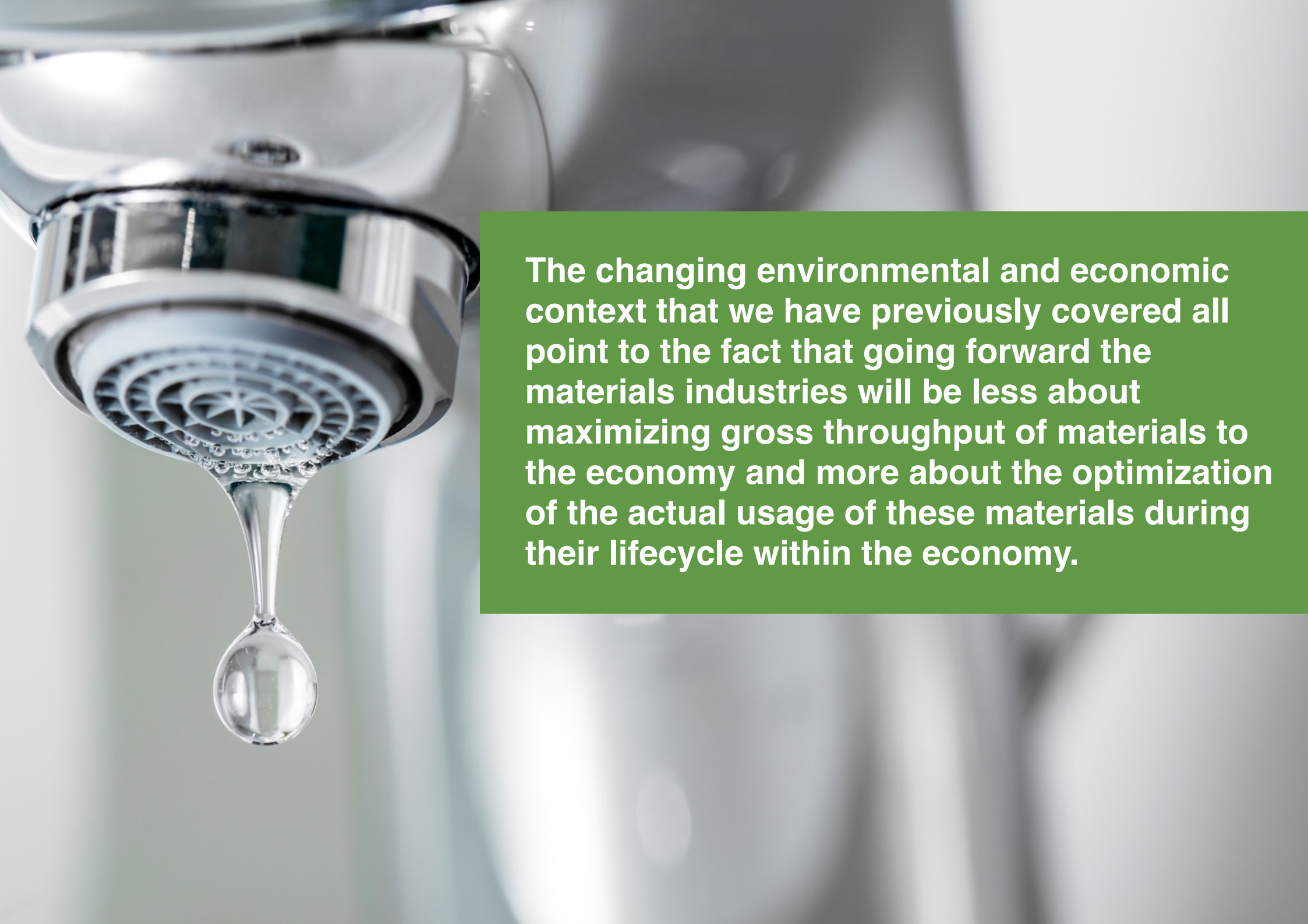
This direct correlation between economic development and an increase in resource consumption is a product of the linear model that lies at the heart of industrial systems of organization. And it is becoming increasingly apparent that it is this linear model that is what really needs to change to enable the large upscale in economic development without reaching the limits to the availability of resources or the capacity for natural ecosystems to function effectively. And it is the paradigm of a circular economy that most effectively articulates an approach to uncoupling economic growth from natural resource consumption.

Section 3l Solutions

Solutions Overview

Central to achieving optimal outcomes for both the environment, business organization and consumer, within the materials industry, is in aligning business models with overall efficient and environmentally sustainable outcomes. Achieving an effective circular economy means aligning the incentives of business, end user needs and environment, it has to work for all stakeholders and most importantly work to align their interests. In the current, linear economic system a take-make-waste approach is apparent, in which natural resources are used to create a product, which then ends up as landfill after usage. This linear system uses certain, familiarly, business models, typically described as a ‘transactional business models’. This is of course extremely familiar to us, it is the model of selling something, where a product changes ownership from manufacturer to consumer upon sale.

Many companies’ business models are not set up to do much else than earn money from volume, this inevitably creates a push model where producers are trying to push out ever more products and resources, while also hoping that they will not last longer than the bare minimum before people through them away to return to buy more (the so-called lightbulb conspiracy). Within this paradigm, the idea of producing less or helping consumers to use less appears totally contradictory to business logic, and it is. That is why the business model has to change fundamentally before any real progress can be made, leveraging competitive advantage through the circular economy requires a paradigm shift in business logic, but if done successfully it represents a massive potential.



The changing environmental and economic context that we have previously covered all point to the fact that going forward the materials industries will be less about maximizing gross throughput of materials to the economy and more about the optimization of the actual usage of these materials during their lifecycle within the economy.

More Complex Business Models

Tapping into this new opportunity requires a new more complex business model that is more focused on managing the usage of the material over the course of its lifecycle. A model that is focused on generating value and revenue from functionality instead of the gross production of materials. Within this model businesses are competing on the functionality that they provide, by producing more functionality with less material and changing from ownership to performance-based payment models, this is instrumental in translating products designed for reuse and long usage into attractive business value propositions.

This means a much greater understanding of the materials value chain, how is the value created? Where along the life cycle is it lost? How do you match each level with the correct usage? This is in many ways an inversion of current business models that are very much focused on their limited segment in the supply chain. Resource scarcity will require organizations to rethink their business models around life cycle, but this should be seen as an opportunity, to add value, become differentiated and increase revenue. Businesses need to ask themselves what is the real core value and essence of what we deliver to customers, and how can circular business models help us rethink how we deliver that value?

Businesses in this industry should no longer see themselves as simply selling resources on mass but instead move up the value chain to become end-to-end material solutions providers. Building their business models around the full life cycle of material flows through the economy, with their value proposition focused on the actual points where the material delivers a service.

Innovative Disruption

The materials and mining industries may be the last to be directly disrupted by new IT-enabled start-ups, but businesses in these industries need to be increasingly looking outside the box. In the age of disruptive innovation competition doesn't necessarily come from within your direct industry, or a specific location within the value chain, but instead cuts across the entire value chain. Today we see companies like Google that once established can easily move sideways into new industries(such as the auto industry or book publishing) and this is the nature of disruption in the rising networked economy. Businesses need to be looking along the value chain to see where the value is and how the network of players interact and evolve.

If they don't act soon, they risk being overtaken by innovative companies that are already coordinating upstream and downstream activity to recover precious materials in the most cost-effective way, or indeed supplanting traditional materials completely. There is no way around it, mining and metals companies are going to have to become much more engaged with downstream users of their materials. Miners must start looking at their portfolio and assess where the risks of decreased demand or substitution are most likely. We then need a much clearer understanding of which materials can be recovered most cost effectively – given expected projections of demand – and where new business models across or even between supply chains are required to ensure incentives are aligned.

Key Vectors of Change

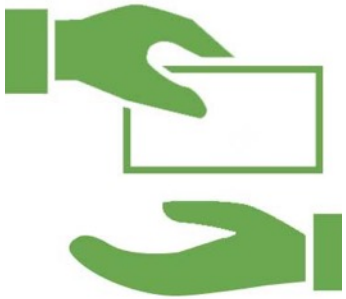
In adapting to the new economic reality of the circular economy and new opportunities provided by information technology business models will need to evolve their makeup to engender a number of key structural transformations, these include:

A more towards a platform business model

A change from selling materials as products to businesses and end users, to becoming platforms that facilitate the recycling, up-cycling and exchange of resources between users

A more towards a nonlinear model

A change from a traditional linear value chain where the emphasis is on gross input and throughput, to a nonlinear circular value network where the emphasis is on maximizing the efficient use of resources within the system.



A more towards an as-a-service model

A shift from selling materials as discrete one-off products, to selling the functionality of a material through a sustained as-a-service contract model

A move towards managing the full life cycle

A shift from fulfilling one segment within the value chain, to managing the full value chain from cradle to grave

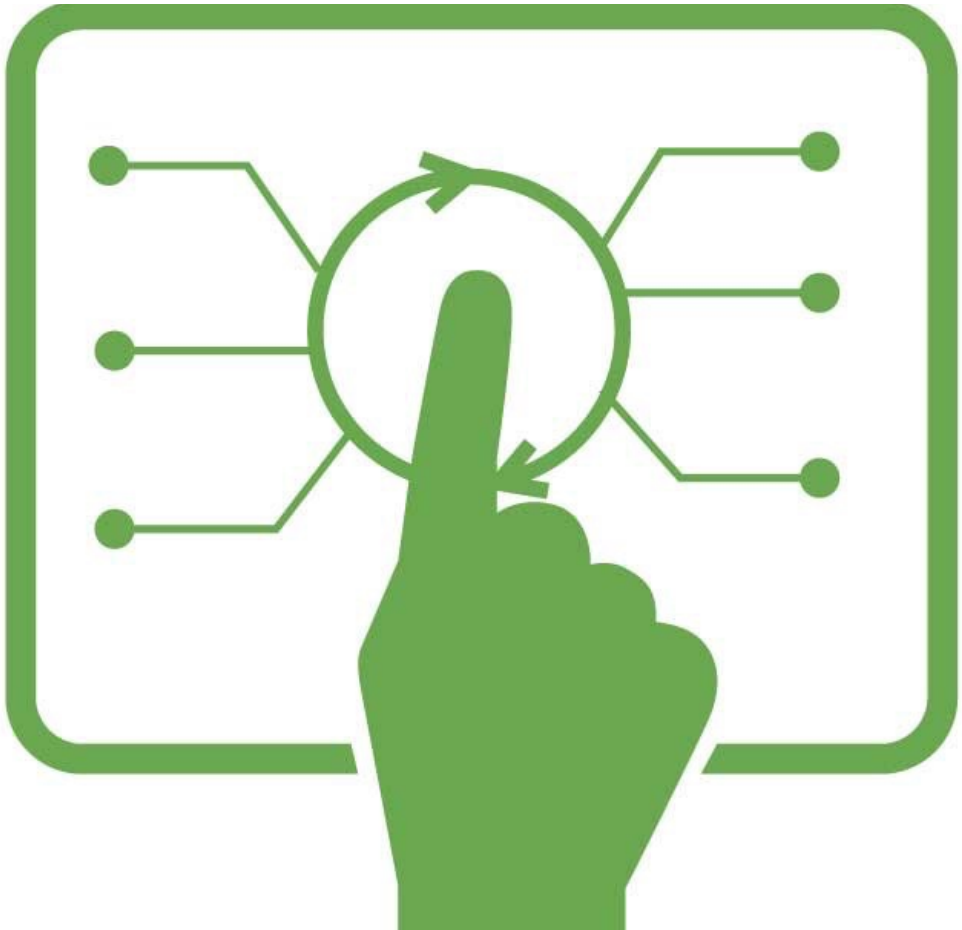
Resource Platforms

As we move into the circular economy less and less of the value will come from the extraction and selling of virgin material and more and more of the value will come from the recycling and (probably most importantly) the exchange of materials between users. Thus, standard revenue streams of extracting and selling raw materials as a product will likely decrease while at the same time a whole new source of value will open up not in selling products but instead in facilitating peer-to-peer interactions, from company to company or from end-user to end-user. This is a very different economy that is focused on enabling interaction, exchange, and access instead of simply selling products, we have already seen this business model emerge in many other industries and today it goes by the name of a platform business model.

The Platform Business Model

The platform business model is emerging to be most closely aligned with the workings of a post-industrial information and services economy. Platform designed businesses are an evolution in business model away from the traditional monolithic organization that produced and sold goods to other businesses or end users, and towards a model where businesses function as platforms providing essential services and solutions for connecting producers and consumers.

Material companies can become not only providers of materials but also move up the value chain to become platforms that enable the exchange of materials between businesses or end-users. This is a move from a closed business model of selling one's own products in a linear fashion, from you to the user, to opening up in enabling others to exchange resources. By opening up to become a platform organization the business can not only generate revenue from the sale of its own products but as a materials platform, it can also generate revenue by enabling the exchange of other resources between end users in a peer-to-peer dynamic.



In creating an open platform model this enables you to leverage capabilities outside of the organization and this is where the real value is today. Everyone, organizations and end users alike, has materials in some shape or form that are often lying around or locked up in some way, in an attic, a basement, a warehouse or scrap yard. Providing the IT-enabled platform solutions for unlocking these, reallocating them to places of demand offers huge potential for value generation.

Case Example

One good example of a platform business model to the materials industry is The United States Materials Marketplace that recently won the award as a leading digital disruptor in the circular economy. The organization describes itself as such: The United States Materials Marketplace is a project of the US Business Council for Sustainable Development, World Business Council for Sustainable Development, and Corporate Eco Forum to scale up business-to-business materials reuse across the US. This marketplace facilitates company-to-company industrial reuse opportunities, help companies to identify new supply chains and value streams through materials exchange and support the culture shift to a circular, closed-loop economy.

The Marketplace serves as a collaborative platform not only providing a way for companies to align material streams but also serves an increasingly important convening role. It amplifies the voices of like-minded businesses seeking to modernize regulatory structures to better enable sound materials to reuse across borders and boundaries. And to address the challenge of including smaller players, a new co-op approach is in development to connect the city, state and national-level projects to the Marketplace.

The project is hosted on the US BCSD's cloud-based Materials Marketplace software. This online tool enables participating companies and project staff to easily post materials available or desired, identify reuse opportunities, and exchange underutilized materials. More than a passive materials exchange, through a built-in interface the project team monitors marketplace activity, identifies possible reuse opportunities and actively pushes out those opportunities to relevant companies as recommendations. If the parties involved need assistance, the project team helps facilitates transactions between companies.

“Digital technologies, disruptive new technologies, like 3D printing, like the internet of things and connected devices and sensors are providing new ways for companies to support and enable their business models in the circular economy. They are finding ways to be more operationally efficient, they are finding ways to enable things like sharing platforms, to shift from products to services, to be able to embed digital technologies in machinery, to be able to take it back at the end of life cycle, remanufacture it, refurbish it. So for me digital technology is the story of the circular economy." Peter Lacy author of Waste to Wealth

Harnessing the Crowd

When we switch our focus to what is outside of the organization, onto what pre-exists within the system, we can begin to see this as the raw stuff for an innovative business model built around simply connecting these owners. So that resources can be exchanged and flow to the point of most usage. Thus generating value and providing the possibility to capitalize on the transactions. But accessing all of this available value that is out there requires building effective platforms, or so-called two-sided markets.

These platforms need to provide the basic capabilities to make transitions frictionless. In the way that eBay or Amazon enables frictionless exchange by providing all of the software capabilities for people to easily list items, find items and exchange goods and finance. But on top of this can also be added an extra level of value and differentiation in the form of social and environmental capital. With platforms, we can easily build gamification and socialization into the system. Use information to inform, educate, quantify and gamify material cycles. In this way, the environmental and sustainability dimension can also add value in the form of natural capital that can be exchanged.

Nonlinear Processes

In a circular economy, the focus shifts from gross throughput to efficiency of usage, where every point of waste is an opportunity to build a business model by closing the loop. Although the most important thing to remember is that most of the people and resources in your industry are outside of your organization, but you can tap into this through building IT enabled platforms that provide them with the tools to reduce waste and effectively coordinate the usage of resources. Thus, it is not just waste within your narrow domain within the industry but instead all across the value chain that should be seen as your business opportunity. This excess capacity outside of your organization can only really be tapped into by enabling others to identify it, close the loop, conserve resources and thus reduce expenses. By enabling others to reduce expenses in this way you have a value proposition that can become a viable revenue Stream.

"81% of those polled in the mining industry say industry boundaries will dramatically blur as platforms reshape industries into interconnected ecosystems …circular business models are disrupting industries around the world. In fact, our research revealed successful adoption of these business models has exploded in the past decade… initially, market disruption through circular business models was driven by startups. Now large multinationals are making serious moves as well. "- Accenture Consulting Report

Organic and Technical Cycles

Technical Nutrients

Made of highly stable materials which can be used again and again, technical nutrients are designed to be retrieved and reused within the closed-loop cycle of sustainable manufacturing

Organic Nutrients

Resources that once used, can be disposed of in any natural environment and decompose into the soil, providing food for small life forms without affecting the natural environment.

Materials and resources can be divided into two kinds, on the one hand, consumables which have a rapidly degrading life cycle. With every usage they degrade significantly, these are called organic nutrients, a paper would be an example of this. On the other hand, we have durable resources that do not wear out with each usage, but instead deliver the service of their usage without significantly degrading, these are called technical nutrients, and an example would be aluminum.

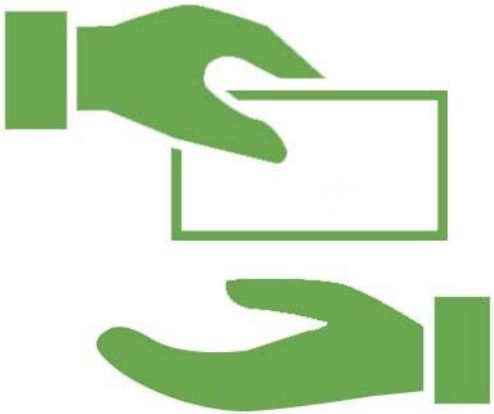
Organic nutrients should be designed to reenter the biosphere safely, this means understanding the cycle through which the biosphere can regenerate them again and seeing that cycle as part of the production process, where we are harnessing biological processes and ecosystems cycling to restore the material to usage. Technical nutrients are designed to circulate at high quality in the production system without entering the biosphere, as well as being restorative and regenerative by design. For technical nutrient material we are analyzing the material cycle through various stages of its usage and degradation, looking at how value is delivered or lost at each stage in order to identify possible business models based upon up-cycling, recycling, refurbishing, repurposing etc.

Industrial Symbiosis

Another important dimension to a more efficient cyclical resource economy is in the creation of synergies through what is called industrial symbiosis which is an association between two or more industrial facilities or companies in which the waste or byproducts of one become the raw materials for another. Industrial symbiosis engages traditionally separate industries in a collective approach to yield mutually profitable transactions through the physical exchange of resources in a synergistic fashion. Industrial symbiosis involves creating and sharing networks through which different industries and businesses can exchange resources, this requires looking outside of traditional industry boundaries.

Industrial symbiosis systems collectively optimize material and energy use at efficiencies beyond those achievable by any individual process alone by yielding mutually profitable transactions for novel sourcing of required inputs and value-added destinations. Industrial symbiosis systems create a network of organizations exchanging resources in a synergistic fashion in so doing they reduce waste and generate added value. If a business can identify these synergistic opportunities a viable business model can be made by simply setting up the network for exchange, again this is a form of a platform business model.

Industrial symbiosis systems such as the web of materials and energy exchanges among companies in Kalundborg, Denmark have spontaneously evolved from a series of micro innovations over a long time scale but they can also be purposefully design as a platform business model adding value by enabling synergies between companies



Materials as a Service

Information technology is enabling a new kind of access economy, where the value is shifted from ownership of products to the service that they deliver, what is sometimes call virtual ownership. The as a service model offers the possibility for a radical jump in the efficiency of resource utilization in that it can liberate materials and resources from a single ownership that monopolizes the resource reducing access to its functionality to a small subset of its possible usages.

For example, the manufacturing company Miele provides washing machines as a service, with a smart meter and feedback to customer services. One of the primary innovations in this economic model is the way different people, parties, and institutes collaborate to deliver a whole different experience to the consumer with much less impact on the natural environment.

Selling Functionality

Services are all about functionality and the as a service business model closely aligns revenue streams with the actual delivery of functionality to the end user. This helps to break down the dichotomy between producers and consumers, the once off purchase that pits producer and consumer against each other, as one tries to maximize sales by pushing out more products and hoping that customers will return more often. While the customer, on the other hand, has to constantly struggle against a bombardment of product marketing that producers are trying to get them to buy irrespective of if they need them or if they are of any value. The product model (although it has its advantages in some cases) is in many cases a lose-lose situation for both producers, consumers and environment in that it mis-aligns their incentives.

With the use of information technology and particularly when we move to a platform business, we can easily switch to an as a service model that can generate much more efficient outcomes for all. Information technology enables us to virtualize any resource and then offer for sale the service of that resource instead of the material or resource itself, and this liberates it from the monopoly of ownership, locked up functionality that goes with it and the resulting redundancy. Material companies can evolve to meet the demands of this new economy, to become IT enabled materials access providers. Thus enabling a much more effective system of resource allocation and sharing and in so doing generate added value to fuel their growth.

"Imagine these scenarios: instead of selling platinum, a miner could create platinum-as-a service for the car industry and retain ownership across the cycle; or metals companies could design reusable steel girders that function like LEGO bricks to plug into new buildings."

Sonia Thimmiah Global Mining Lead at Accenture

Life Cycle Management

The current model for a materials lifecycle divides it up among various owners as a set of discrete stages to the resource life cycle, with limited interoperability between them in a circular economy we need businesses that manage across the full lifecycle by enabling interoperability and coordination across the value chain to create synergies and added value. Information technology and the emerging Internet of things increasingly allows us to sense and track products and materials as they pass through the economy, to understand their full life cycle. Companies are no longer constrained to a relatively simple set of data about their small role in this larger ecosystem, but instead by shifting to a platform as a service model they can build an enduring relationship with the customer and product over its full life cycle. Coupled to this is the rise of big data, the internet of things and advanced analytics that can enable producers to quantify and measure things about their products (and their usage) that were previously impossible. When we start to couple this with materials flow analysis we can start to get a real picture of how resources are changing over their life cycle.

"Changing business models from not selling products any more but renting products out, looking into pay per use models will create a total new dynamic out in the market and create an enormous need for reverse processes, it will make overall products cheaper because we have a viable situation and we know how to recover the value out of the products, even if it is only material recovery as the lowest level recovery that we are looking at, still you can fully optimize that process and you even have an incentive as a manufacture of saying how do I design my product because I know I will get it back and I will get the benefit at the end of life"

Patrick Wiedemann, CEO Reverse Logistics

Case Example

Material providers can become full manager's of material flows from cradle to grave, taking responsibility across the value change in order to maximize the use value to the end user, reduce waste within the overall system and capture the retained value. One good example of this is Philips lighting that has been a leader in this space of circular solutions.

Philips sells lighting as a service, in which the company aims to reach more customers by retaining ownership of the lights and equipment so customers do not have to pay the upfront costs of installation. Philips also ensures the sound environmental management of its products by taking them back at the appropriate time for recycling or upgrading. Frans van Houten the CEO Royal Philips, Netherlands, describes this model as applied to their business with Schiphol Airport as such. "We went to Schiphol (airport) with a proposition that they can buy lighting as a service that takes away the installation adoption barrier. It saves the airport 50% of their electricity bill. It gets them a product that lasts up to 75% longer. So they have fewer replacement cycles and they save labor and it gives us a relationship with Schiphol that will last many years. It actually reduces my selling expenses and it continues that ongoing business partnership, all in all, this deal was very profitable both for Schiphol airport and for Philips." Here the business is managing the life cycle process of the material, the points at which value is delivered and how to up-cycle the product as it becomes degraded through usage.

If we take the example of painting a car in an auto repair shop, if this process is done traditionally out of 10 kg purchased only 1kg will remain on the car. But after a thorough materials flow analysis is conducted it has been shown that if you reduce losses within the paints preparation and application and by limiting overspray you will only need 3.2 kg of paint to achieve the same results

Waste-as-a-Profit

Life cycle business models require a paradigm shift to see every point of waste along the materials value chain as an opportunity for value creation. Every point of waste along the entire value chain is a weakness in the business model and a business opportunity. The key capacity in achieving this is in understanding the cascading value of a material as it travels across the value gradient from virgin material to the end of life and identifying methods for re-adding value at each stage to restore it to a valuable product and close the loop.

Reuse, repair, upgrade, refurbishment, capacity sharing, longevity, life extension each one of these is a business opportunity in the making along any material value chain, from metals to fabrics to construction materials. By using a platform services model materials can be made for long life, exchange and reuse thus benefiting producers, consumers, and environment.

Conclusion

As this paper has tried to show the business opportunities for raw material providers within the emerging circular economy are vast. The time is clearly here for a transition given on the one hand the growing push from environmental constraints plus growing potential for disruptive innovators and on the other hand a growing pull from customers with a desire for sustainable solutions plus the wealth of new value opportunities within the circular economy paradigm.

But success within this circular economy requires a very different way of thinking and way of operating, in many ways an almost complete inversion of the industrial model. This nonlinear model requires us to look outside the box, not at our place within the value chain but instead the entire value chain, not at the material itself but how it relates to others in symbiotic relations, to look not at the production of materials but at the exchange of materials, not at selling products but at delivering functionality, not at creating things but a preventing waste. The future basic materials companies that succeed within the circular economy will look every different from that of the past. They will be IT-enabled, platform organizations that facilitate the optimal usage and exchange of resources along the life cycle within an ecosystem of companies and users that are working symbiotically, improving efficient usage, reducing risk and volatility and enabling a more stable and sustainable economy.

As the sustainable economy becomes an ever clearer and present reality we can say confidently companies and regions that initiate the change toward circular solutions will have a head start and be a strategically position to deal with competition and avail of the new opportunities. But taking full advantage of this opportunity will take a paradigm shift both in business logic and models, as the author Peter Lacy once put it - “It is clear to me that we do need systems thinkers to be able to piece together the different parts of the jigsaw, to understand how we reshape supply, how we reshape demand and the rules of the game".


"The circular economy is an innovation engine that puts the re- back into resources. It provides for continuous benefit to be provided to all generations by the reuse of things, material, energy, water. By designing things that can become useful over and over again. This is the largest business opportunity ever seen by our species and the leaders of the economic future will be people who understand that by design we can create perpetual assets and optimizes them to create businesses that thrive" Pro. William McDonough Stanford

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