JOURNEY TO THE CIRCULAR SUPPLY CHAIN

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Contents

Introduction

Supply chains are changing and the rate of change is increasing to the point of disruption. The stable, elongated, “take-make-dispose” supply chains that we have lived with for many years, even decades, is rapidly losing relevance in light of current and future market demand.

Over the last two or three decades we saw supply chains grow, with globalisation, through a move to centrally manufactured products, in cheap labour markets, aided by both faster communication and the propensity for Original Equipment Manufacturers (OEMs) to outsource manufacturing and supply chain expertise to ‘specialist’ third parties. This was a strategy to manage expansion without the pain of setting up operations – easier to give it to somebody who is already doing it - and also because outsourcing is a means of converting fixed costs into variable costs, removing the capacity variance in manufacturing and supply chain operations.

Oncoming Change

The move to low cost geographies was at the expense of manufacturing jobs in regions such as Western Europe and The US, which declined steadily from the late 1990s (see figures 1 and 2 below) and resulted in the loss of 5.5 million jobs in the US. According to the OECD, US manufacturing jobs as a percentage of total employment fell from 25% in 1970 to 10% in 2009; manufacturing adopted a far less significant role in the US economy as it was outsourced to cheaper labour markets1.

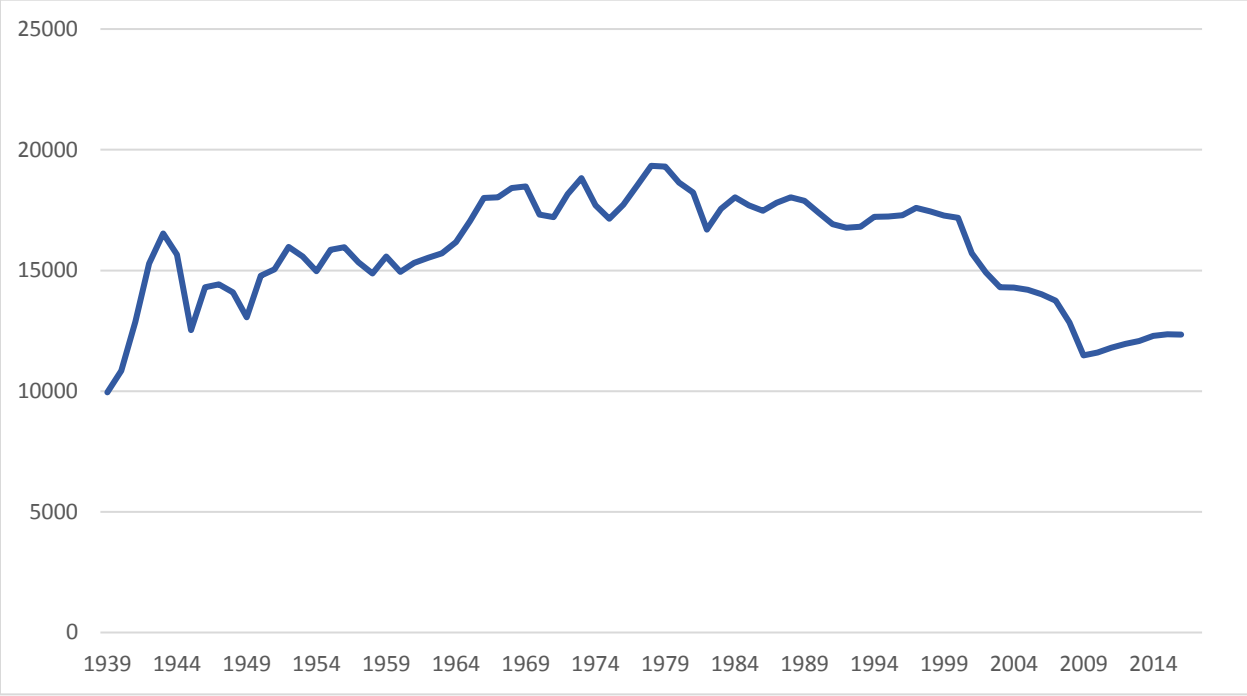


Figure 1: Manufacturing Employee Numbers in the US from 1939 to 2016 (thousands)[2]

[1] https://data.oecd.org/emp/employment-by-activity.htm
[2] Data taken from https://data.bls.gov/pdq/SurveyOutputServlet

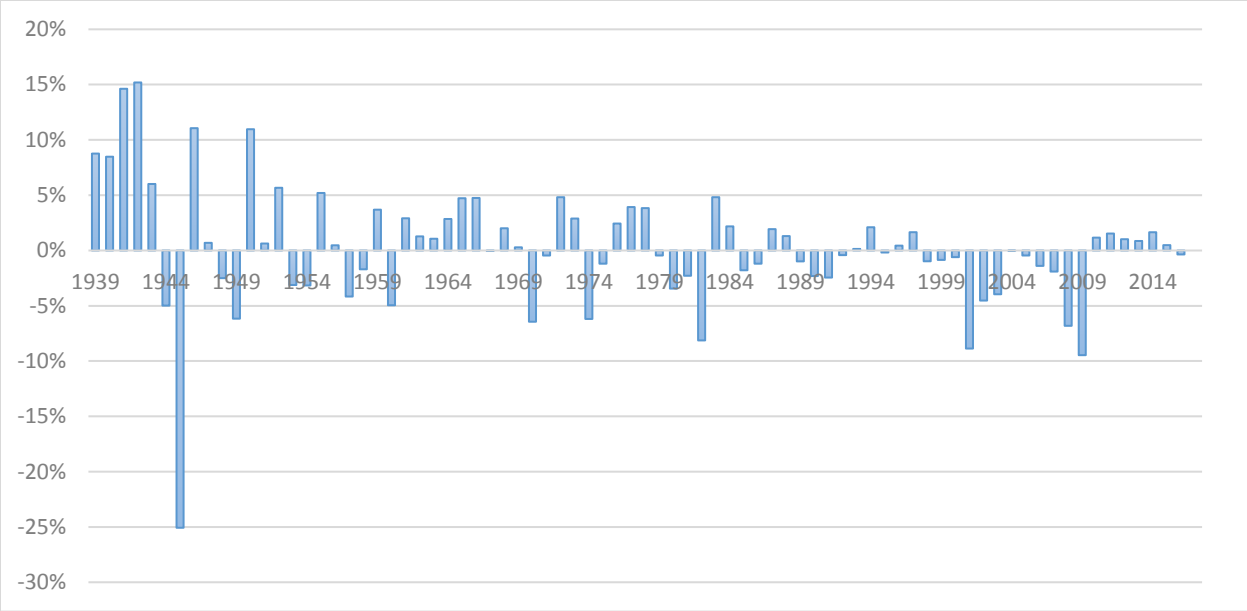


Figure 2: Manufacturing Employee Numbers in the US from 1939 to 2016: Annual % Change[3]

Supply chains followed the manufacturing trend to low cost geographies and we saw growth in Third Party Logistics (3PL) services to link manufacturing with the distribution network, and to manage the warehousing and transportation of finished goods. This model remained largely unchanged for almost twenty years and became very stable with some minor, incremental, productivity improvements, but without any dramatic shifts in operational performance.

Supply chains were of an elongated take-make-dispose nature, whereby raw materials are converted into components and then assembled into finished products, distributed and then disposed of at end of life. There was little or no provision for end of life repair or remanufacture, and this exercise was costly as supply chains were not flexible enough to cope with this reverse loop; it was easier to throw the product away and ship a new one.

But this situation has changed and the change is increasing in magnitude. We are seeing a shift from centrally manufactured products (which are then shipped by air, ocean and road through a network of distribution centres and storage facilities) to a more regional manufacturing and distribution model.

There are a number of reasons for this evolutionary change:

- **Speed to Market** – with shortening product life cycles, getting products to market quickly becomes paramount and the traditional, elongated supply chain is no longer fast enough.
- **Expectancy of Immediacy** – the rise of e-commerce with rapid communication and data links means that traditional buying methods no longer satisfy customer demand. Customers want and expect products at the push of the 'send' button. This is driving speed to market, but also it drives surplus and excess inventory as the 'Immediate Supply Chain' is not compatible with the traditional elongated supply chain. Products have to be buffered in inventory in distribution centres to try and shorten lead times.

[3] Data taken from https://data.bls.gov/pdq/SurveyOutputServlet

Therein lies another problem; the distribution centres are not well placed to service shortened lead time demand, neither are they set up to handle e-commerce demand characteristics – shipping to numerous locations in units of one, which increases shipping costs and causes productivity inefficiencies in traditional labour intensive distribution centres. Couple this with high return rates experienced with e-commerce and the problem is exacerbated.

- **National Protectionism** - Donald Trump putting 'America First'[4]; Brexit; the growth in popularity of right wing political activism in France, Germany and Austria. The political arena is changing and the belief of working in a Global framework is showing cracks with uncertainty around future trade tariffs as the onus shifts to looking after one's own interests.
- **Technology** – the ever increasing acceleration of technological improvements means that manufacturing no longer has to be centralised. The ease of communication and transfer of information and data means that production can take place remotely. New production techniques such as additive manufacturing (or 3D printing) enable products to be made with new functional designs closer to consumption, which reduces transportation, storage and inventory costs. Artificial Intelligence, advanced robotics, machine to machine communication, and all the other developments associated with industry 4.0 allow easier decentralisation of production and decrease reliance on manual intervention. This removes the cheap labour cost arbitrage that caused the relocation of manufacturing to low labour cost geographies in the first place.
- **Remanufacture** – as we will see later, the world is moving away from the take-make-dispose supply chain to adopt a more circular model that promotes reuse of products, components and raw materials.

'As manufacturing goes digital…it will allow things to be made economically in much smaller numbers, more flexibly and with a much lower input of labour, thanks to new materials, completely new processes such as 3D printing, easy-to-use robots and new collaborative manufacturing services available on-line. The wheel is almost turning full circle, turning away from mass manufacturing and towards much more individualized production.' [5] (Paul Markillie, The Economist)

The shift from global to regional is a phenomenon with front page space on the political agenda. Obama made it a central focus of his final term in office and also set up the annual 'Maker' week for entrepreneurs to bring their ideas to life. Trump and Clinton leveraged the future of manufacturing in their manifestos, both from a job creation perspective and to promote the manufacturing technology advances. The UK government has just announced that they will be creating a white paper to assess how the UK can better take advantage of manufacturing to foster economic growth. Philip Hammond, UK chancellor, also announced plans in the budget to raise UK spending on research and development from 1.7% to 2.4% of national income by 2027[6].

[4] https://www.whitehouse.gov/america-first-foreign-policy

[5] http://www.economist.com/node/21552901

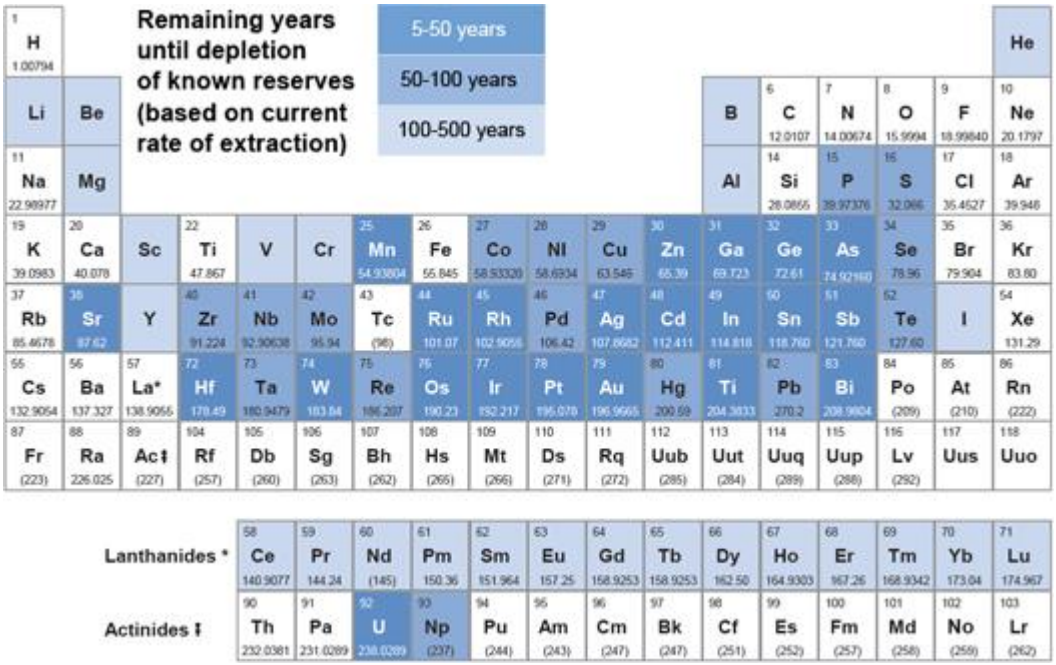
[6] https://www.theguardian.com/business/2017/nov/27/clark-details-industrial-strategy-productivity-business-watchdog-white-paper?utm_source=esp&utm_medium=Email&utm_campaign=GU+Today+main+NEW+H+categories&utm_term=254128&subid=24107847&CMP=EMCNEWEML6619I2

Diminishing Resources

The world in which we live has a finite amount of elements, and developments in technology have ensured that we use these elements in all aspects of our daily lives. This process continues with our ever-increasing demand for rare earth elements. These resources are being depleted and will, at some point, run out.

As a society we are living longer. Nutrition and access to care, as well as medical advances in terms of prevention, treatments, DNA mapping, and more, are all helping us to push the boundaries of life expectancy. According to UK newspaper The Telegraph, one third of all UK babies born this year can expect to live to over 100 years[7]. With the UN predicting a global population increase from the 7.3 billion people we have today to 8.5 billion by 2030[8], then we will need more resources and to utilise those resources far more effectively than the take-make-dispose supply chain allows.

We already see water resources under threat as we increase agricultural production, and by 2025, two thirds of the global population may face water shortages[9], but it is also rare earth elements that are threatened. Figure 3 below shows the scarcity of chemical elements and all our consumer electronic products, telecommunication infrastructure, laptops, smartphones, cars, aeroplanes…just about anything with an electronic content will consume up to 60 of these rare earth elements - the average smartphone contains up to 62[10].



[7] http://www.telegraph.co.uk/news/health/news/10511865/Two-thirds-of-todays-babies-could-live-to-100.html
[8] http://www.un.org/en/development/desa/news/population/2015-report.html
[9] https://www.worldwildlife.org/threats/water-scarcity
[10] https://www.acs.org/content/acs/en/education/resources/highschool/chemmatters/past-issues/archive-2014-2015/smartphones.html

Figure 3: Depletion of the elements11

In the past we have often seen organisations, and even countries, embarking on 'environmental' or 'green' initiatives to promote their environmental credibility, but in reality, these were often no more than lip service paid to the idea of sustainability. As soon as there was a downturn in business, sinking share prices, or profitability, it was the green initiatives that were sacrificed in the early rounds of cost-cutting. The greed and demands of short-term market performance trumped long-term environmental impact. But this has started to change, and whilst we still have some very powerful non-believers in climate change and element depletion, most informed people, corporations and governments acknowledge facts and the evidence and realise that the way we behaved in the past is no longer sustainable.

[11] http://reports.weforum.org/toward-the-circular-economy-accelerating-the-scale-up-across-global-supply-chains/mounting-pressure-on-resources/

A New Generation of Decision Makers and Influencers

Since the end of The Second World War, we have been quick to pigeon-hole generations and name them as such; Baby Boomers, Generation X, Generation Y and of course the ubiquitous Millennials. Much has been said and written about the changing attitudes of young people and the impact they are having upon society, and whilst a lot is attributed to Millennials, it is more the attitude of society in general that is changing. No doubt that young people are more receptive to change, that is true of every generation, but to lay all the catalysts of change at the door of the Millennials is not exactly true. However, as a lot of the research into generational behaviour is bracketed under the term Millennial, we will use that term to illustrate some of the changing behavioural traits we see in the younger generation.

Figure 4: The Millennial Generation[12]

Millennials have differing views on many topics and behave in very different ways to their predecessors. One of the major changes is that we are now in a 'Sharing Economy', or we are starting to see 'Product as a Service.' This can involve, for example, a system of pay-per-use. Instead of owning an asset, you just pay when you use it. Rolls Royce have built a model where customers only pay for a jet engine during actual usage ("Power by the Hour"[13]), and Philips Lighting now offer 'light as a service'[14]. Sharing and pay-per-use are now mainstream models that will have a major impact on all types of products and services.

As a society, we are becoming more willing to share our assets; car sharing initiatives are growing rapidly, we use Airbnb and Uber ever more frequently, and more people than ever prefer the experience over the asset ownership. Forbes[15] has shared a number of insights into the millennial as customer; "Millennials demand self-service, algorithmically, and crowd sourced customer service options. Paradoxically, millennial customers also crave a true, authentic, personalized experience as customers."

Millennials see car ownership as an option and certainly not something to aspire to, they live at home with their parents longer, and often don't see home ownership as something to strive for. Millennials also pay attention to the values of the companies and brands that they buy from; they are much more

[12] http://www.alanrudnick.org/2016/05/31/millennials-lazy/

[13] https://www.worldfinance.com/markets/rolls-royce-is-driving-the-progress-of-the-business-aviation-market

[14] https://www.philips.com/a-w/about/sustainability/sustainable-planet/circular-economy/light-as-a-service.html

[15] https://www.forbes.com/forbes/welcome/?toURL=https://www.forbes.com/sites/micahsolomon/2015/11/14/2016-is-the-year-of-the-millennial-customer-heres-how-to-be-ready/&refURL=&referrer=

concerned with ethical issues (such as the circular economy) than their predecessors[16]. A recent PWC study[17] concluded that 72% of consumers will enter into the sharing economy within the next 2 years; and, unsurprisingly, those most excited by the sharing economy are 18 to 24-year-olds.

We are also seeing changes in buyer behaviour; the Business to Consumer (B2C) and Business to Business (B2B) models with their traditional characteristics and lines of demarcation are blurring. As consumers we are starting to expect the rigour, delivery and quality commitments of B2B purchases and the business buyer demands the personalisation and tailored customer service experience of B2C; we are now seeing B2B/C as standard buyer behaviour. According to Accenture, business buyers are "bringing expectations of high-quality experiences from their homes to their offices.[18].

[16] https://www.forbes.com/sites/micahsolomon/2015/11/14/2016-is-the-year-of-the-millennial-customer-heres-how-to-be-ready/#6c0b5cad5ffc

[17] https://www.pwc.com/us/en/technology/publications/assets/pwc-consumer-intelligence-series-the-sharing-economy.pdf

[18] https://www.accenture.com/us-en/blogs/blogs-b2b-customer-experiences-does-csuite-really-care

Extending the Product Lifecycle

The take-make-dispose, elongated supply chain is one that fed manufacturers, transportation companies and consumers alike with a supply of finished goods readily available for replacement. We have seen products designed for failure within a limited lifetime to promote re-purchase; we have constant technology refreshes and software upgrades so we have to purchase the latest product variant even though the existing product is still capable of undertaking the function for which it was originally designed and purchased. Many organisations have promoted this in an effort to keep revenues growing with new, replacement products.

Even if a whole new product wasn't purchased, replacement parts had to be supplied from original manufacturers to maintain warranty. Swiss watch manufacturers often ensure exclusive access to the supply of spare parts by invalidating the warranty of any watch fitted with "copycat" (and much cheaper) parts. In the automotive industry, spare car parts and even engine oil is promoted by the car manufacturer at high prices to secure after-market revenue and 'nudge' the consumer into making certain purchasing decisions. These decisions are usually less in line with logic and more in line with high spending[19].

The spare parts business in itself is one that particularly demonstrates the waste that exists with traditional, centralised manufacturing and distributed supply chains. Products are re-ordered based upon re-order point constraints and manufactured in economic batch or economic order quantities, minimising set-up costs within the manufacturing facilities. Parts are then shipped to distribution centres or forward stocking locations, where they are stored awaiting call off for consumption. Not only does this incur transport and inventory storage costs, products run the risk of still being on the shelf well after the original product's expiration (constant change of consumer taste and technology is responsible for that), hence causing obsolescence and eventual write-offs – it is a model stuffed with redundancy.

With distributed manufacturing, localised sourcing, environmental consciousness and changing attitudes we see that the take-make-dispose supply chain is no longer welcome. As we move towards circular supply chains, we are starting to see designers and manufacturers finding opportunities to extend product revenues using remanufacturing, repair and reuse to extend the product life-cycle.

In the take-make-dispose supply chain, product value peaks at the end of the manufacturing cycle – typically when the product is at the end of the production line. Everything after this is cost, including transportation, distribution and sales. Although the product will increase in price, due to mark-ups, the actual value is at its maximum when no extra value can be added.

So product manufacturers can now extend their revenue stream by remanufacturing outdated products – product life-cycle extension. So we will start to see products being designed for swap-outs, remanufacture and replacement. This, in turn, leads to modular design, which eases this process and also allows for ease of assembly closer to point of consumption. Therefore, we will continue to see remanufacturing facilities close to the point of consumption and return. In 2016, Ikea introduced a new "circular economy" strategy including "care and repair, rent, share, bring back and resell" tactics to

[19] Thaler, R.H. & Sunstein, C.R., Nudge: Improving Decisions about Health, Wealth and Happiness. Yale. 2008.

elongate product lifecycles.[20] Nike also officially committed to the circular economy in 2016, entering into partnership with the Ellen MacArthur Foundation to develop a new, sustainable, circular strategy[21].

Despite the above, the implications for manufacturers are not easy, as re-designing products for reuse and extended product life-cycle takes extra resources and costs. Even with the best of intentions, this isn't going to happen overnight. Some companies still prefer replacement over reuse or recycling, as this is easier than extending the product life-cycle. Whilst Apple claim that they want to use remanufactured components, their MacBook is one of the most difficult laptops to repair, for example the battery is glued in to position and some of the memory hard wired into the electronic circuitry in an effort to not be interchangeable. "The Apple Retina is the most difficult laptop we've ever taken apart"[22].

In the US there is an ongoing battle over legislation on The Right to Repair, to prevent manufacturers from making repair and remanufacture of products difficult or impossible unless undertaken by the OEM or by authorised repair vendors (at elevated costs). Twelve US states have already introduced Fair Repair registration[23]. So, whilst there will always be elements of protectionism and reluctance to change the status quo, the drive for remanufacture at a local level is hard to resist.

Simultaneously, we have seen growth in straight reuse through reselling. Products that are replaced or upgraded, but still have continuing economic value, are being sold back into the supply chain and to consumers, in many instances with little or no physical repair activity. Many returned products are classified as No Fault Found (NFF) or No Defect Found (NDF) and are practically as good as new. These are products that consumers can pick up at reasonable prices and websites such as eBay or specialist used product resellers make the sale of this equipment easy.

Even products considered to be yesterday's technology still have residual value in developing markets. Some OEMs encourage this as it can promote brand awareness in markets where they are yet to penetrate. We are seeing a number of very profitable companies emerge that simply resell used products to a waiting and willing developing market.

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20 http://www.sustainablebrands.com/news_and_views/brand_innovation/maxine_perella/sustainable_life_home_how_ikea_plans_become_circular_

21 https://www.ellenmacarthurfoundation.org/news/nike-global-partner

22 https://www.wired.com/2012/06/opinion-apple-retina-displa/

23 http://repair.org/stand-up/?_sm_au_=icHD481WF64VMQvM

Circular Replaces Linear

"*The circular economy is restorative and regenerative by design. Relying on system-wide innovation, it aims to redefine products and services to design waste out.*[24]*"*

Simply stated, the circular economy is a model wherein products are designed so that raw materials will not escape out of the supply chain – whenever possible, materials are recycled and reused, to prevent the depletion of valuable and irreplaceable resources. The key point is the reduction, and eventual elimination, of waste. In their recent publication, Waste to Wealth, Lacy and Rutqvist highlight 4 areas of waste[25]:

- Embedded value, where components and material are disposed of, not reused
- Capability, underutilised or idle assets – underpinning the growth in the sharing economy
- Resources, materials that are only used once and then exhausted
- Lifecycles, where products are disposed of when they are still functional or have 'in-built' shortened life cycles for replacement.

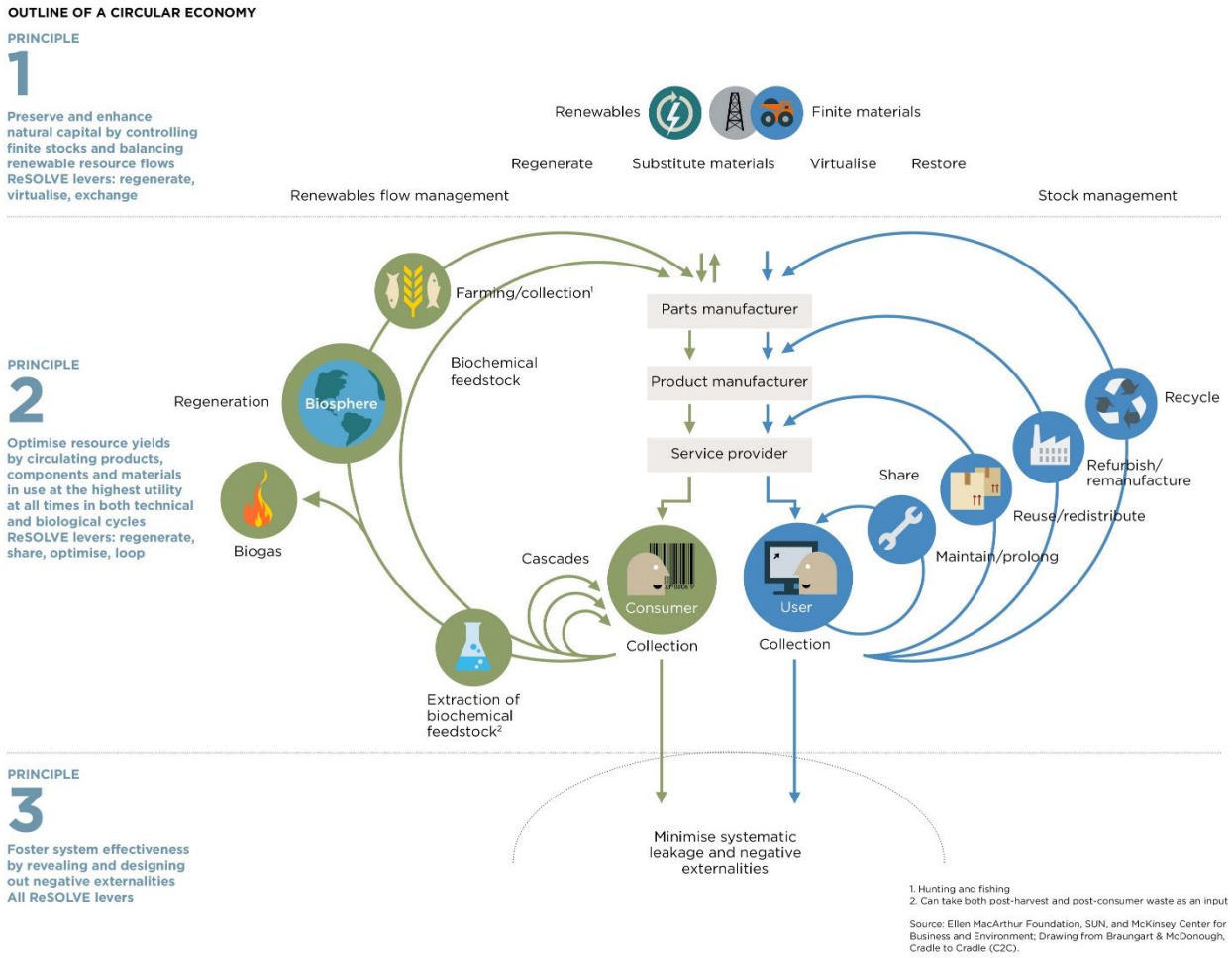
In total, they estimate that this "waste", and therefore the circular economy marketplace, has a combined worth $4.5 trillion by 2030. Hawken, Lovins and Lovins introduce the concept of "natural capital"[26]; the "natural resources and ecological systems that provide vital life-support services to society and all living things", and they highlight how current business practices are depleting natural capital. Economic activities are wasteful and using up resources that are "literally priceless".

"Today's linear 'take, make, dispose' economic model relies on large quantities of cheap, easily accessible materials and energy, and is a model that is reaching its physical limits." The Ellen MacArthur Foundation

The circular economy or loop economy was a concept originally developed in 1976 by Walter Stahel, a Geneva based engineer with his first published paper for the European Commission about the 'loop' economy[27]. The circular economy gathered momentum with organisations such as the Ellen MacArthur Foundation[28], established by the athlete following her solo round-the-world sailing expedition. Today, many organisations, companies and institutions have seized on the initiative because it often gives an innovative opportunity to increase profitability.

[24] https://www.ellenmacarthurfoundation.org/circular-economy
[25]Rutqvist, J. & Lacy, P., From Waste to Wealth, Springer, 2015
[26] Hawken, P. Lovins, A.B. & Lovins, L.H. Natural Capitalism: Creating the Next Industrial Revolution. http://www.natcap.org/images/other/NCsynopsis.pdf
[27] Stahel, W. & Reday-Mulvey, G. Jobs for Tomorrow: The Potential for Substituting Manpower for Energy. Vantage Press. 1981.
[28] https://www.ellenmacarthurfoundation.org/

The Circular Economy Model



The Circular Economy, The Ellen MacArthur Foundation[29]

[29] https://www.ellenmacarthurfoundation.org/circular-economy

Impact upon Global Supply Chains

The implications of the circular economy for the take-make-dispose supply chain are varied and have a number of potential outcomes. The most obvious outcome is that products in a circular economy no longer follow any traditional model of supply chain. The impact is a shift towards distributed manufacturing and localisation, both in manufacturing and localised sourcing. Products manufactured close to consumption can be returned to the same facility to be remanufactured, and therefore re-enter the supply chain. Local manufacturers have both the equipment and expertise to do just this.

With an increase in remanufactured product and local production, it follows that we will see a reduction in global transport volumes. We have secondary markets for remanufactured products, harvested components, reclaimed precious metals, as well as straight resale and remarketing. As more products are remanufactured, we will start to see more companies enter this space. Organisations that previously grew rich on the take-make-dispose supply chain will see an opportunity to grow their service offering by switching to a circular model, as well as to protect their position in a rapidly changing market.

Some OEMs will find supply chain transition very difficult – particularly those that have grown globally through outsourcing their manufacturing and supply chains (as well as service functions) to sub-contractors. These sub-contractors have a geographical presence, are considered knowledgeable in their fields, and act as aggregators by utilising capacities in factories or in transportation by combining and consolidating products and transportation flows. Sub-contract manufacturers, third party logistic providers, airlines, shipping companies all sell their capacity and expertise so the OEM doesn't have to build the capability. These organisations subsequently leverage variable costs based on volumes and throughputs as trade-off for building fixed costs by doing it themselves, with the added benefit of dealing with 'experts.'

This established model goes some way to underpin the take-make-dispose supply chain that has been the norm for several decades. We have seen this model become very stable with incremental improvements over time in terms of productivity and efficiency. Over time, nothing radical has changed, but we have seen small improvements that gave one party a short-term competitive edge until the rest of the market caught up. This model commoditises services, and profit margins are squeezed tighter with each incremental step for the organisations executing the model. Now, we are seeing a transition and it is radical - we are finally moving away from take-make-dispose stability, but the OEMs have outsourced their execution and in doing so gave up expertise to make any dramatic transition within their manufacturing and supply chains - change comes at a price.

The manufacturing and supply chain experts have also become comfortable with the take-make-dispose supply chains. They have evolved and perfected their expertise over many years. Changing or doing something innovative in reaction to market demands is difficult culturally, operationally, structurally and even conceptually. Everybody is comfortable with the status quo, even though margins are continually squeezed, but the market is demanding a change – so we have a dilemma. The OEMs can't necessarily undertake this change by themselves and the sub-contracted parties don't always have the wherewithal

or desire to change, or even don't want to recognise the change. Innovation doesn't come easy or naturally[30].

There is therefore a major opportunity available. An organisation that can enable and to help the OEMs transition to the new model, by providing a service that allows them to adopt new practices, will make major gains in this scenario. Former supply chain sub-contractors will have to sacrifice old business practices in order to cash-in on these new opportunities. Inaction will only result in further margin pressure in a tightly squeezed and volatile market, and the opportunity in "supply chain redesign" for companies such as 3PLs is already becoming apparent.

"A huge opportunity for LSPs (Logistics Service Providers) that emerges in the wider context of digital transformation accrues from their expertise in orchestrating complex supply and manufacturing networks. Orchestrating is a key competency in the interconnected world. Taking on activities such as assembly of products and product customization has been the starting point for the reinvention of the traditional logistics sector."[31] The World Economic Forum

Moving to a distributed, localised manufacturing model means that we can expect to see a reduction in carbon footprints as more raw materials are processed closer to consumption. Companies will return and remanufacture, rather than transport new finished products around the world. It goes without saying that there is a significant intrinsic value of not throwing products away. The take-make-dispose supply chains will suffer, but overall the new model will provide net income benefits at international level.

According to the WEF, nearly one third of all food produced worldwide becomes wastage, and yet one in nine people are undernourished[32]. The financial implications of so much waste are exponential; every year, $940 billion is invested in the production of food that will never be eaten. 4.4 billion tons of greenhouse gases are emitted for nothing. This is a pattern that cannot continue; we need change and it needs to happen now.

[30] Mason, R. Purvis, L. Wilson, M. Lahy, A. Overcoming the challenges of being innovative in outsourced logistics provision.
[31] World Economic Forum. Impact of 4th Industrial Revolution on Supply Chains. 2017. http://www3.weforum.org/docs/WEF_Impact_of_the_Fourth_Industrial_Revolution_on_Supply_Chains_.pdf
[32] https://www.weforum.org/agenda/2017/10/appetite-for-destruction-to-save-the-planet-we-must-fight-food-waste/

The Circular Economy recommends us to switch

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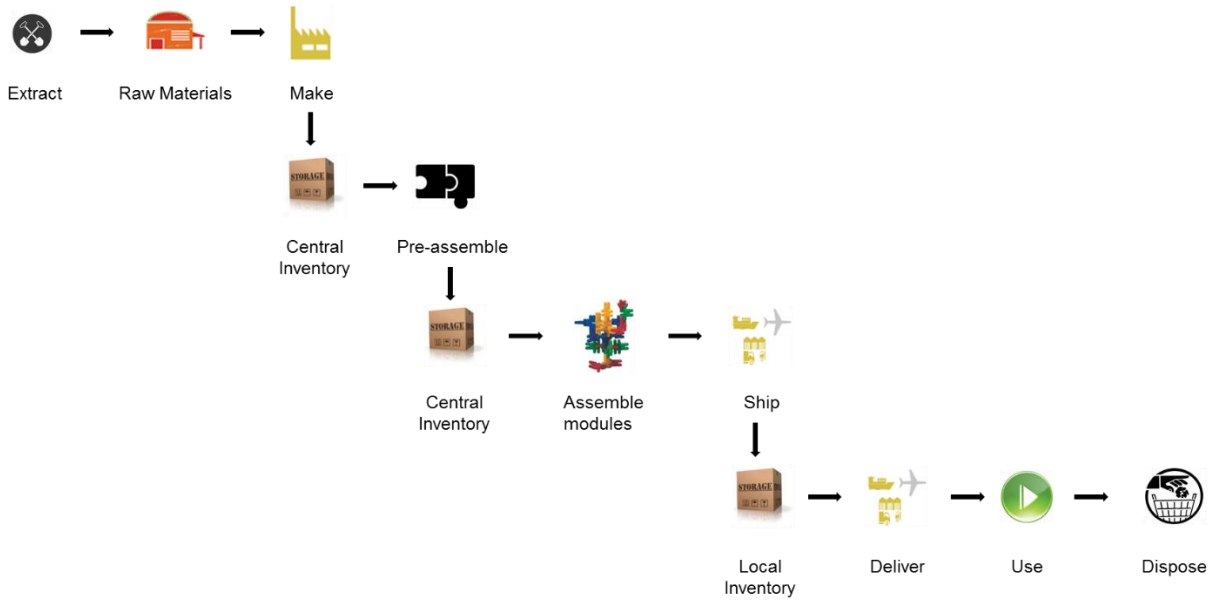

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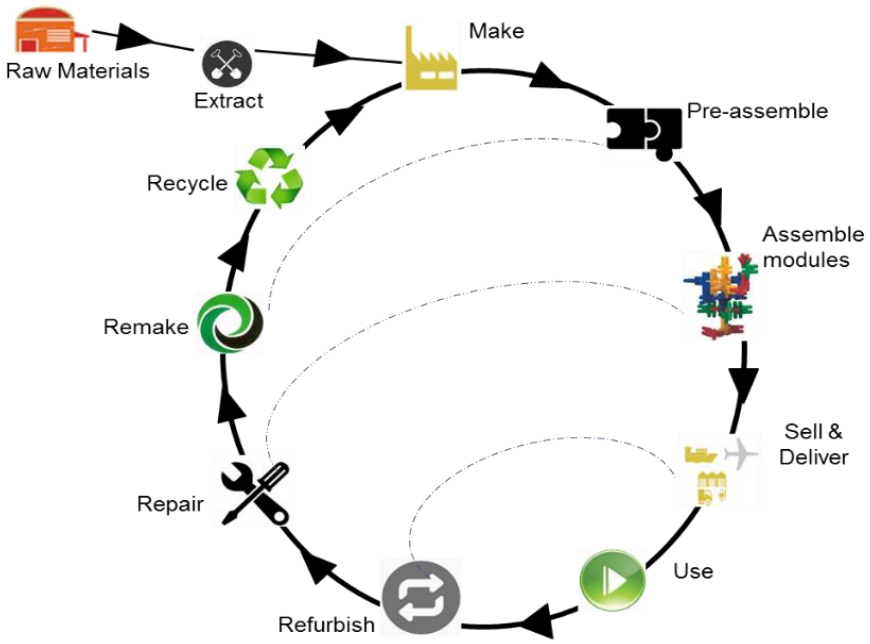

Conclusion

So what conclusions can we draw from all this?

We are already experiencing many changes happening all around us. The migration from elongated take-make-dispose supply chains to shorter, flexible, localised circular supply chains is well underway. The sharing economy, products-as-a-service, open-source and crowd-sourced business models are everywhere from software and design to venture funding. We are over the precipice of disruption and the traditional, mature, status quo supply chains are no longer sustainable and cannot cater to current and future demand.

Manufacturing and supply chains are facing major new challenges and embracing the digital and technological advances in artificial intelligence, robotics, additive manufacturing, data analytics, the Internet of Things, e-business, blockchain and more. The drive for speed to market, personalisation and instantaneous service means that our manufacturing and supply chains have to be faster, more flexible and responsive, which means moving to local, on-demand and environmental models of supply chain, replacing the linear model with a circular one.

Orchestrating the switch to new models of supply chain will provide major opportunities for quick-thinking organisations. The circular economy opens up new avenues in operations and thinking, it is in step with the macro-economic developments and societal changes we see around us, and it is as compelling as it is intriguing. There are many barriers to overcome at international, national, organisational and product level; but these are gradually being addressed and will be dealt with in due course.

Can there be any further doubt that the waste generated by take-make-dispose supply chains should be a thing of the past?

We certainly think not. Certainly, it won't be a thing of the future.

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