A Trajectory for Sustainable Industrialization

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Abstract

Laissez-faire industrialization that was fuelled by capitalism led to most of our problems today. This necessitated the rise of sustainability to set boundaries on the endless growth of capitalism. Sustainability counters industrialization in three popular ways, socially, economically, and environmentally. The most important being environmental considerations as that is where most of the damage is from anthropogenic climate change. To form a trajectory for industrialization: I express the idea of the snowball effect from successive industrial revolutions that demonstrates the acceleration of growth from capitalism. I establish the capitalist nature of industrialization through mercantilism and colonialism. I explore how current industry popularised the notion of Industry x.0 to overshadow unsustainable progress. I conclude that as technological progress outgrew sustainable progress, the current trajectory for industry is unsustainable because of the capitalist engine that runs progress today.

Keywords: sustainability, industrialization, capitalism, mercantilism, progress, industrial revolution.

A Trajectory for Sustainable Industrialization

The term “sustainability” as a concept only came into the limelight by the mid-20th century as a movement to oppose laissez-faire industrialization (Caradonna, 2014, p. 3). As a product of modern progress, industrialization is but one facet that seeks to provide concrete improvements in human understanding and societal gain. Consequently, industrialization created a new form of progress, technological progress, building upon another facet of modern progress in Technoscience. Technological progress is seen as the innovation and advancement to new mechanisms that either simplify procedure and/or have a greater benefit. Technological progress, though, meant nothing without profit, which forms the basis of the modern capitalist system – the epitome of consumption. The engine for progress today is a capitalist one, where growth occurs through profit and accelerates with consumption. Therefore, sustainability emerged to counter consumption thereby limiting growth, leading to the popular claim that modern progress created a sort of disparity that sustainability exists to balance (Caradonna, 2014, p. 20). This analysis posits a specific question: is sustainable progress possible? Furthermore, is sustainable capitalism possible? One could say that the root cause for all of this is the Industrial Revolution, which fuelled by capitalism, only accelerated in its growth regardless of sustainability to the point that we landed on the Moon, and are now planning on colonizing Mars. This paper aims to dissect sustainability and its relationship with capitalism, to link colonialism with capitalism and the subsequent industrialization, and a look into how current industry is conducted.

Sustainability

There is now a need to set boundaries for humanity's growth according to our planet's limits, as the exponentially growing world economy and population are projected to exceed our planet's finite resources and delicate ecosystems (Sachs & Ki-moon, 2015, p. 1). Numerous global conferences were held to set these boundaries: the Stockholm conference in 1972 that kickstarted the global discussion on the environment and human development, the Earth Summit in 1992 where the Convention Agreement was signed to mitigate anthropogenic climate change, and the Paris Agreement in 2015 that set measurable goals. There are even yearly conferences where nations congregate to share their progress in climate action. The fact that anthropogenic climate change is a product of industrialization shows that progress has to be redefined at a global level, environmental considerations have to hold the same weight as social, political, and economic concerns.

To emphasise the necessity of redefining progress, a recent study postulates Climate Tipping Points (CTPs), points of no return, that when crossed, ecosystems gradually transform to an extreme and disrupt the global bionetwork to the point that certain parts of the Earth become uninhabitable. These CTPs could be our planet's limits, with the author claiming that we have already passed several CTPs, regardless of net zero policies (Armstrong McKay et al., 2022). Therefore, the concept of sustainability emerged as a way to set boundaries on capitalist progress by establishing a link between society, economy, and the natural world.

Social sustainability refers to how an action would affect the people, assuring them with their basic human rights. By the early 1800s, industrialization prospered the bourgeoisie and created the proletariat, the middle class and the working class. The bourgeoisie as the owners of factories would exploit the proletariat class through long work hours, low wages,

and even child labour, all to maximize the factories profits (Stearns, 2020, pp. 124 – 125). This laissez-faire industrialization eventually led to the 1848 revolutions all across Europe with the working class demanding for higher wages and better working conditions in factories. These revolutions did fail, but they still sent ripples through governments to implement policies on factories to discourage future revolutions (Caradonna, 2014, p. 68). The capitalist bourgeoisie was the problem, the accumulation of wealth motivates one to value their own success by adopting a conventional attitude that undermines those working for them, all in the name of profit.

Economic sustainability is the mindful use of resources for long-term growth, these resources being raw materials, capital, labor, etc. The main concern in the 1972 Stockholm conference was the moderation of the planet's finite resources – even before discussion on climate change took flight, as laissez-faire industrialization fails to set a boundary for itself (Sachs & Ki-moon, 2015, p. 1). Furthermore, the modern capitalists have promised the people with "trickle-down economics", where the concentration of wealth at the top will eventually trickle down to the lower levels. (Olinksy & Mayerson, 2013). The fact that the wealthiest 1% hold more wealth than the 99% solidifies the wealth inequality between social classes (Cussen, 2022). As a product of the modern capitalist system, trickle-down economics does not conform to economic sustainability.

Environmental sustainability seeks to provide a voice for the environment, which only recently became a global concern. The centuries of rampant industrialization without a care for the environment has caused a build-up of greenhouse gases. The main culprit being the energy sector with the oil and gas industry – one of the oldest industries along with the textiles industry. Today seven of the ten largest companies in the world are oil and gas companies, like Royal Dutch Shell, British Petroleum, China National Petroleum, etc (Sachs & Ki-moon, 2015, p. 396). These companies are not going to stop their operations any time

soon, as long as other industries and even countries require energy, there is profit to be made. Evidently, the engine for progress today is a capitalist one.

Taking all this into account and observing industrialization today, is the current trajectory of industry sustainable? For one, Caradonna (2014) claims that "sustainability presupposes an industrial present that cannot endure—the realization that current approaches will not hold up over time… An inherently sustainable society would not need an explicit movement" (p. 20). Nevertheless, the abundance of journal articles on sustainable development in current and future industry compels one to believe that the discourse on sustainability is the seed for a paradigm shift. Thus, the prime method to formulate a trajectory for anything is to analyse both past and present conditions.

The Industrial Revolution

It is difficult to discuss sustainability when it did not exist as a common term with the advent of the industrial revolution and the consequent proliferation. As expected, the concept and its components were still there through activists. The Luddites, who attacked the notion of replacing human by machine – social sustainability. Along with the actions and meditations of influential philosophers like John Muir and John Stuart Mill. Muir stressing the importance of sustaining mother nature on her pedestal – environmental sustainability. Mill who critiqued the rising economic system, a capitalist economy, that boasts boundless growth – economic sustainability (Caradonna, 2014, p. 62). Even though the current day understanding of sustainability was not in the picture, there was a need to redefine progress, as industrialization, a process with as many detriments as its benefits, had become its main driver.

On one hand, the industrial revolution was a necessary step for humanity to transition from an agrarian to an industrial society, as evident by the numerous benefits it led to in the

short and long term. Some immediate benefits were: increased production and efficiency, increased wages, and more jobs along with division of labour. Many of the things we take for granted today are a result of the industrial revolution: instant global communication, modern healthcare, and year-round out of season food.

On the other hand, the detriments of the industrial revolution were tiny in the short run compared to the technological progress it brought, but they far outweigh the benefits in the long run. In the beginning, some detriments include: little to no health standards in factories, cheap labour, and extensive use of child labour. Specifically, child labour was not a product of the industrial revolution, but it was exacerbated as the use of children in key areas of manufacturing was motivated by the low cost in taking orphans in droves from urban poorhouses and displaced farmhands (Stearns, 2020, pp. 5–6). Today, these same effects can be seen in developing countries, which is further compounded upon by the negative effects of transitioning to an industrial society. Some effects include: widespread pollution, deepening of social inequalities like the income gap, and anthropogenic climate change. One effect that is ubiquitous in media is climate change as a result of human endeavours, leading to some to question if it was all worth it.

One catalyst for the industrial revolution was the Enlightenment, a movement set on human liberation that illuminated new ways to understand and experiment with the world, leading to a paradigm shift in science and how humanity progresses (Harvey, 1990, p. 12). This shift in thinking was applied to tools. The adoption of tools to help humanity shape the world is an intrinsic feature that cannot be put aside and needed to be brought up to new standards. As the tools used in an agrarian society were basic, where the bare minimum is to get the job done, there was now a new way to innovate on said tools through science to make even better and more sophisticated tools to reap higher benefits. This goes to show that the

industrial revolution cannot be treated as an isolated event, but as a melting pot of movements and ideas, ingredients that coalesced to detonate a revolution for humanity.

Timeline

Today's popular understanding of industrialization is split into four revolutions, each with its own defining technology. The First Industrial Revolution (Industry 1.0) in the 1700s occurred in England, where mechanization of manufacturing was possible because of unrestrained innovation and a great deal of investment, generally prioritising parts that have repeated physical movements. The textiles market was first to be industrialized, mechanizing one part of the process led to increased supply to other parts, which triggered demand for mechanization of other parts, eventually landing on a process that is fully mechanized. This increased the production and efficiency of the textiles industry to that point that delivery and distribution of goods could not keep up, therefore there was now a demand for further innovations in said areas, leading to the advent of the steam engine (Wen, 2021, p. 8). It would seem that there was a snowball effect that forced industries to innovate on their processes to keep up with the supply and demand.

From then on, later revolutions followed a similar pattern with the snowball effect. The industrialists were bold enough to constantly try new technologies because they are continually chasing the prospect of increased profits. The Second Industrial Revolution (Industry 2.0) in the 1800s was possible due to advancements in electricity, allowing industries to electrify everything, increasing production in both volume and variety because of mass production and the all-new assembly line. The Third Industrial Revolution (Industry 3.0) in the 1900s introduced early computers that were able to do calculations magnitudes faster than any human can, decreasing manufacturing and delivery time, which incentivized industries to automate everything. Finally, the Fourth Industrial Revolution (Industry 4.0) in

the 2000s attempts to implement Cyber Physical Systems to sustain the human factor in manufacturing, as the application of Artificial Intelligence to machines for further customization threatens human labour, in other words, digitize everything (Sharma & Jain, 2020, p. 2). Each successive revolution had its own general framework of technologies and an increase in supply and demand in an industry, which set the seed of a revolution in one part, to then proliferate to other parts. All satiated by frequent innovations built on scientific endeavour mostly funded by pioneering capitalists and colonized countries.

Colonialism and Capitalism

Another ingredient for the detonation and subsequent spread of the industrial revolution was Western Colonialism. Which was well underway before the industrial revolution, with colonies setup in parts of Africa, Asia, and America, where governments were ran by the colonizers. With established routes, Mercantilism – state-controlled trade – took hold with merchants and governments taking advantage of the emerging markets to maximize profits and minimize costs. Mercantilism being an economic system founded by Europeans to be the first true international economy, yet it was still not a free economy because of a centralized authority. Mercantilist governments would restrict trade by imposing tariffs on outside colonies and reducing prices on certain goods to force their colonies to only trade with the mother country, to stimulate their own exports and force sought after imports (Frieden, 2012, p. 18).

The industrial revolution flourished in England and Europe because of the colonial era, as there was already an abundance of raw materials and human labour ready to be used (Stearns, 2020, p. 43). To no one’s surprise, as colonies were fought for between mercantilist powers over centuries and along with the spread of industrial society, this slowly eroded the mercantilist system. The modern factory was born because of constant new technologies and

bigger machinery that increased production and efficiency while requiring dozens of skilled workers in the process. First in England, the mercantilist restrictions on trade gradually fell as industrialists believed that removing them would increase demand for their goods, allowing optimal use of the increased supply due to industrialization (Frieden, 2012, p. 21). Without these barriers on England's manufacturing industries, free traders emerged and England became the world's first free economy, as other countries did the same not long after; a precursor to the modern capitalist economy.

Current Industry

Nowadays, discussion on sustainability manifests itself in many ways. In industry, the main objective of a business is to satisfy the bottom line and even exceed it to make a profit; this is the prime measure of success for a business. From discourse on sustainability, business's today have expanded their main objective into the Triple Bottom Line (TBL). The TBL – devised by John Elkington – is a framework often used by businesses to measure their success by three essential factors: social, economic, and environmental. It is also further simplified into the three P's: People, Planet, Prosperity (Elkington, 1998). This framework attempts to transform the capitalist business into a sustainable business, and it is just one of the countless avenues businesses take for a more sustainable operation and approval from today's society. In a more general sense, it is beneficial to split the broad concept of sustainability into these three components. Each constituent component can then be taken as a whole with their own parts, rendering the discussion explicit and manageable. This makes it easier to determine sustainable practices as certain fields may satisfy one component more than the others, leading to discussion and even action on the latter; in the end it all contributes to the wider discussion on sustainability.

Now that sustainable development seems to be at the forefront of progress, as evident by the yearly global conferences and the recent call to action by the United Nations (UN) Sustainable Development Goals (SDGs) in 2015. The Brundtland Commission, a commission led by the UN, released an influential report in 1987 that defined sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs". Built on the already mentioned three pillars of sustainability: social, environmental, and economic considerations (as cited in Sachs & Ki-moon, 2015, p. 5). There are countless journal articles, books, and magazines that explore how future industry would look like as there is no general consensus for future revolutions According to Groumpos (2021), "The research topics for Industry 5.0 and Industry 6.0 are quite open and very challenging" (p. 6). Some of the topics include: a low carbon industrial revolution, a solar revolution, a humanized revolution. The discussion is quite open due to the various needs of industrialized countries that focus on attaining sustainable development in different areas, and it is challenging because of the forward thinking required to lessen the burden on future generations.

The main issue with calling these phenomena "revolutions" is that they do not necessarily undermine previous advancements. In fact, they innovate on them through scientific endeavour because of the prospect of economic and societal gain, progressing with convenient ideas while disposing of redundant ones. This is exactly why nowadays they are referred to as Industry 1.0, Industry 2.0, etc. Presently, we live in Industry 4.0, the age of digitalization. Mosconi, the author of "The new European industrial policy: Global competitiveness and the manufacturing renaissance", reports that this naming scheme started with Industry 4.0 brought up as a "new concept for German economic policy based on high-tech strategies" (as cited in Roblek, 2016, p. 1). Clearly, the use of a version number implies a sort of upgrade to the previous iteration, acting as a buzzword that is now ubiquitous in

journal articles, magazines, and the general media because of its simplicity. Furthermore, this shows that revolutions occur when technological progress has reached a breakthrough to warrant an iteration, regardless of sustainable progress. Another way to look at revolutions is for political gain, especially in early industrialization. The heavyweights – Britain, France, Germany, and Russia – during that time were in an industrial race to see who can outgrow and consume the other; with an additional playground in their colonized countries. In essence, the move from the industrial revolutions to the popular notion of Industry x.0 only reinforces the reality that the world is dominated by technological progress that overshadows the real problem with unsustainable progress.

The concept of Industry 4.0 is different for separate fields because of their intense specialization in today's society. A suitable umbrella definition comes from PricewaterhouseCoopers (PWC), an international company at the forefront of economic development and one of the Big Four accounting firms, "industry 4.0 focuses on the end-to-end digitization of all physical assets and integration into digital ecosystems with value chain partners." (As cited in Sharma, 2020, p. 3). This builds upon Industry 3.0 that focused on early computers that automate certain parts of an assembly line or operation. Now, cyber-physical systems dominate the whole production line from supply chain to customer service, to the point where customization is at the forefront of product development. Moreover, the whole idea of Industry 4.0 is built on the internet, which allows near instantaneous worldwide communication between humans, and human and a machine, or even machine to machine.

To be specific, one field that benefits greatly from Industry 4.0 is the manufacturing industry, where smart factories produce smart products. According to Roblek (2016), the smart factory consists of sensors and autonomous systems that have the ability to assist machines through self-optimization that improves processes (p. 4). The textiles industry is a great example as it benefits greatly from this feedback loop that ideally would constantly

iterate the process of manufacturing a product, creating a smart product that adheres to certain requirements set by management or consumers. Evidently, Industry 4.0 exists as a result of the internet. Cyber-physical systems are a foundation now, which built upon Industry 3.0's automation that replaced humans in certain parts of the assembly line, Industry 4.0 further reinforces that; removing the human factor.

Conclusion

The industrial revolution was a necessary step in the evolution of human development. This step, caused by capitalism, formed a chasm that holds all the social, economic, and environmental problems resulting from industrialization. Capitalism itself is a feature of industrialization through the erosion of mercantile restrictions during the colonial era that led to global free trade. Followed by the emergence of sustainability as a movement to illuminate the chasm and counteract the capitalist society. Sustainability now exists to set boundaries on the modern capitalist system that boasts endless growth, to form an immovable object that stops an unstoppable force. Social sustainability seeks to equalise the disparities formed by industrialization in the poverty gap and the wealth gap. Economic sustainability pursues the forward-thinking on long-term effects from resource usage today on future generations, rather than focusing on the present; specifically in capital. Environmental sustainability urges humanity to be responsible for the planet now more than ever as most of the damage had already been done through industrialization.

The main reason for this is the snowball effect from successive industrial revolutions. Capitalism, as the engine for progress, only accelerated growth throughout the past few centuries, accelerating technology too fast for sustainable approaches to be implemented. As such, sustainable progress is not possible and the current trajectory of industry is unsustainable, as long as progress runs on a capitalist engine.

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