The Sustainability Imperative

A Value Chain Response to a Systemic Issue

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News clippings from the world over illustrate the impacts of climate change and environmental degradation resulting from human activity. The global economy cannot sustain this level of growth without increased environmental impacts. This is a global, systemic problem that requires a global solution. While many industries contribute to the problem, products are central to the solution, products that are sustainable by design. Digital twins and modeling and simulation are key to understanding the changes needed early in the product lifecycle when they have the most impact. A digital thread spanning the value chain is essential to gathering the necessary data to achieve sustainability objectives and is increasingly enabled by business platforms that can create, gather, manage, and help leverage disparate data sources. This is becoming critical as extended producer responsibility (EPR) regimes become pervasive that require value chain reporting by manufacturers in most industries. Leading companies are embracing these changes and are finding ways to enhance revenues and improve their environmental record.

Sustainability: A Global Issue Demanding a Global Response

Every week seems to bring more stories from around the world that illustrate the impacts of climate change and environmental degradation resulting from human activity. While metrics suggest that those impacts started growing with the advent of Industry 1.0, otherwise known as the Industrial Revolution, resource extraction and use, and the impacts of those actions, really accelerated as developing economies around the world strove to achieve the "middle class life" enjoyed by the developed world. Figure 1 highlights some key sustainability facts and figures.[1]

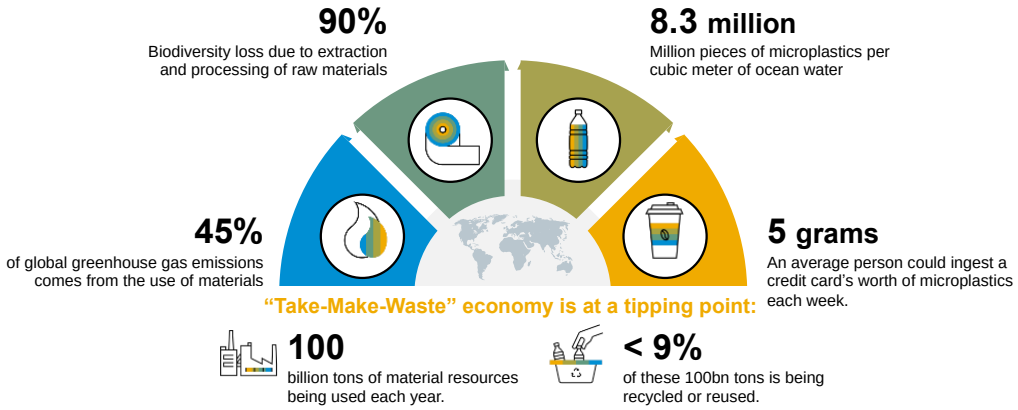

Figure 1—Today's Global Economy at a Sustainability Tipping Point
(Courtesy of SAP)

[1] Research for this paper was partially supported by SAP.

Gyres of plastic clog ocean trade routes. According to a 2017 study, 44% of the plastic ever made was produced since 2000.[2] Plastics may not fully degrade and they can produce microplastics, which have been found in the air we breathe and in animals of all types, including humans.

Atmospheric carbon dioxide (CO_2) growth dates to Industry 1.0 and accelerated with Industry 3.0 in the 1980s creating the global crisis we face today. Today, the supply chains for eight industries account for approximately 50% of global emissions: food, construction, fashion, fast moving consumer goods, electronics, automotive, professional services, and other freight.[3]

At the same time, the ubiquitous nature of smart, connected products in most industries is putting more and more electronics into global waste streams. Recycling these electronics is a dirty, dangerous business historically pushed off to developing countries. Those countries are now pushing back, leaving few alternatives to deal with this growing problem.

The world cannot sustain this level of growth and the related environmental impacts. This is a global, systemic problem that demands a systemic approach with buy-in from countries around the world, many impacted by the actions of others far more than their own. In 1987, the United Nations (UN) Brundtland Commission defined sustainability as "meeting the needs of the present without compromising the ability of future generations to meet their own needs."[4] In 2015, the UN adopted a set of 17 Sustainable Development Goals (SDG), shown in Figure 2, as a "universal call to action to end poverty, protect the planet and improve the lives and prospects of everyone, everywhere."[5] the UN SDG have provided that universal call by offering a language countries and companies can use to articulate their efforts.

The Case for Sustainable Products

At the company level, research suggests that companies are investing resources to address the UN SDG. A recent Accenture/World Economic Forum study found that 79% of the 1,122 CEOs surveyed by the UN Global Compact in 2021 said the pandemic has highlighted the need to transition to more sustainable business models.[6] That same study found that companies with deeply embedded sustainability management practices outperformed their peers by 21% on profitability and positive outcomes, so clearly good can be done and money can be made in the process.

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[2]https://www.nationalgeographic.com/science/article/plastics-facts-infographics-ocean-pollution
[3]https://www.bcg.com/publications/2021/fighting-climate-change-with-supply-chain-decarbonization
[4]https://www.un.org/en/academic-impact/sustainability
[5]https://www.un.org/sustainabledevelopment/development-agenda/
[6]https://www.accenture.com/_acnmedia/Thought-Leadership-Assets/PDF-5/Accenture-Shaping-the-Sustainable-Organization-Report.pdf

Figure 2—UN Sustainable Development Goals
(Source: United Nations[7])

One way that companies are making money from their investments in sustainability is by attracting environmentally-conscious customers. A 2021 IBM Institute for Business Value study found that 22% more consumers say environmental responsibility is very or extremely important when choosing a brand than did in 2019. In addition, 62% of consumers now say they're willing to change their purchasing behavior to help reduce negative impact on the environment (up from 57% in 2019).[8]

If customers want sustainable products and companies can be successful delivering them, why haven't more companies pursued this approach? One reason is that it is very hard. Making systemic changes to the DNA of companies is not for the faint hearted. With such big problems facing a given company, it can be very difficult to plan concrete action and execute on those plans. It also makes it really difficult to measure progress. Little baseline data exists and supply chains can be impervious to offering up the needed information accurately and in a timely manner. Measurement is key to truly understanding the root causes of problems and the success of efforts to address them. Today's analytics solutions can help sift the volumes of data to suggest high-value actions in development, manufacturing, and field support. Companies can do better but they must do so systematically to maximize impacts and to make the necessary course corrections.

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There are many things that companies can do to make their organization and its operations sustainable. For example, professional services supply chains made the top emissions list because of business travel. The pandemic forced new approaches leveraging meeting technology that will likely continue even after business travel becomes routine again. But making products and their lifecycles more sustainable will have the biggest impact because many of those operational

[7] https://www.un.org/sustainabledevelopment/sdgs-framework-for-covid-19-recovery/
[8] IBM Institute for Business Value. "Sustainability at a turning point," 2021

gains will be enabled by products that companies buy to support those operations. CIMdata maintains that products need to be sustainable by definition.

Sustainable Product Lifecycles by Definition

To be sustainable by definition means that a product's lifecycle environmental impact needs to be understood, ideally when the product is being defined. The notion of managing products from idea through life is at the core of CIMdata's definition of product lifecycle management (PLM): a strategic business approach enabled by an appropriate set of technologies to support the collaborative creation, use, management, and dissemination of product-related intellectual assets from idea through life. Ideally, PLM strategies and enabling solutions span both the product lifecycle and its value chain, which is even more critical than ever to systematically address sustainability issues. CIMdata includes many digital tools in our PLM definition that are used to define, plan, and assess product concepts and their performance in the real world. Precisely which digital tools are included depends on the products made by the company. Regardless of the needed tool suite, industrial PLM strategies are increasingly underpinned by enterprise-grade platforms that manage the expansive web of data, value chain collaboration, and connections with other data sources that help support the product lifecycle from idea through life. One key capability in such platforms that is essential in sustainability programs is the ability to quickly build and propagate dashboards that can support organizational sustainability efforts by monitoring their progress in real-time.

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Designing for sustainability builds on the traditions of concurrent engineering, which originally focused on collaboration between design and manufacturing early in the product definition stage. The same ideas must be applied for sustainability: it must be baked into the processes, tools, and metrics to ensure success. At a minimum, the lifecycle should start with formal requirements definition, with specific metrics attached related to an organization's sustainability objectives. The solutions employed to support a company's PLM strategy must support requirements of traceability across the lifecycle, to ensure that requirements are met, often through rigorous verification and validation (V&V) processes that are common in discrete manufacturing industries like automotive and aerospace and defense.

Digital twins, a concept originally developed in the aerospace industry, are a key enabler for understanding the impacts of new materials, manufacturing processes, and field support process changes. To CIMdata, a digital twin is a virtual representation (i.e., digital surrogate) of a physical asset or collection of physical assets (i.e., physical twin) that exploits data flow to/from the associated physical asset(s). While much focus is placed on engineering simulation-based twins, multiple types of digital twins are possible to support different aspects of product lifecycle decision-making. A 2021 CIMdata-Altair survey asked industrial respondents about their potential adoption of digital twins focusing on manufacturing, maintenance, operations, and financial considerations, in addition

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to those based on physics and supporting engineering.[9] 45% of respondents said they would have digital twins in production in five years, with another 25% in pilot. But more than half of the respondents said they planned more than one digital twin, and twins focused on maintenance and manufacturing were chosen most frequently. Digital twins, and other modeling techniques, are essential to understanding product behavior, manufacturing processes, and maintenance in the field. While in many cases these twins are based on product geometry defined in mechanical computer-aided design (MCAD), more and more companies are leveraging model-based systems engineering (MBSE) which can start before geometry is available and dovetails nicely with MCAD and other tools as part of a holistic product development approach. The ability to simulate products and processes before realization using digital twins and supported by a MBSE process can help define and elaborate V&V procedures and lifecycle support processes, including elements like digital work instructions to support field usage and maintenance.

A related concept that is essential to supporting efforts in sustainability is the digital thread. CIMdata defines a digital thread as a communication framework that connects data flows which can be used to produce an integrated, holistic view of an asset's data from physical and virtual systems (i.e., its digital twin) throughout its lifecycle across traditionally siloed functional perspectives. The need to gather, manage, and leverage data across multiple functional perspectives is one of the drivers of the platformization trend in the PLM market. Smart, connected products have more types of data and intellectual property associated with them than ever before, and can have more tendrils connected to other parts of the value chain that can provide valuable information to inform decision-making and generate revenue. Value chain collaboration and support is essential to achieving sustainability objectives since much of a product's impact comes from the components within it (and how they were made, packaged, shipped, etc.).

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Another concept that has taken hold in many global manufacturers that supports sustainability objectives is the Circular Economy. A circular economy is "a model of production and consumption, which involves sharing, leasing, reusing, repairing, refurbishing and recycling existing materials and products as long as possible" that aims at tackling global challenges like climate change, biodiversity loss, waste, and pollution.[10] Originally promoted by the Ellen MacArthur Foundation[11], global leaders of many stripes are now actively participating in this initiative, with partners including Google, Ikea, Microsoft, Starbucks, Philips, Nestle, PepsiCo, and The Coca-Cola Company. Because this approach often encourages using new materials and processes across the lifecycle, simulation and analysis becomes even more essential to understanding future performance early in the development process. Engineering or physics-based digital twins are key to develop that understanding. In a circular economy, most products will have a new

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[9] https://www.cimdata.com/en/resources/complimentary-reports-research/commentaries/item/17318-technology-convergence-accelerating-for-a-smarter-more-connected-world-commentary
[10] https://en.wikipedia.org/wiki/Circular_economy
[11] https://ellenmacarthurfoundation.org/

and expanded life, with many benefiting from real-time monitoring now economically enabled by the Internet of Things (IoT). PLM-enabling platforms need to be able to leverage this data to inform product development and maintenance decisions that improve the sustainability footprint of companies' offerings.

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As discussed in a previous section, most of the plastics ever manufactured came into existence after 2000 and most of this waste comes from packaging. For decades product companies have talked about the importance of the bill of materials, essentially the "ingredients" in the product, and then more recently about the Bill of Process, which is focused on the manufacturing processes needed to bring a product into existence. With the increased emphasis on plastics and packaging we now have a new bill to worry about: the Bill of Packaging. A liquid product that comes in a bottle may be packaged in a cardboard box and surrounded by shrink wrap. All of these materials, and many more, must be considered in our sustainability measurements. Many of these measurements are being driven by standards, some of which are about to become painfully real to global manufacturers.

Global Reporting Demands Global Value Chain Response

One of the earliest sustainability-driving regulatory actions was the Waste Electrical and Electronic Equipment Directive, the European Union (EU) directive focused on waste from electrical and electronic equipment (WEEE). WEEE started in 2002. After its first nine years the directive was amended and expanded, with more metrics put in place and the goal of recycling at least 85% of electrical and electronics waste by 2016. The directive continued to be expanded, with an increasing emphasis on extended producer responsibility (EPR), where the companies that made the products would become more responsible for their proper disposition.

This is about to become very real in plastics remediation enforcement. Over 40% of plastics used are single-use and to date recycling efforts have not made a dent in that waste stream. Of course, single-use plastics are not the only culprits. The smart, connected products ubiquitous in many industrial segments are adding to the global totals. Many countries are looking to EPR-based regulations to improve on this spotty record. Figure 3 illustrates just how broadly EPR taxes and regulations are spreading around the world. In the EU, companies will need to significantly increase their reporting on their plastics use to avoid tax consequences in 2022 and beyond.

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These new reporting requirements are quite complex, and often vary by industry or country. The data required is distributed across enterprise systems and global value chains. Companies will need better systems to support these requirements; systems that can help them leverage this data to generate insights on current practices and their possible evolution, and how they can best collaborate with their value chain partners on meeting the requirements.

How do companies get started? Just as in the adoption of other new processes, companies need to develop a baseline understanding of where they are starting their journey vis-a-vis their chosen sustainability metrics. As suggested earlier, Bills of Packaging become more important to the overall assessment. Those should extend beyond the end product packaging to include any parts, assemblies, and subsystems that value chains may contribute to the final product. Enterprise systems like enterprise resource planning (ERP) and supply chain management (SCM) can often readily support these new reporting requirements. New packaging techniques and materials must be systematically assessed using digital twins and other simulation techniques common in a company's PLM environment. Plastic may not be totally eliminated in the end, but they can be significantly reduced and only used in selected applications where they are the best choice to meet the packaging requirements.

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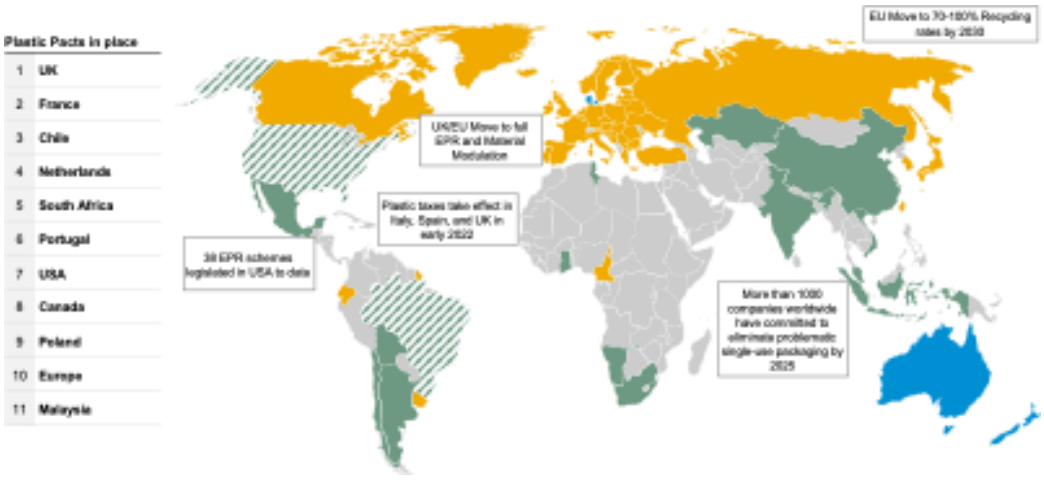

Figure 3**—Global Regulations on Plastics are Increasing**
(Courtesy of SAP)

The extended producer responsibility movement continues to gain steam so more regulations beyond plastics are in the offing. That is why CIMdata uses the phrase "the sustainability imperative" because it is no longer a choice. The world, and the companies in it, must take action on these existential threats. Companies can survive, and even thrive, if they build sustainability into their DNA. The topics covered in this white paper include technologies, solutions, and approaches that can help those companies reach their sustainability objectives. Do you want to drive the change and be a leader or be driven by it and suffer competitively?

Conclusion

Global headlines document the impacts that human activity has had on our environment. Improving sustainability is a systemic issue that requires a systemic, global response. The UN Sustainability Goals provide a useful framework, one widely adopted by countries and individual companies to document their state and assess their plans and actions. Products are major contributors to environmental degradation and product lifecycle management (PLM) processes and solutions are central to reducing their environmental impacts. Capabilities like digital twins,

modeling and simulation, and the digital thread are critical enablers that connect product companies with their far-flung value chains who must collectively plot the most appropriate response. They are best delivered on platforms that can support this collaborative activity, helping to gather, manage, and analyze data that can catalyze action across the extended enterprise. This is increasingly important as countries are moving toward extended producer responsibility regimes that bring real penalties to value chains not meeting their evolving requirements. This is another key reason that platforms are critical: there are many EPR requirements across the globe, and they are constantly being updated. Having a system in place that can help structure the right actions and responses for each market will be central to market and environmental success.

About CIMdata

CIMdata, an independent worldwide firm, provides strategic management consulting to maximize an enterprise's ability to design, deliver, and support innovative products and services by identifying and implementing appropriate digital initiatives. For nearly forty years, CIMdata has provided industrial organizations and providers of technologies and services with world-class knowledge, expertise, and best-practice methods on a broad set of product lifecycle management (PLM) solutions and the digital transformation they enable. CIMdata also offers research, subscription services, publications, and education through certificate programs and international conferences. To learn more, visit www.CIMdata.com or email info@CIMdata.com.