

The Sustainability Imperative

PLM for Green Engineering

Sustainability and Complex Decision Making

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Responding to Regulatory Requirements

Meeting the Market and Benefiting the Business

Sustainable Products and Operations

Case Study: Hewlett-Packard

The Circular Economy

Case Study: Cummins Sustainability Strategy

PLM: Central to the Digital Thread

Modeling the Smart, Connected World

Enhancing Value Chain Management

Call to Action

Conclusion

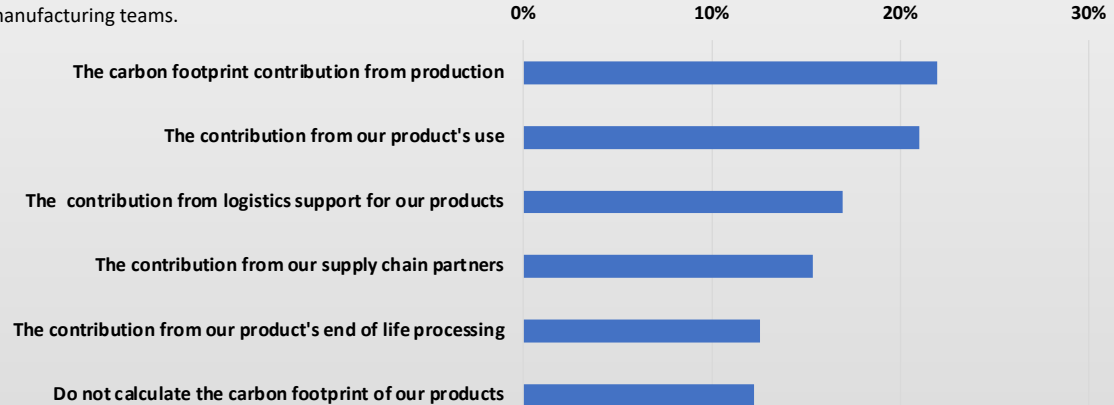
From Concurrent Engineering to Design for X

How do product companies achieve market success? What makes one product successful while others are not—or don't make it to the market? Getting any product to market involves a set of trade-offs—whether they are made consciously or not—that often span multiple technologies, corporate functions, and business processes. Consistent success requires that companies understand the trade-offs they are making and the benefits those decisions bring to the product and business.

Take design for manufacturing (DfM), for example. In the 1990s, companies began to realize their siloed development processes—where engineering threw their designs over the wall to manufacturing—were not effective. Emerging concurrent engineering practices focused on the effect of design choices on manufacturability, which involved early and persistent collaboration between design and manufacturing teams.

Leading industrials from the late 19th century into the 20th century, like GM, Westinghouse, Magnavox, and Kodak championed this approach. DfM was the first type of trade-off considered, but more soon followed: design for assembly, design for maintenance, design for additive manufacturing, etc.

Today, companies can make better decisions with a richer understanding of the effects of such trade-offs. They often consider the same trade-off decisions, but the implications that they evaluate span a much more complex extended ecosystem. Among the most complex trade-offs to understand are those that involve elements of sustainability—things like recyclability, carbon footprint, and reuse. To truly understand and design for carbon footprint, for example, requires a tremendous amount of information about the lifecycle of a product.



Elements Included in Carbon Footprint
(2022 CIMdata Foresight Sustainability Research)



Responding to Regulatory Requirements

Part of a larger set of environmental challenges

One reason why a company might endeavor to understand complex sustainability tradeoffs is to meet regulatory requirements. Competing in global markets enabled by far-flung value chain partners make relevant an expanding set of regulations, whether global, regional, or industry specific. Many of these requirements stem from growing concerns about the environment and sustainability.

For example, in 2003, the European Directive on Waste from Electrical and Electronic Equipment (WEEE) initiated a focus on the topic, prescient and increasingly influential given our evolution into a smart, connected world since then. Along with the Restriction of Hazardous Substances Directive (RoHS) the WEEE provides strict guidelines to companies that wish to sell electrical and electronic equipment (EEE) in the European Union. Those companies must fulfill product compliance

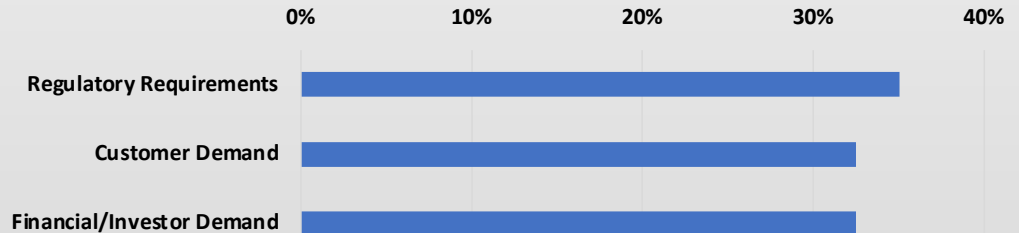
requirements and support end-of-life management in each country: provide take-back, recycling, and recovery solutions to their supply chain stakeholders as well as to the goods' chain users. The sheer amount of information necessary to meet these regulations and, furthermore, to show that they are being met, is staggering.

It comes as little surprise then that CIMdata's global survey of industrial manufacturers identified "addressing regulatory requirements" as the top motivation for their sustainability efforts (35%). Taken alone this datapoint suggests that companies see sustainability largely as a burden of regulation, but that is not the case. Combining those respondents motivated by "customer demand" and "investor demand" reveals that most companies (65%) are motivated by the same market forces that drive the desire to make better products, to

decrease costs, and to accelerate time-to-market. In other words, today sustainability is widely recognized as another variable that companies use to differentiate themselves to consumers and investors.



Top Reasons for Sustainability Efforts
(2022 CIMdata Foresight Sustainability Research)



Sustainability and Complex Decision Making

Responding to Regulatory Requirements

Meeting the Market and Benefiting the Business

Sustainable Products and Operations

Case Study: Hewlett-Packard

The Circular Economy

Case Study: Cummins Sustainability Strategy

PLM: Central to the Digital Thread

Modeling the Smart, Connected World

Enhancing Value Chain Management

Call to Action

Conclusion



Meeting the Market and Benefiting the Business

Driving toward real corporate social responsibility

The idea of sustainability being a positive for both the business and consumer was not always the case. Corporate efforts in sustainability began as one topic in corporate social responsibility (CSR) programs that first became popular in the 1960s. In the early days it was often more about “virtue signaling” than real action.

Over the decades since there occurred a slow but monumental shift: companies increasingly saw improved environmental stewardship as important to their bottom line. For example, the growth in global manufacturing highlighted the outsized energy consumption of that key industrial sector and provided a focus for energy reduction efforts. And recent studies by IBM support the position that sustainably can be good for both market differentiation and bottom-line results.

So, how do companies connect the dots? One way is to leverage guidelines like the UN Sustainable Development Goals (SDGs), which has been

described as “the blueprint to achieve a better and more sustainable future for all.” They address the “global challenges we face, including poverty, inequality, climate change, environmental degradation, peace and justice.”* As such, the SDGs offer companies effectively free market research into those aspects of sustainability their customers and investors care about.

CIMdata’s research into sustainability in the PLM Economy, which constitutes the software and services companies that help industrial companies meet their product lifecycle management (PLM) objectives, has shown that all of the top 25 PLM firms have active sustainability programs and many relied on the UN SDGs to describe their efforts. While not all the 17 UN SDGs are product-related, achieving these goals will rely heavily on products and the processes involving them.



UN Sustainable Development Goals†

*Study by the IBM Institute for Business Value. “Sustainability at a turning point.” 2021. <https://www.ibm.com/downloads/cas/WLJ7LVP4>

†Source: <https://www.un.org/sustainabledevelopment/sustainable-development-goals/>

Sustainability and Complex Decision Making

Responding to Regulatory Requirements

Meeting the Market and Benefiting the Business

Sustainable Products and Operations

Case Study: Hewlett-Packard

The Circular Economy

Case Study: Cummins Sustainability Strategy

PLM: Central to the Digital Thread

Modeling the Smart, Connected World

Enhancing Value Chain Management

Call to Action

Conclusion



Sustainable Products and Operations

Digital transformations should support sustainability

In our global survey on sustainability, 65% of respondents said that sustainability is a C-level topic at their firm, which is consistent with our findings in the PLM Economy as well. Making operations and products more sustainable is about making well informed choices. CIMdata believes that digital transformation and sustainability should be tightly linked. While 88% of our respondents said they had on-going digital transformation efforts, the linkage to sustainability was weaker than we would have hoped.

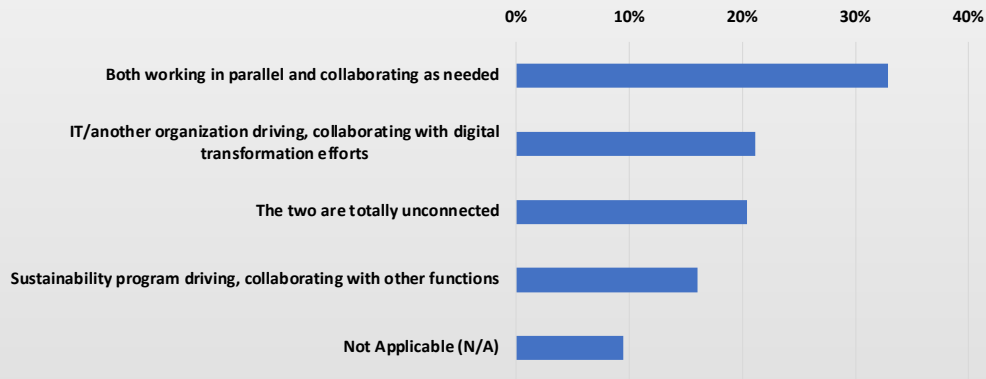
CIMdata also believes that the PLM Economy has a huge potential role in planning and executing sustainability efforts. Products need to be designed for sustainability, including the ability to measure their environmental impacts to support tracking key process indicators (KPIs). These ensure that organizational goals are met. This includes packaging. We have long spoken about managing Bills of Materials, but Bills of Packaging are becoming equally important given their outsized role in environmental degradation—making them a target of stricter regulations.

For manufacturing companies, digital manufacturing and planning solutions can help drive improvements to manufacturing operations. Some of the most successful Internet of Things (IoT)

applications to date have been in logistics analysis and improvement.

Underpinning all of this are new and ever-expanding requirements for data from across the extended enterprise to understand how each facet of the product contributes to its sustainability impacts. This includes the contributions of global value chains and field support activities.

Internet of Things (IoT) can help machines perform to specifications either in the factory or in the field. It helps minimize product waste and scrap, keeping systems running flawlessly. Also, a circular economy utilizing “product as a service” business models would use connectivity to deliver that IoT capability in a cost-effective way.



Relationship of Sustainability to Digitalization
(2022 CIMdata Foresight Sustainability Research)

Sustainability and Complex Decision Making

Responding to Regulatory Requirements

Meeting the Market and Benefiting the Business

Sustainable Products and Operations

Case Study: Hewlett-Packard

The Circular Economy

Case Study: Cummins Sustainability Strategy

PLM: Central to the Digital Thread

Modeling the Smart, Connected World

Enhancing Value Chain Management

Call to Action

Conclusion



Case Study: Hewlett-Packard

HP aims to be the most sustainable and just technology company

HP is a leading global provider of software, technologies, and products with a rich history and tradition in computer and printer manufacturing. As a large manufacturing company that produces thousands of products each year, they are aware of their carbon footprint. HP is taking action to turn into an environmentally friendly manufacturer.

HP has a 2030 Sustainability Impact Vision to become the world's most sustainable and just technology company. This vision is based on three pillars which are Planet, People, and Community. For example, its Planet pillar is focused on climate action and achieving net zero greenhouse gas (GHG) emissions across the HP value chain by 2040. The next goal is reaching 75% product circularity and reducing by 50% value chain GHG emissions by 2030. Additionally, HP is trying to accomplish carbon neutrality and zero waste in HP operations by 2025.

The technology leader is focusing their sustainability strategies on product circularity and reusability. The goal is to reduce materials, keep materials in use longer, and minimize deforestation. To track year over year progress against their defined targets, HP collects information from their products, services and supply chain regarding materials intensity, product usage (energy, paper, waste), repairs, etc.

While today their Large Format Printing sustainability group is collecting most of the information manually in Excel spreadsheets, they plan to collect all this information in PTC's PLM solution, Windchill (e.g., material type, % of recycled content, weight, etc.). This way, they can have it all together in one database to prepare better dashboards and analyze the data easily at portfolio level to make better decisions.



**HP's 2030 Sustainability Impact Vision
Considers Planet, People, and Community**

(Courtesy of HP)

Sustainability and Complex
Decision Making

Responding to Regulatory
Requirements

Meeting the Market and
Benefiting the Business

Sustainable Products and
Operations

Case Study: Hewlett-Packard

The Circular Economy

Case Study: Cummins
Sustainability Strategy

PLM: Central to the Digital
Thread

Modeling the Smart,
Connected World

Enhancing Value Chain
Management

Call to Action

Conclusion



Sustainability and Complex Decision Making

Responding to Regulatory Requirements

Meeting the Market and Benefiting the Business

Sustainable Products and Operations

Case Study: Hewlett-Packard

The Circular Economy

Case Study: Cummins Sustainability Strategy

PLM: Central to the Digital Thread

Modeling the Smart, Connected World

Enhancing Value Chain Management

Call to Action

Conclusion

The Circular Economy

Circular concepts and digital threads drive sustainability strategies

Many depictions of the product lifecycle are linear, often proceeding from idea to end of life. However, most products die a miserable death, at least in environmental terms. About 40% of plastic waste is single-use. Many industrial products including machinery, electronics, and toxic components are difficult or impossible to recycle.

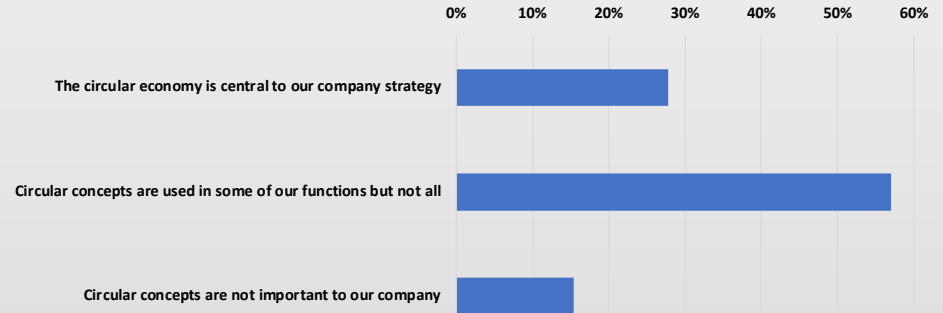
A circular economy is a model of production and consumption focused on reusing, sharing, leasing, repairing, refurbishing, and recycling as much as possible. This concept is promoted by the Ellen MacArthur Foundation and CIMdata thought it important enough to make it the theme of our global 2014 PLM Market & Industry Forum series. In our survey on sustainability, 28% said circular concepts are central to their company strategy and 57% said circular concepts were used in some company functions. Only 15% said circular was not important to their company.

If we are rethinking our products from idea through life, we need to manage the information and processes to gather information necessary to support decision-making and track progress

toward sustainability metrics. The notion of the digital thread is also gaining traction in industry and CIMdata believes it is essential to meet the sustainability challenge. CIMdata defines the digital thread as a communication framework that connects data flows.

The digital thread 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 and across traditionally siloed functional perspectives.

While the digital thread is often associated with the full product, it also should contain the necessary information about component or assembly reuse, refurbishment, and recycling to fully support a circular approach. This will require different business relationships and data sharing across global value chains than typically exist today. Our survey results suggest that many companies are contemplating those changes. Later, we will describe how PLM solutions can be leveraged to achieve them.



Importance of Circular Concepts to Company Strategy
(2022 CIMdata Foresight Sustainability Research)



Case Study: Cummins Sustainability Strategy

Tackling a global climate challenge requires doing more with less

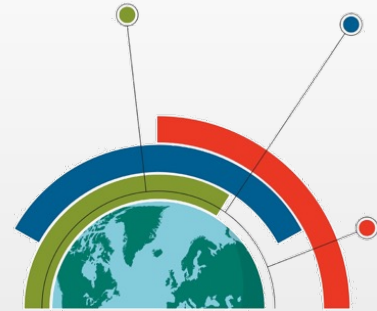
As a leader in social and environmental responsibility, Cummins is committed to doing their part to create a more sustainable, prosperous world. That's why Cummins launched PLANET 2050, a novel sustainability strategy that sets quantifiable goals for the entire company starting in 2030 and stretching out to embody longer-term aspirations by 2050.

By 2030, Cummins aims to achieve several milestones. For example, they plan to reduce absolute greenhouse gas emissions by 50% from facilities and operations; create a Circular Lifecycle Plan for every part to use less, use better, and use again; and generate 25% less waste in facilities and operations as percent of revenue.

With sustainability in mind, Cummins set out to rethink their design process. About 70% of a product's lifecycle CO2 footprint is set during its design. This means that if Cummins wants to minimize a product's environmental impact, it needs to establish the foundation during the design phase.

The right design tools cannot guarantee innovation, but they can help create circumstances where it is more likely to occur. That's why Cummins is using Creo, a leading 3D computer-aided design (CAD) tool which is trusted by designers and engineers around the globe.

After design engineers describe the engineering and operations requirements for the task, Creo offers up a suite of design and simulation tools to aid in the development of the concept more efficiently. This avoids the typical back and forth that occurs between the designer and analyst, thus allowing a much more effective use of these critical resources.



PLANET 2050

Cummins PLANET 2050 Strategy Sets Quantifiable Goals for the Entire Company

(Courtesy of Cummins)

"As employees of Cummins, we're expected to act as stewards of the planet, and what that means is we're taking very seriously the amount of material we put into our new designs and the amount of water that is required to manufacture them."

Mr. David Genter, Director of Design Engineering at Cummins

Sustainability and Complex Decision Making

Responding to Regulatory Requirements

Meeting the Market and Benefiting the Business

Sustainable Products and Operations

Case Study: Hewlett-Packard

The Circular Economy

Case Study: Cummins Sustainability Strategy

PLM: Central to the Digital Thread

Modeling the Smart, Connected World

Enhancing Value Chain Management

Call to Action

Conclusion



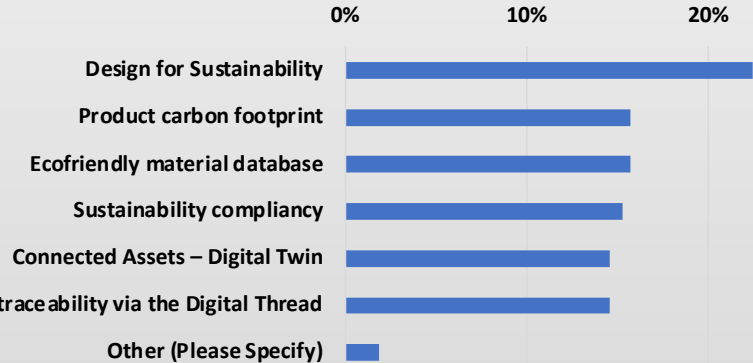
PLM: Central to the Digital Thread

Digital thread provides the backbone of sustainability

Achieving organizational sustainability objectives will require data to track progress and support decision making. CIMdata believes that the best place to orchestrate this data is in a PLM-enabling solution, as the digital thread typically starts there in helping to define and manage products from idea through life. These offerings are typically well suited to manage disparate data and are often integrated with other enterprise software. Most PLM offerings also enable new forms of IT and business process integration, enabling things like mashups and dashboards that are critical to improving decision-making. They can help deliver up-to-date information and guidance across disparate business functions.

How do manufacturers capture sustainability regulations, requirements, as well as company targets and goals in their product design? In our survey, 40% said that regulatory requirements and company targets and goals are defined in formal product requirements. It does make sense if we consider that many of the respondents work in aerospace and defense and automotive. We also asked our respondents about which technologies or capabilities they see as critical to meeting their sustainability goals. PLM topped the list at 40%, followed by supply chain management (29%), the digital thread (22%), and mechanical computer-aided design (MCAD). PLM is unique among these technologies for its ability to support nearly all elements of sustainability, including design for sustainability and product carbon footprint—the two principal concerns addressed by PLM, as identified by CIMdata’s research.

Sustainability Use Cases Supported by PLM
(2022 CIMdata Foresight Sustainability Research)



Windchill and The Digital Thread

Windchill, as a global platform for collaboration, can enable sustainable product lifecycle management. By supporting product data at the core, enterprises leverage the digital thread to become more environmentally friendly companies with real-time insights to data that achieve actionable business outcomes and enterprise value. This “product data revolution” enables a radical redesign of almost all business models, processes, products, and services. Windchill brings multidisciplinary teams, product teams, and feature teams together, during this sustainability transformation for fully focused business outcomes.

Sustainability and Complex Decision Making

Responding to Regulatory Requirements

Meeting the Market and Benefiting the Business

Sustainable Products and Operations

Case Study: Hewlett-Packard

The Circular Economy

Case Study: Cummins Sustainability Strategy

PLM: Central to the Digital Thread

Modeling the Smart, Connected World

Enhancing Value Chain Management

Call to Action

Conclusion



Modeling the Smart, Connected World

Digital twins link real and virtual worlds

As mentioned earlier, sustainability will require trade-offs between a host of new criteria. Many types of modeling currently support product lifecycle activities and modeling will be even more important to meet an organizations sustainability objectives. The digital thread is key to orchestrating the necessary data that will power digital twins of products, processes, and product usage.

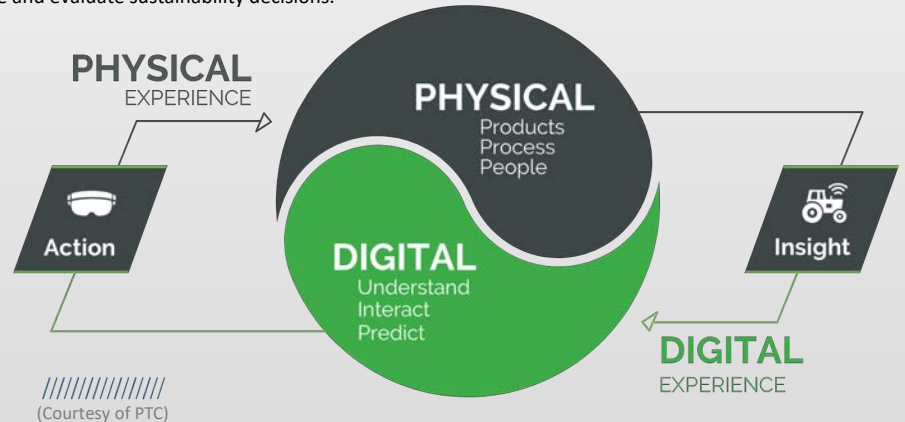
CIMdata defines a digital twin as a virtual representation (i.e., digital surrogate) of a physical asset or collection of physical assets (i.e., physical twin) that exploits data flow to/from the associated physical asset(s). Digital twins are essential to envisioning, animating, and evaluating potential futures. Most companies will implement more than one type of digital twin according to the results of a recent CIMdata survey.

Many digital twins rely on simulation and analysis offerings to accurately predict real-world behaviors. Simulation can help define appropriate verification and validation procedures later in the product lifecycle. Simulation can also help designers optimize material usage in their designs. It can highlight potential failures before a physical product is built. Manufacturing simulations can help reduce energy and materials usage during manufacturing.

The holistic view of an asset throughout its lifecycle, provided by a digital twin, empowers stakeholders with the information needed to make and evaluate sustainability decisions.

Designing in Creo

About 70% of a product's lifecycle CO2 footprint is set during the design phase. Minimizing environmental impact starts here. A designer in charge of lightweighting a product can experiment with materials, design for different manufacturing methods, and simulate real-world performance—all within Creo's digital world, helping set the stage for innovation.



Sustainability and Complex Decision Making

Responding to Regulatory Requirements

Meeting the Market and Benefiting the Business

Sustainable Products and Operations

Case Study: Hewlett-Packard

The Circular Economy

Case Study: Cummins Sustainability Strategy

PLM: Central to the Digital Thread

Modeling the Smart, Connected World

Enhancing Value Chain Management

Call to Action

Conclusion



Enhancing Value Chain Management

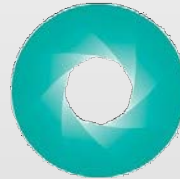
Sustainability is impacted by the complete value chain

Data for the digital thread, and likewise, sustainability, comes from disparate sources and in many different formats. The data and process management platforms at the core of industrial PLM implementations must creatively display the information to support sustainability programs. These efforts go way beyond cost roll-up information that are commonplace today.

Take calculating greenhouse gas (GHG) emissions for example. In CIMdata's global survey, 12% of respondents do not calculate the GHG of their products, but instead focus on their product processes (22%) and the products use in the field (21%). Only 15% consider the contribution of their supply chain partners. This low number is consistent with a recent New York Times article documenting the failures of large, well-known companies to adequately include supply chain contributions to their total GHG emissions, with some companies missing as much as 95% of that overall impact.*

That is why our survey respondents saw that enhanced supply chain management is crucial to sustainability and CIMdata agrees. How can companies improve? Many supply chain management practices were becoming more virtual

to support the Industry 4.0 vision, and virtualization has increased with the global turmoil of the last several years. Any assessments of value chain partners will need consistent measures to be effective. For example, the GHG Protocol[†] offers a useful framework that structures GHG information into three parts: Scope 1 measures are indirect, upstream from a "Reporting Company", Scope 2 measures are for a Reporting Company directly, and Scope 3 measures are downstream from the Reporting Company. The protocol's documents offer practical guidance for companies looking to more accurately calculate their total GHG emissions.



(Courtesy of PTC)

GREENHOUSE GAS PROTOCOL

* See: <https://www.nytimes.com/2021/11/02/business/corporate-climate-pledge-supply-chain.html>

† See: <https://www.wri.org/initiatives/greenhouse-gas-protocol>

Sustainability and Complex Decision Making

Responding to Regulatory Requirements

Meeting the Market and Benefiting the Business

Sustainable Products and Operations

Case Study: Hewlett-Packard

The Circular Economy

Case Study: Cummins Sustainability Strategy

PLM: Central to the Digital Thread

Modeling the Smart, Connected World

Enhancing Value Chain Management

Call to Action

Conclusion



Call to Action

A big task ahead, so the time to get started is now!

This eBook opened by driving home the reality of choice. Companies will have to choose how they address the Sustainability Imperative. They can see it as a burden of regulation or an opportunity to differentiate. The former will leave them in a constant state of reactivity, while the later empowers them to compete.

CIMdata talks about the Sustainability Imperative because we firmly believe that it is. We are not the only ones. In a 2020 study by Accenture, 73% of executives said that becoming a “truly sustainable and responsible business” was a priority in the next three years.* Executives seem to be for it. What about their customers? IBM found that consumers are also making it a priority in buying decisions, choosing brands based on their environmental responsibility.†

Many companies are not acting because the perceived costs of sustainability are blinding them to the opportunities sustainability offers. A survey done by the UN Global Compact‡ in 2021 found companies that built sustainability into their “DNA” delivered more financial value and broader stakeholder impact. Those companies with the most embedded sustainability practices outperformed their peers by 21% on both profitability and positive sustainability outcomes. All of this research suggests that it is possible to do right by the planet, the people impacted by your operations, and improve profits—also called the “triple bottom line.”

Achieving that triple bottom line is not easy. This eBook focuses on how the PLM Economy offers the tools and process support to provide a foundation for sustainability program success. It also requires a lot of strategic and business

process improvements, as well as communication and organizational change efforts to alter the “DNA” of your extended enterprise. There is a lot of work to do. Can you afford to wait?



* “Shaping the Sustainable Organization.” Accenture/UN. 2021. https://www.accenture.com/_acnmedia/Thought-Leadership-Assets/PDF-5/Accenture-Shaping-the-Sustainable-Organization-Report.pdf

† IBM Institute for Business Value. “Sustainability at a turning point.” 2021. <https://www.ibm.com/downloads/cas/WLJ7LVP4>

‡ See: https://www.accenture.com/_acnmedia/Thought-Leadership-Assets/PDF-5/Accenture-Shaping-the-Sustainable-Organization-Report.pdf

Sustainability and Complex Decision Making

Responding to Regulatory Requirements

Meeting the Market and Benefiting the Business

Sustainable Products and Operations

Case Study: Hewlett-Packard

The Circular Economy

Case Study: Cummins Sustainability Strategy

PLM: Central to the Digital Thread

Modeling the Smart, Connected World

Enhancing Value Chain Management

Call to Action

Conclusion



Sustainability and Complex Decision Making

Responding to Regulatory Requirements

Meeting the Market and Benefiting the Business

Sustainable Products and Operations

Case Study: Hewlett-Packard

The Circular Economy

Case Study: Cummins Sustainability Strategy

PLM: Central to the Digital Thread

Modeling the Smart, Connected World

Enhancing Value Chain Management

Call to Action

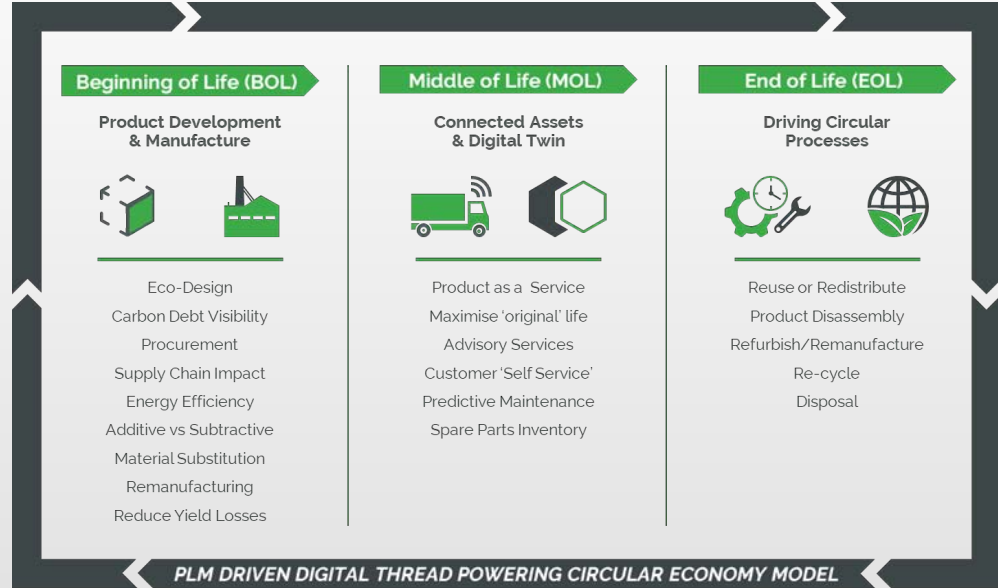
Conclusion

Conclusion

PTC provides solutions to help fulfill sustainability goals

PTC believes companies of all sizes should be focused on minimizing their environmental impact. We see larger organizations taking a lead role in sustainability initiatives and driving their supply chains to support them. Suppliers want to ensure compliance as a competitive edge by providing their customers with, for example, a “green certificate.”

As a leading provider of digital transformation solutions in the manufacturing sector, PTC is becoming increasingly aware of its role and responsibility to support sustainability strategies. Windchill, as a global PLM platform for collaboration, can enable green product lifecycle management. PTC’s position, products, and strategy are an enormous lever to turn the industry and economy toward addressing sustainability. It’s about replacing resource consumption with information.



CIMdata | Global Leaders in PLM Consulting
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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. To learn more, visit www.CIMdata.com.



DIGITAL TRANSFORMS PHYSICAL

