

The Sustainability Imperative

CIMdata 2022 PLM Market & Industry Forum

The Sustainability Imperative

PLM Market & Industry Forum

A CIMdata PLM Leadership Event

6 April 2022

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Our Mission...

Strategic management consulting for competitive advantage in global markets

CIMdata is the leading independent global strategic management consulting and research authority focused exclusively on PLM and the digital transformation it enables.

We are dedicated to maximizing our clients' ability to design, deliver, and support innovative products and services through the application of PLM.

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The Sustainability Imperative

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Key Takeaways

The Sustainability Imperative – 2022 CIMdata PLM Market & Industry Forum

- Our planet and solar system gave us a place to thrive, helped protect us from harm – except ourselves
- Environmental movement began about 60 years ago, a lot of conversation, laws but not much progress
- Environmental degradation getting real, more actions taken on this systemic issue
- The PLM Economy central to the response, which must consider people, process, and technology
- The hard work just starting...

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Agenda

The Sustainability Imperative

- The Big Blue Marble & Our Common Future
- The Sustainability Imperative
- The PLM Economy Central to a Systemic Response
- Concluding Remarks

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Our Home

And its extended family have made it a nice place to build a civilization



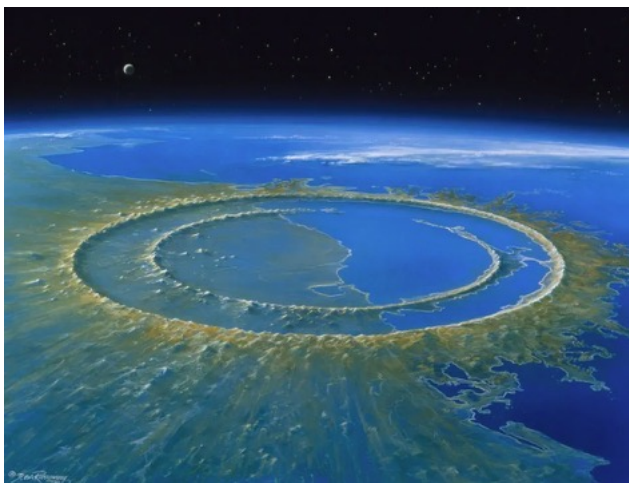
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Some Have Snuck Through

66 million years ago an asteroid crashed into the Yucatán Peninsula – Chicxulub crater



<https://www.nytimes.com/2016/11/18/science/chicxulub-crater-dinosaur-extinction.html>

- 10 KM in diameter
- Artist's conception, not visible
- Widely accepted that caused a mass extinction event
- 75% of plant and animal species became extinct
- Including all non-avian dinosaurs

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Earthrise

"The most influential environmental photograph ever taken"



- Taken by William Anders during the Apollo 8 mission Christmas Eve, 1968
- Dubbed Earthrise
- One of Life Magazine's 100 Photographs that Changed the World
- "We set out to explore the moon and instead we discovered the Earth"
 - William Anders, Christmas Eve, 2018

<https://en.wikipedia.org/wiki/Earthrise>

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The Big Blue Marble

Taken by the Apollo 17 crew on the way to the Moon in 1972, one of most reproduced images in history



- The first full image of the Earth by human hand
 - Satellite image used on the first Whole Earth Catalog in 1968
- First time Apollo on the right trajectory
- Revealed Earth to be precious, fragile, and protected only by a wafer-thin atmospheric layer
- Became a symbol of the environmental movement

https://en.wikipedia.org/wiki/The_Blue_Marble

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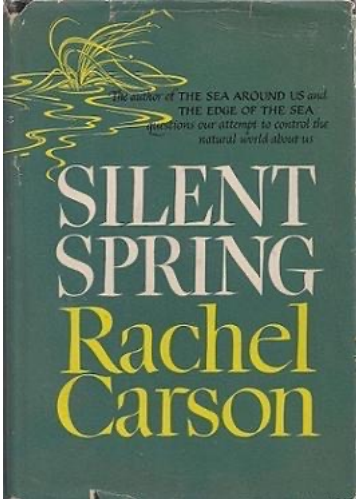
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Sounding the Call

1962 book by Rachel Carson, inspired environmental activism



- Overarching theme: the powerful—and often negative—effect humans have on the natural world
- Focused on pesticides, accuses the chemical industry of intentionally spreading disinformation and public officials of accepting industry claims uncritically
- Encouraged responsible, carefully managed chemical use with an awareness of their impact on ecosystems
- Worked on banning DDT, led to Environmental Defense Fund in 1967, EPA founded in 1970

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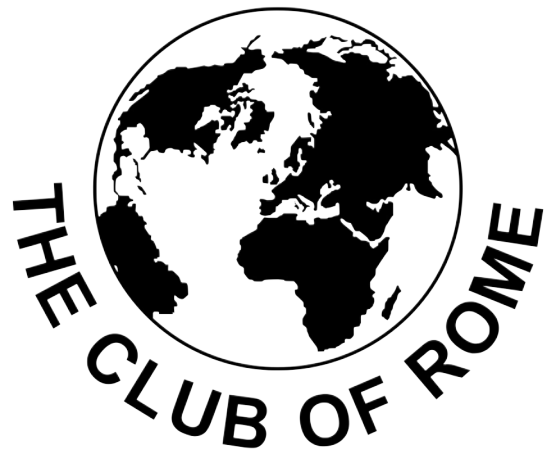
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The Club of Rome

Global leaders convened in 1968

- 100 members selected: current and former heads of state, UN execs, diplomats, scientists, economists...
- Mankind's problems cannot be solved piecemeal
- All are interrelated
- "Meta-problem" or "meta-system" essentially calling for a system of systems approach



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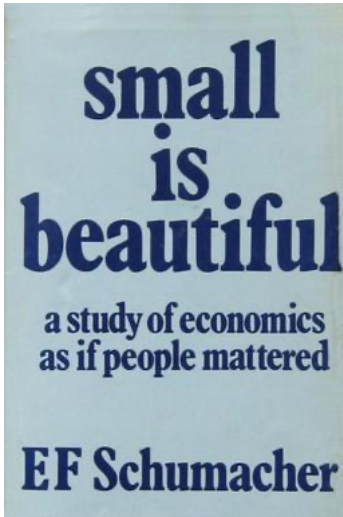
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Sounding the Call

"Small Is Beautiful: A Study of Economics As If People Mattered," 1973



- Small, “appropriate technologies” vs. bigger is better
- Published amid a confluence of environmental, social, and economic forces
- 1973 energy crisis was a wake-up call
- Globalization in full swing
- Believed the modern economy was unsustainable
- Natural resources treated as income, should be treated as capital – not renewable, subject to depletion

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Our Common Future

Brundtland Report published October 1987 by the United Nations

- Sweden urged UN council in 1968 to have a conference focused on human interactions with the environment
 - 1972 event in Stockholm, contentious event
 - US, Britain, Italy, Belgium, the Netherlands formed “Brussels Group”
 - Declaration with 26 principles re the environment and development; an Action Plan with 109 recommendations, and a Resolution
- Brundtland Report also pushed a systems approach, defined sustainable development



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First International Earth Summit

June 1992 in Rio de Janeiro



- Convened to address environmental protection and socioeconomic development at the global level
- The assembled leaders signed the Declaration on Global Climatic Change and Biological Diversity
- Led to the Kyoto Protocol and the Paris Agreement

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The Industrie 4.0 Vision

4th Industrial Revolution focused on creating smart products, procedures, and processes

In a “smart, networked world”, the Internet of Things and Services will make its presence felt in ... (five key areas identified for action in 2009: **climate/energy**, mobility, health, security and communication.)

This transformation is leading to the emergence of smart grids in the field of **energy supply**, **sustainable mobility strategies** (smart mobility, smart logistics) and smart health in the realm of healthcare. In the manufacturing environment, vertical networking, end-to-end engineering and horizontal integration across the entire value network of increasingly smart products and systems is set to usher in the fourth stage of industrialisation – “Industrie 4.0”.

Source: DFKI 2011

Recommendations for implementing the strategic initiative INDUSTRIE 4.0, Final report of the Industrie 4.0 Working Group

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Human Impacts Accelerated with Industry 1.0

Changes in the means of production and materials helped lead us to where we are today (1 of 2)

- Combustion goes back to the “discovery” of fire
 - Wood, coal still prevalent today
- Petroleum used in Babylon 4000 years ago, China 2000 years ago
- Pooled in many places, distillation routinized in the 19th century: first “modern” well in Titusville, Pennsylvania in 1859, drilled with a steam engine
- Approximately 84% of hydrocarbons in petroleum to fuel
- Other 16% the raw material for pharmaceuticals, solvents, fertilizers, pesticides, and plastics
- Consuming products ubiquitous, e.g., internal combustion

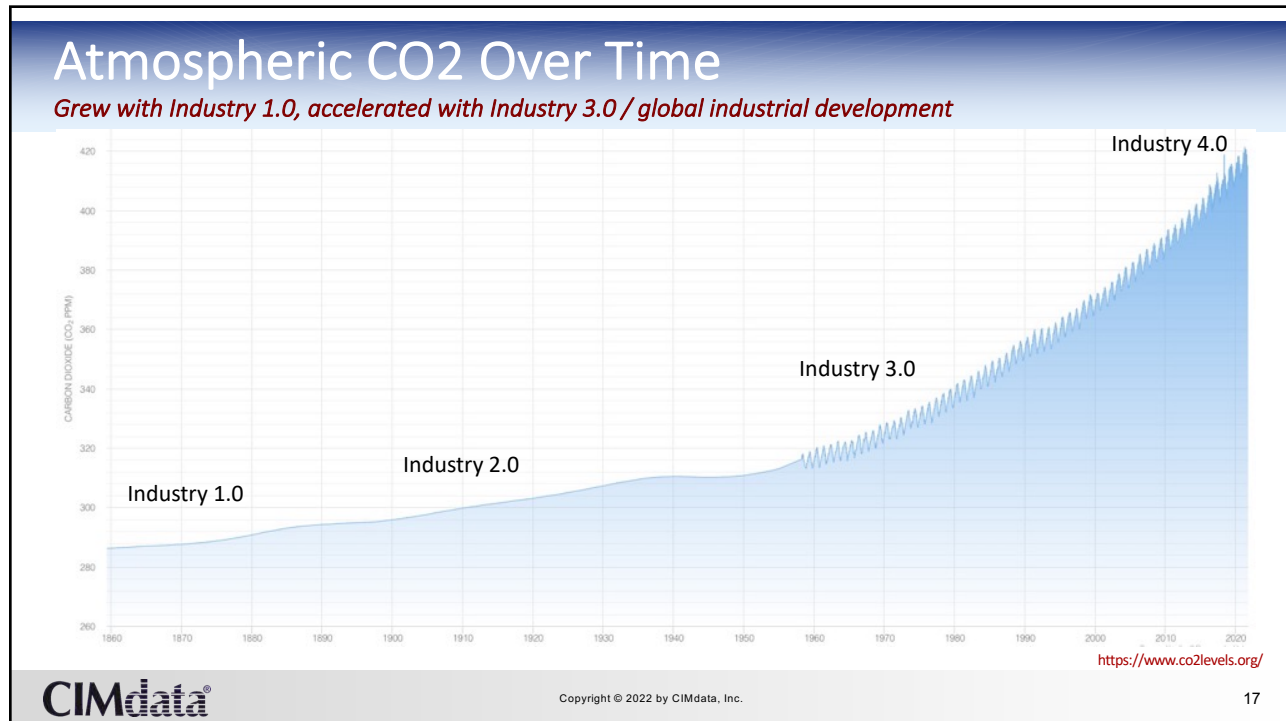
“...nature’s treasure chest...”

<https://www.worldometers.info/oil/>

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Human Impacts Accelerated with Industry 1.0

Changes in the means of production and materials helped lead us to where we are today (2 of 2)

- "I want to say one word to you...plastics."
- Bakelite invented in 1907, first synthetic plastic
- Estimate 8.3 billion tons produced, 6.3 tons waste, only 9% recycled
- Today China, Indonesia, Philippines, Thailand, and Vietnam dump more plastic into the sea than all other countries combined
- About 40% of plastic is single-use, tossed when done
- About 44% of plastic ever made is since 2000!
- Other pollutants used in plastics processing, e.g., BPA's

<https://www.nationalgeographic.com/science/article/plastics-facts-infographics-ocean-pollution>
<https://www.mayoclinic.org/healthy-lifestyle/nutrition-and-healthy-eating/expert-answers/bpa/faq-20058331>

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Gyres Prevalent in Our Oceans

Difficult to measure, hazard to navigation

<https://www.sportdiver.com/great-pacific-garbage-patch-facts-map>

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Invading Our Bodies

Microplastics in products, in the air we breathe

- Ocean gyres are visible signs
- What about the “invisible”?
Microplastics
- Most plastics “shed” tiny particles
 - Shaking baby formula in a plastic bottle – baby could consume 1 million particles/day
- Even in the air around us
- Respiratory impacts, chemical toxicity – more marine studies than human to date

<https://www.nature.com/articles/d41586-021-01143-3>

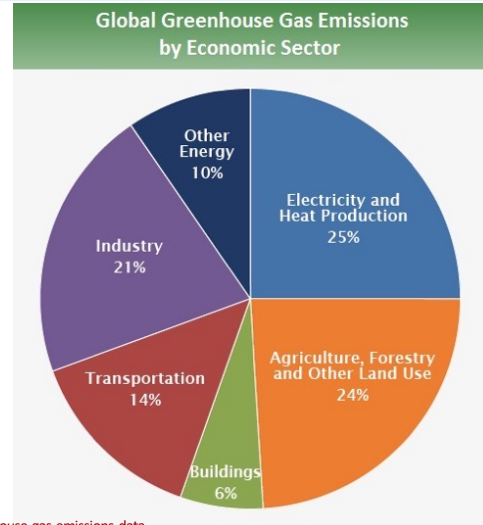
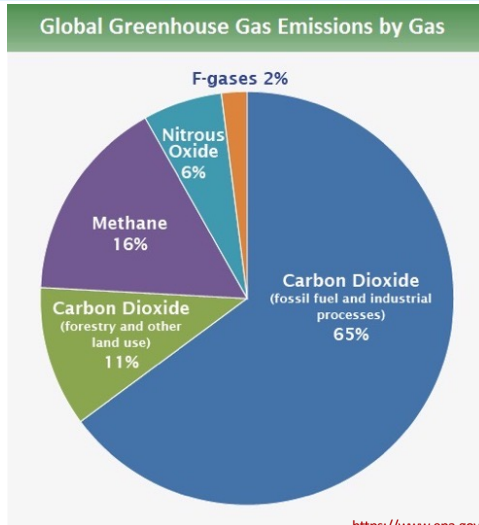
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Fouling Our Air and Water

Methane worse than CO2, fracking polluting both air and ground water (2010 data)



<https://www.epa.gov/ghgemissions/global-greenhouse-gas-emissions-data>

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Recycling?

Less than you think, just as dirty or dirtier

- Aluminum and steel comparative success stories
- Only a small percentage of plastics recyclable, often not into what first used for, e.g., microfiber fleece
- Move to composites adds strength, reduces weight...not recyclable
- Electronics recycling uses toxic chemicals, ship the problem to another country...and those countries are pushing back
- Fast fashion is choking the planet
- Have to stop it at the source...



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Sustainability

Facing global challenges, building capacity for the Earth's biosphere and human civilization to co-exist

- Developed world created the environmental crisis
- Who bears the brunt of environmental degradation?
 - Economically disadvantaged
 - Developing countries
- Need a systemic solution that addresses the problems without putting them on the shoulders of the same groups currently impacted by them
- “The Sustainable Development Goals are 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.”

<https://www.un.org/en/academic-impact/sustainability>

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UN Sustainable Development Goals

Goals “the blueprint to achieve a better and more sustainable future for all”



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

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Sustain

Going back to first principles

sustain verb

sus·tain | \ sə-'stān \

sustained; sustaining; sustains

1: to give support or relief to

2: to supply with sustenance: *NOURISH*

3: *KEEP UP, PROLONG*

4: to support the weight of: *PROP*; also: to carry or withstand (a weight or pressure)

5: to buoy up; sustained by hope

6a: to bear up under

b: *SUFFER, UNDERGO*; sustained heavy losses

8: to support by adequate proof: *CONFIRM*
testimony that sustains our contention



<https://www.merriam-webster.com/dictionary/sustain>

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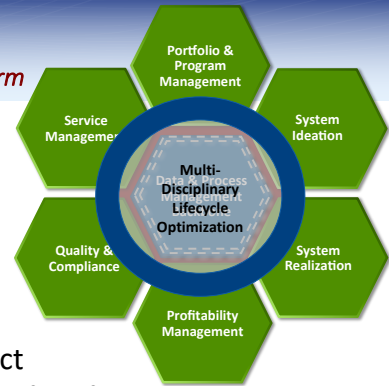
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PLM – CIMdata’s Definition

Digital transformation of the lifecycle—enabled by a product innovation platform

- Strategic business approach
 - **NOT** just technologies
 - Consistent set of business solutions
- Collaborative creation, use, management & dissemination of product related *intellectual assets*
 - All product/plant definition information – the virtual product
 - AEC, MCAD, EDA, ALM, SE, requirements, simulations, analytics, portfolio, formulas...
 - All product/plant process definitions – the virtual processes
 - Processes that plan, design, produce, operate, support, decommission, recycle...
- An innovation platform that supports the extended enterprise
- Spans the full lifecycle, from idea/concept through life

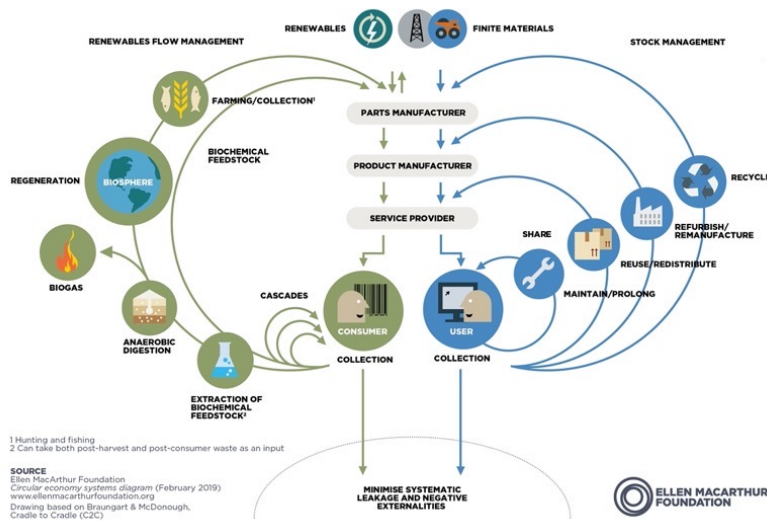


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The Circular Economy

Goal to “transform every element of our take-make-waste system” – Theme of the 2014 CIMdata PMIF



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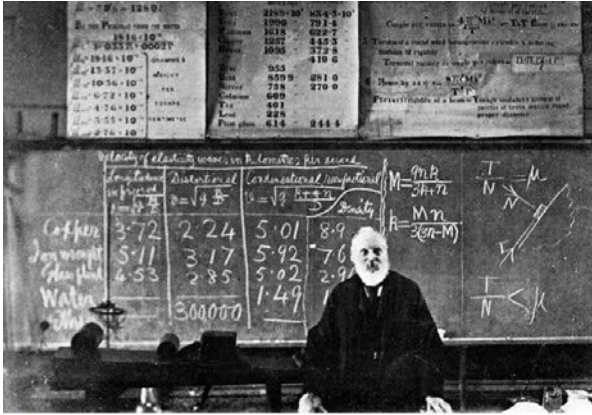
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To Measure Is To Know

Doomed to "knowledge of a meager and unsatisfactory kind" – first scientist elevated to the House of Lords



Lord Kelvin's Final Lecture

- "To measure is to know."
- "If you cannot measure it, you cannot improve it."
- "When you can measure what you are speaking about, and express it in numbers, you know something about it; but when you cannot measure it, when you cannot express it in numbers, your knowledge is of a meager and unsatisfactory kind."

https://www.researchgate.net/figure/The-final-lecture-of-Lord-Kelvin-1824-1907-at-Glasgow-1899-Credit-C-National-Museums_fig4_225765965

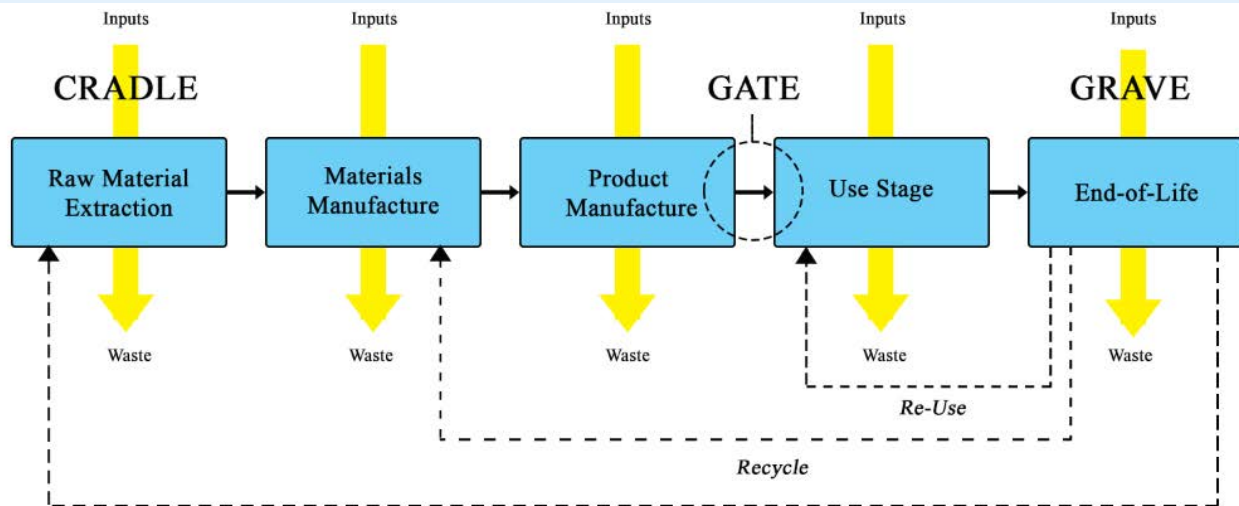


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Lifecycle Assessment (LCA)

Assessing environmental impacts from the lifecycle stages of a commercial product, process, or service (1 of 2)



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Lifecycle Assessment (LCA)

Assessing environmental impacts from the lifecycle stages of a commercial product, process, or service (2 of 2)

- LCA studies the environmental aspects and potential impacts from “cradle-to-grave” from raw materials acquisition through production, use and disposal
 - The general categories of environmental impacts needing consideration include resource use, human health, and ecological consequences
- LCA procedures in the 14000 series of environmental management standards of the International Organization for Standardization (ISO), in particular, in ISO 14040 and ISO 14044
- Susceptible to practitioner bias even with ISO guidelines – analyses by “10 different parties could yield 10 different results”

https://en.wikipedia.org/wiki/Life-cycle_assessment

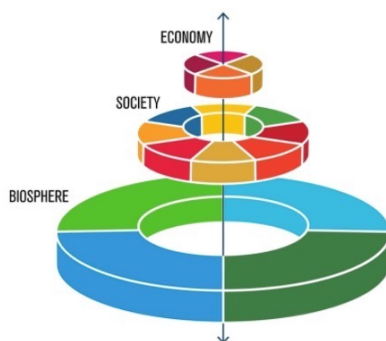


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The Value Balancing Alliance

Impact Measurement and Valuation (VMI) – <https://www.value-balancing.com/>



Quantify impacts on society, customers, employees and the environment

Pro-bono Consultants
Strategic Partners
Policy Advisors
Academics

Deloitte **EY**

KPMG **pwc**



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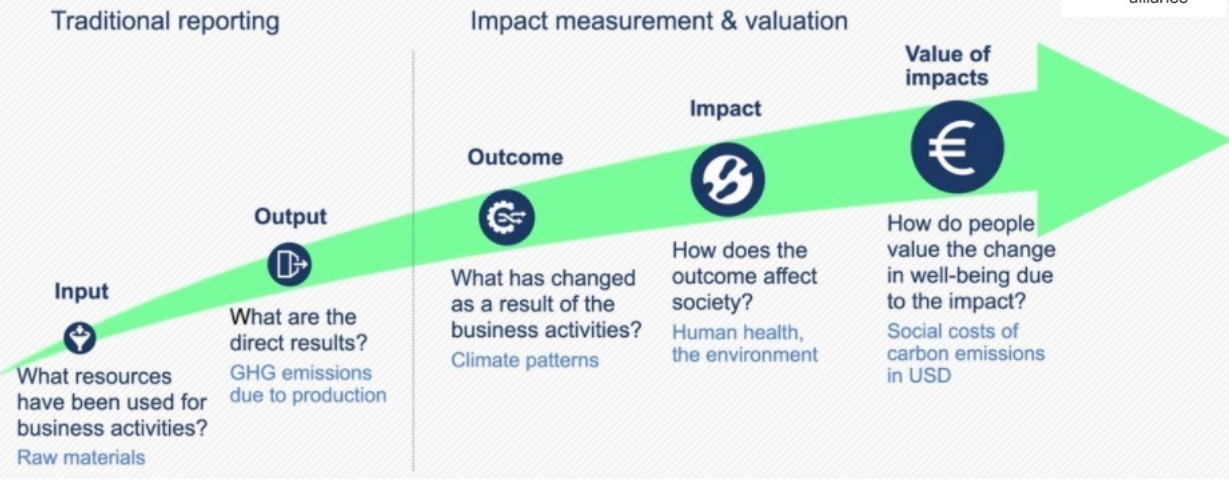

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The Value Balancing Alliance

Impact Measurement and Valuation (VMI) – <https://www.value-balancing.com/>



The diagram illustrates the Value Balancing Alliance process flow, which is divided into two main sections: Traditional reporting and Impact measurement & valuation. The process is represented by a green arrow pointing right, with four stages: Input, Output, Outcome, and Impact. The final stage is Value of impacts, represented by a Euro symbol (€). The diagram also includes a table of questions and answers for each stage.

Traditional reporting	Impact measurement & valuation
Input What resources have been used for business activities? Raw materials	Outcome What has changed as a result of the business activities? Climate patterns
Output What are the direct results? GHG emissions due to production	Impact How does the outcome affect society? Human health, the environment
	Value of impacts How do people value the change in well-being due to the impact? Social costs of carbon emissions in USD

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Carbon Neutrality = Net-Zero CO2 Emissions

Phrase has gone beyond just carbon

- "Carbon-neutral" the 1996 Word of the Year in the US (Oxford Dictionaries)
- Greenhouse Gases (GHG) a related phrase/acronym
- The term is used in the context of carbon dioxide-releasing processes associated with transportation, energy production, agriculture, and industry.
- The term "net zero" is increasingly used to describe a broader and more comprehensive commitment to decarbonization and climate action
- Beyond carbon neutrality, including more activities under the scope of "indirect emissions," and often including a science-based target on emissions reduction, as opposed to relying solely on offsetting

https://en.wikipedia.org/wiki/Carbon_neutrality

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WEEE/RoHS & EPR

Long-gestating Directives about to get real with extended producer responsibility (1 of 2)

- The Waste Electrical and Electronic Equipment Directive (WEEE Directive), together with the Restriction of Hazardous Substances Directive (RoHS) Directive 2011/65/EU, became European Law in February 2003
 - WEEE set collection, recycling and recovery targets for all types of electrical goods
 - RoHS restricted use of ten hazardous materials in the manufacture of various types of electronic and electrical equipment
- Multiple revisions, slow adoption across the EU, had to create infrastructure to support it
- EPR puts onus on producers as polluters, most effective means to achieve higher environmental standards in product design

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WEEE/RoHS & EPR

Long-gestating Directives about to get real with extended producer responsibility (2 of 2)

- Take-back provisions – producers must take back products at end of useful life – EPR financially encourages manufacturers to design for recycling and make products last longer, takes onus off governments
- Directive (EU) 2019/904 – single use plastics
 - A 77% separate collection target for plastic bottles by 2025 – increasing to 90% by 2029
 - Incorporating 25% of recycled plastic in PET beverage bottles from 2025, and 30% in all plastic beverage bottles from 2030
 - Implementing Decision 2022/162 – rules for calculating, verifying, and reporting on reduction in consumption of single-use plastic food containers and beverage cups
- EPR benefits hard to quantify, LCA can result in double counting

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Concurrent Engineering

Practices emerged in the 1990s, reflects basics of system engineering process, systems thinking

- Need for Design for Manufacturing (DFM) recognized in late 19th century
- Promoted by academics, leading industrials like GM, Westinghouse, Kodak
- But how to do it?
 - Requiring approval by other functions
 - Using liaison personnel
 - Meetings between representatives of different functions
 - Using cross-functional teams to accomplish integration
- Necessary integration fully described in the 1950s, some think digital tools provided the path
- Today well beyond DFM → DFX to consider many other needs

Robert P. Smith, "The Historical Roots of Concurrent Engineering Fundamentals," IEEE Transactions on Engineering Management, Vol. 44, No. 1, February 1997

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What is the Business Opportunity?

How can the PLM Economy best support these requirements?

- DFX PLM-enabled at the core
- Material substitution in products and packaging will need to be (virtually) proven in new applications
- Improving recycling capabilities, equipment
 - Your trash someone else's livelihood
 - 2020 Basel Convention
- Paradigm shifts create a "Whac-a-Mole" situation – attempts to improve result in new problems
- More than just a PLM issue – must involve global value chains in improvements and measurements



<https://en.wikipedia.org/wiki/Whac-A-Mole>

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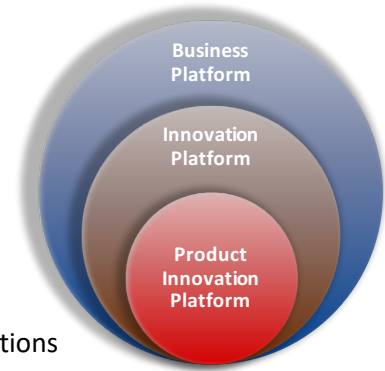
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Business Platforms Key

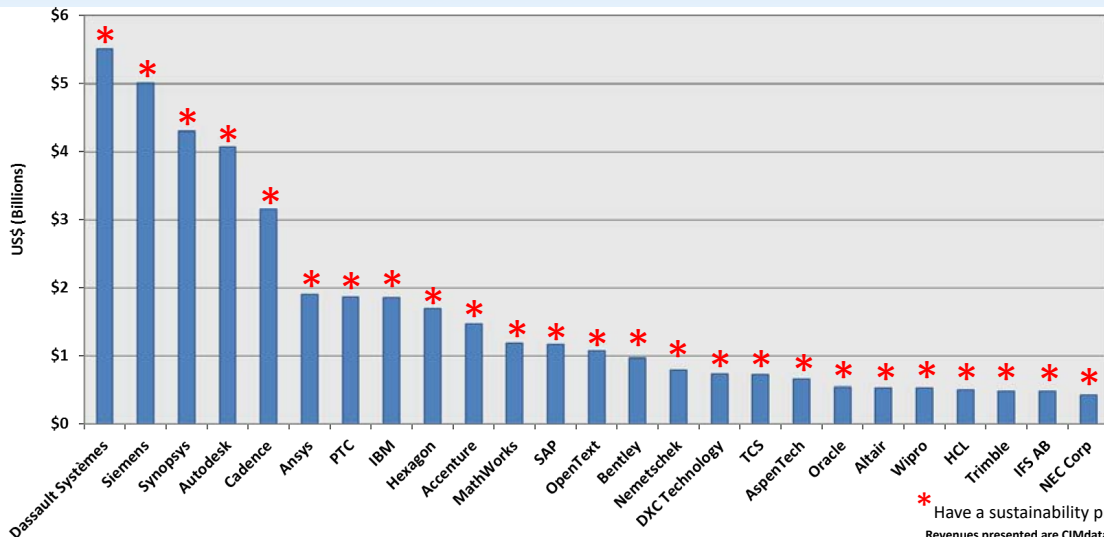
Elements of all three platform levels needed for sustainability (topic from 2015 PMIF)

- “Business Platform”
 - An architecture that allows a comprehensive set of heterogeneous functional process-enabling capabilities to be packaged and configured to establish and support standardized end-to-end business processes, and related data access
- “Innovation Platform”
 - A business platform designed to enable an enterprise’s innovation processes
 - Helping users to create, manage, and re-use data and intellectual property for maximum business impact and effectiveness
- “Product Innovation Platform”
 - An innovation platform that cultivates continuous creativity, yielding improvements in products and processes plus inspiring new and better ones throughout full lifecycles and across generations of a products



2021 Overall PLM Revenue Leaders

Many diverse companies generate PLM revenue



* Have a sustainability program
Revenues presented are CIMdata estimates

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The Green Software Foundation

Non-profit focused on building “green software” – <https://greensoftware.foundation/>



- Focus areas

- Standards: Agreeing on standards, best practices and patterns for building green software
- Innovation: Nurture the creation of trusted open-source and open-data projects and supporting academic research
- Community: Facilitate the growth of a diverse and international community of green software ambassadors

STEERING MEMBERS



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Achieving the “Triple Bottom Line”

“People, planet, and profit” – consumer interest moving sustainability to a competitive advantage

- Public companies are beholden to their shareholders
- Corporate Social Responsibility (CSR) programs emerged in the 1960s
 - Business strategy?
 - Greenwashing?
- One way to evaluate CSR efforts is the Triple Bottom Line
- Elevated consumer interest in sustainability:
 - 93% of global consumers say COVID-19 influenced their views on sustainability
 - 22% more consumers say environmental responsibility is very or extremely important when choosing a brand than in 2019
 - 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)
- PLM solutions and services can help with all three

IBM Institute for Business Value. “Sustainability at a turning point,” 2021



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Shaping the Sustainable Organization

Accenture study in collaboration with the World Economic Forum – leaders make significant gains!

- In a 2020 study by Accenture “73% of executives said that becoming a “truly sustainable and responsible business” was a top priority for their organization over the next three years.”
- “Of 1,122 CEOs surveyed by the UN Global Compact in 2021, 79% said the pandemic has highlighted the need to transition to more sustainable business models.”
- “...leadership teams that build sustainability into the DNA of their organizations are better able to deliver financial value and wider stakeholder impact. In fact, those with the most deeply embedded sustainability management practices outperform peers by 21% on both profitability and positive environmental and societal outcomes.”

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

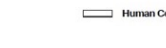
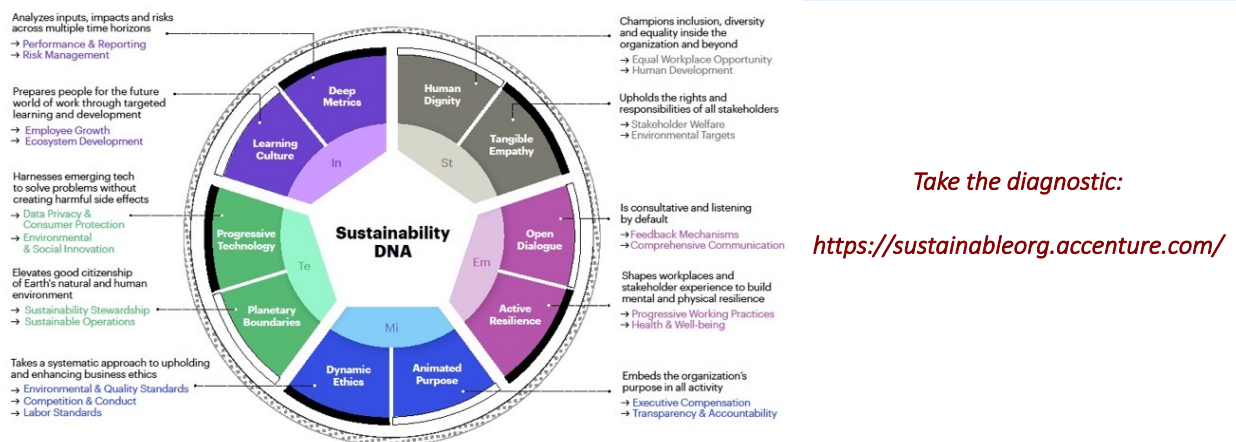


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Shaping the Sustainable Organization

Accenture study in collaboration with the World Economic Forum



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Concluding Remarks

The Sustainability Imperative

- Problems known for decades, the will to act much slower to develop
- From the earliest warnings saw the importance of a systemic response
- “Our Common Future” the right mantra for the challenges ahead
- The PLM Economy crucial to meeting this challenge, helps (re)define the built world and the things in it
- Reach must extend to global value chains and product use through life
- Requires a people, process, and technology approach, need to create “virtuous” cycles
- The hard work is just starting, imperative that we are successful

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