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# HOW CREO SUPPORTS SUSTAINABLE PRODUCT DEVELOPMENT


**WHITE** PAPER

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# Introduction

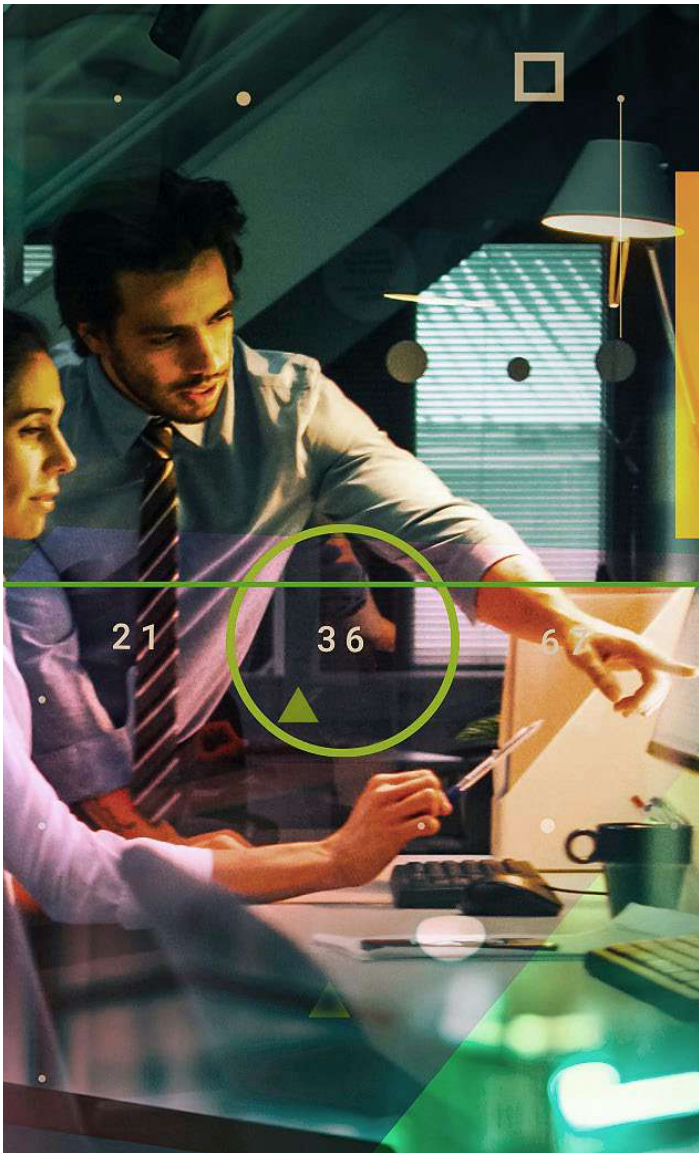
From the extraction of raw materials to their eventual disposal in a landfill, every stage of a product's life has an environmental cost. This has led to a shift in product development practices, moving away from traditional methods that heavily consume resources and generate waste, towards a more sustainable approach that considers the entire lifecycle of a product. This change is driven by moral or ethical considerations and practical necessity as social, economic, and regulatory factors push for greater sustainability in manufacturing.

At the heart of this change in thinking is the understanding that traditional manufacturing practices are characterized by excessive material consumption, energy inefficiencies, and inadequate waste management, making current processes unsustainable in the face of global environmental challenges. And with growing social awareness, widespread adoption of global environmental frameworks, and increasingly stringent regulatory requirements, it's more and more necessary for manufacturers to leverage best-in-class engineering tools to streamline better methods of designing for sustainability.

# Sustainability Standards Framework

A major factor driving manufacturers to adopt sustainable product development practices is the need to comply with legal and standards frameworks. The European Union regulation the **Corporate Sustainability Reporting Directive (CSRD)** came into force in early 2023, strengthening the rules on environmental information that companies must report. This way, investors and other stakeholders can access the information they need to understand how companies affect people and the environment and to assess the financial risks and opportunities related to climate change. The CSRD regulations not only impacts companies within the EU but also those that import parts and products into Europe.

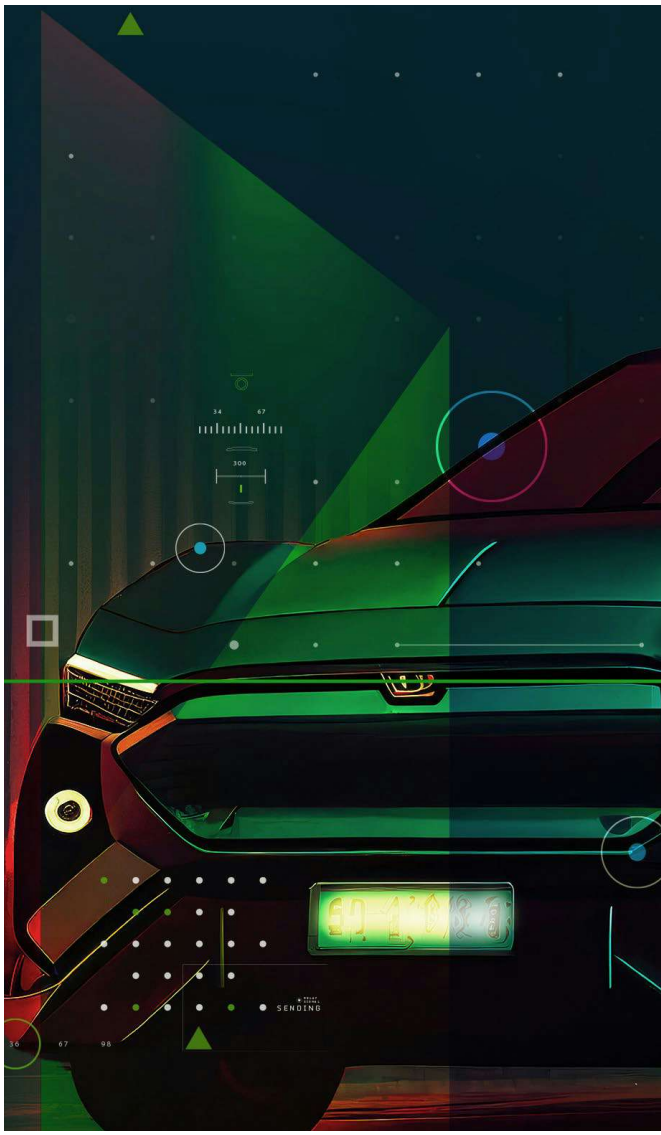
The IFRS Foundation has created the **International Sustainability Standards Board (ISSB)** to implement standards that result in a comprehensive, high-quality global baseline of sustainability disclosures that focus on the needs of investors and the financial markets. The first two standards issued by ISSB include IFRS S1, which provides a set of disclosure requirements that help companies communicate the short-term and long-term sustainability-related risks and opportunities they face to investors. IFRS S2 builds on IFRS S1 by incorporating the recommendations of the Task Force on Climate-related Financial Disclosure (TCFD) and requires the disclosure of information about cross-industry and industry-specific climate-related risks and opportunities. By being aware of these standards, manufacturers can be held accountable for the environmental impact their organizations have.



# Driving Sustainable Product Development

With 80% of a product's lifetime carbon footprint determined at the design stage[1], design engineers have a huge role in making products more sustainable. By leveraging CAD technologies within Creo that offer real-time and high-fidelity simulation, AI-driven generative design, and material and manufacturing insights, design engineers can help to achieve their company's sustainability goals.

Design engineers can apply Design for Sustainability (DfS), which prioritizes resource efficiency and the use of more eco-conscious materials in developing products and processes, to evaluate a product's form, function, and environmental impact. This design approach allows design engineers to focus on choosing low impact materials, minimizing material usage, selecting efficient and responsible methods for part manufacturing, and ensuring part reuse and remanufacturing. This idea can be applied to Design for Sustainable Manufacturing (DfSM), Design for Assembly (DfA), and Design for Disassembly (DfD) which, in a combined approach, improves every aspect of the product development process.



**Design for Sustainable Manufacturing (DfSM)** promotes the use of renewable resources, reducing energy consumption, and minimizing generated waste throughout the manufacturing process.

**Design for Assembly (DfA)** reduces the number of product components and minimizes required assembly operations.

**Design for Disassembly (DfD)** considers in the early upstream stage how to minimize the environmental impact of a product through reuse, repair, remanufacture, and recycling.

[1] Source: Ellen MacArthur Foundation, An Introduction to Circular Design, https://www.ellenmacarthurfoundation.org/news/an-introduction-to-circular-design

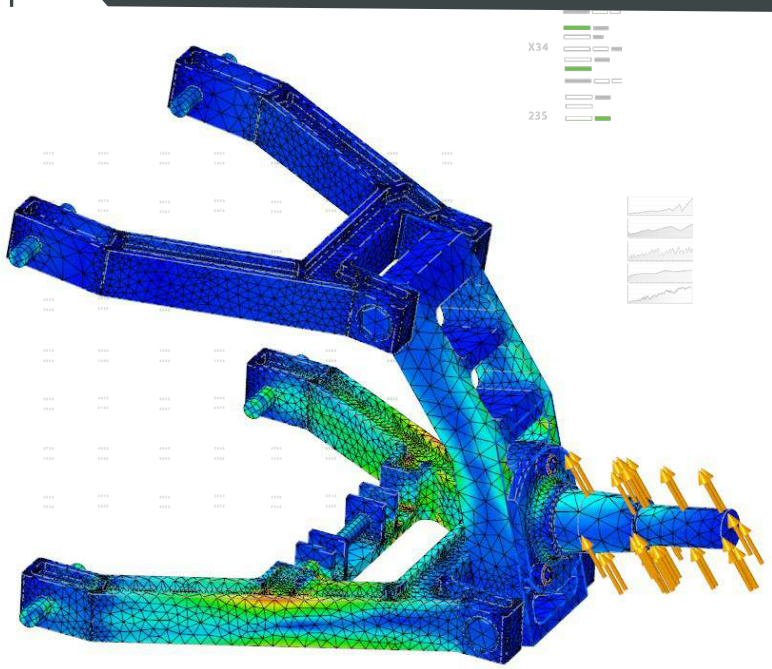
# Shifting Simulation to the Left

Simulation is a powerful tool for sustainable product design when it is used early and often in the design process. By giving design engineers more control over simulations for iterative improvement, sustainability becomes part of the design process. Virtual prototyping allows for comprehensive analyses across structural, thermal, modal, and fluid dynamics, enabling designers to make quick changes and refine their designs early in the development process. This frequent and early simulation approach is supported by fast performance, which allows designers to quickly explore many different design options. Simulation in Creo has many advantages when it is prioritized early in the design process. First, it helps optimize designs at an early stage, which reduces the number of physical tests and the waste generated during prototyping and testing phases. Second, designers can check performance criteria during light weighting iterations, which ensures that materials and resources are used effectively without sacrificing product quality or functionality. Third, this approach leads to higher-quality designs with fewer changes at the production stage, which reduces scrap and improves sustainability by lowering material waste and energy use related to rework.

**Creo Simulation Live (CSL)** combines a CAD modeling and simulation environment to provide real-time analysis results and feedback to evaluate and guide design decisions. CSL provides real-time structural, thermal, and modal analysis while Creo Simulation Advanced includes additional capabilities for real-time fluid flow analysis.

With **Creo Ansys Simulation (CAS)**, PTC and Ansys put the power of gold-standard simulation at the fingertips of the design engineer. CAS offers high-fidelity, high-accuracy simulation for design refinement and validation, resulting in earlier insight into product behavior, reduction of costs, and speeding time-to-market. Creo Ansys Simulation Advanced expands on this with support for multi physics studies and use cases for nonlinear contact and nonlinear material.

https://www.ptc.com/en/products/creo/simulation



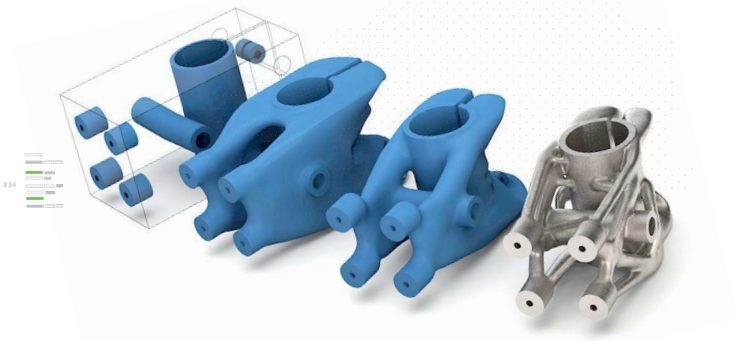
# Dematerialization

Generative design uses AI to create and test many design options based on specific criteria and limits, resulting in dematerialization or less material being used in the final product. One of its main benefits for sustainability is light-weighting, which reduces the energy a product uses during operation by using less material without compromising structure and performance. This also lowers the environmental impacts of getting, making, and disposing of materials, as well as the carbon footprint of the product, which helps with the goals of reducing carbon emissions and protecting the environment. As engineers set realistic limits within production capabilities, Creo's generative design solutions make sure that the designs are not only sustainable but also feasible for production.

**Generative Topology Optimization (GTO)** quickly generates optimized designs to meet requirements and converts them into rich B-rep geometry so that users can enjoy an uninterrupted parametric workflow.

**Creo Generative Design Extension (GDX)** extends Creo's generative design capabilities by enabling analysis of multiple design studies simultaneously GDX automatically identifies the top options, including those that designers may not have even considered.

https://www.ptc.com/en/technologies/cad/generative-design

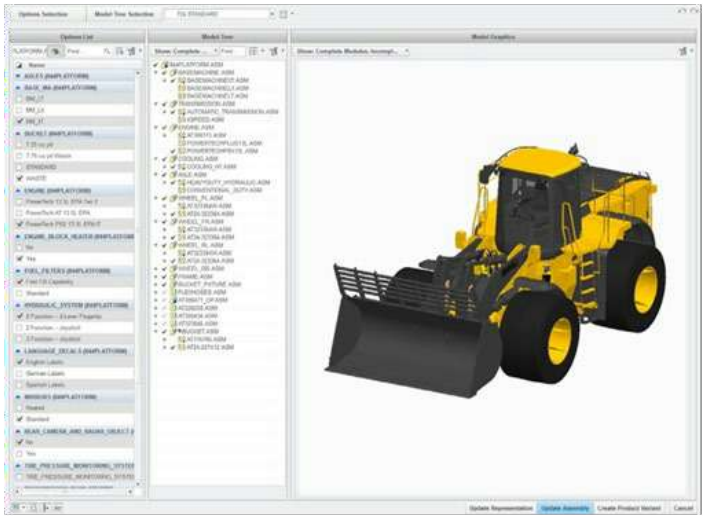


# Material Selection

While generative design focuses on optimizing design geometry to reduce material usage, material selection databases considers factors such as cradle-to-gate carbon footprint, hazardous material compliance, and material recyclability. By tuning materials early in the design phase and balancing sustainability with performance, cost, and appearance, designers can further reduce the embodied carbon footprint of the product.

# Environmental Footprint of Manufacturing Processes

By applying aPriori's  manufacturing insights to the product design and manufacturing process, sustainability can be enhanced considerably. Using data-driven insights, designers can anticipate the environmental consequences of the manufacturing process, such as energy use and waste generation. Based on this data, Creo and aPriori can recommend different materials, geometries, and manufacturing processes to drive sustainability improvements. By evaluating different design alternatives across sustainability, cost, and manufacturability metrics, design choices can be made to ensure that sustainable practices are not sacrificed by practicality or economic factors. This approach also allows for the integration of sustainability factors with cost and manufacturability, ensuring that sustainable practices are smoothly incorporated into the overall product development process. Moreover, by decreasing energy and waste per part manufactured, organizations can lessen their environmental impact while also improving efficiency and resource consumption.



Support for modular xBOM (extended Bill of Materials) backbones with Creo's xBOM creation and management capabilities enables the creation of products with interchangeable components, promoting resource efficiency and circular economy principles. This approach minimizes material waste by facilitating repair, upgrade, and end-of-life disassembly without the need for manufacturing entirely new products for each variation. Additionally, it optimizes inventory management and reduces the environmental impact of transportation through efficient packaging and shipment volumes.

**aPriori's** solutions all provide automated manufacturing insight:

**aP Pro** helps product design, engineering, cost engineering, sourcing and manufacturing organizations identify and eliminate manufacturing cost drivers at the point of origin.

**aP Design** is built for design engineers to get actionable feedback of manufacturability, cost, and carbon directly from 3D CAD models as early as the conceptual phase.

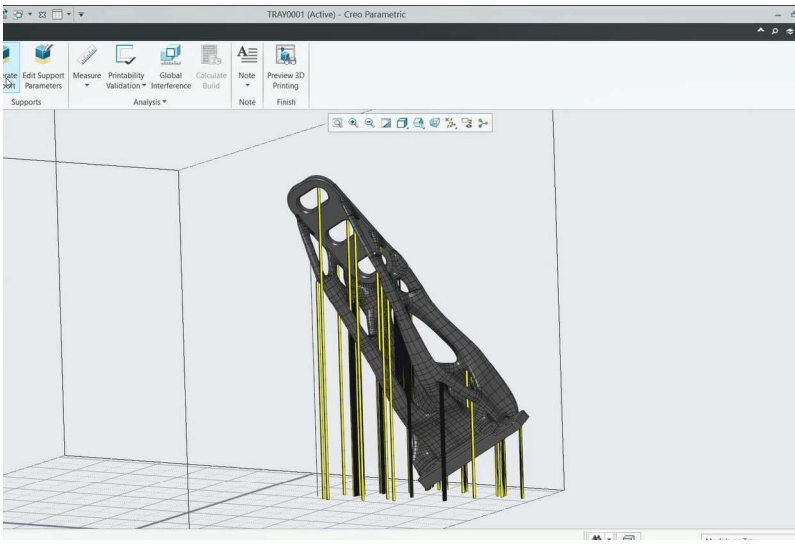
**aP Generate** automatically leverages manufacturability and cost analysis to streamline the product development process.

https://www.apriori.com/solutions/roles/design-engineering/

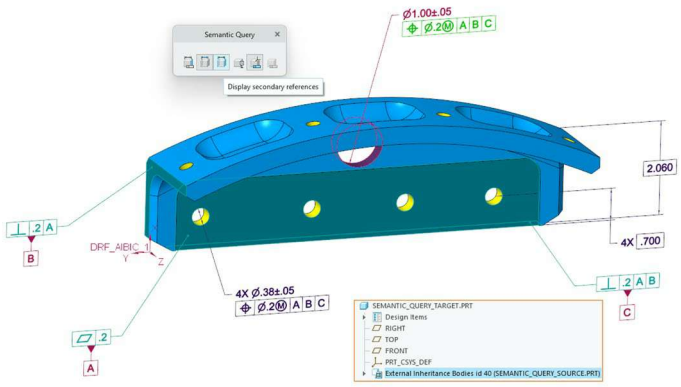
Simultaneously, by dematerializing additive manufacturing in Creo, designers can leverage advanced capabilities such as lattice structures and topology optimization to significantly reduce material usage while maintaining or enhancing performance. This approach not only minimizes material waste, energy consumption, and emissions associated with traditional manufacturing methods but also enables on-demand production, reducing the environmental impacts of overproduction and excess waste. Additionally, it mitigates the need for shipping or transporting products or parts that were manufactured elsewhere, further decreasing the carbon footprint associated with long-distance transportation.

**Creo Additive Manufacturing Advanced**, available in the Creo Design Engineer Professional package, includes all of the lattice structure creation and optimization capabilities of previous packages with the additional abilities to connect to 3D metal printers and automatically generate 3D metal support structures.

https://www.ptc.com/en/technologies/cad/additive-manufacturing




Without an integrated model-based digital thread within Creo, it would be impossible to monitor and measure all of this. This is the single source of truth, where engineers can access and review product data to see the CO2 impact over its entire lifespan. With this information, engineers can more easily reduce product footprints, communicate environmental product declarations, and create and manage digital product passports.




For years, engineers used 2D drawings to deliver product manufacturing information--even as they designed models in 3D. Now, using **Model-Based Definition (MBD)**, engineers embed product data directly into the 3D model, creating a single, reliable source of truth which, as a result, prevents errors and saves on time.

https://www.ptc.com/en/technologies/cad/model-based-definition

# Conclusion

The transition towards sustainable product development reflects a vital reaction to the pressing need to reduce environmental impacts. This change is not only driven by social awareness and ethical obligations, but also by regulatory demands and economic incentives. Companies that can associate their brand and products with sustainability have stronger brand loyalty and reputation and by designing for sustainability, companies can see demand increasing and costs decreasing. As we continue to face the challenges around driving product sustainability improvements, the integration of disruptive CAD tools guides manufacturers towards a more environmentally aware and sustainable future. By harnessing the power of advanced technologies and innovative methods to design for sustainability, manufacturers can navigate the complexities of sustainability with greater effectiveness and efficiency, creating a better world for future generations.

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