

Session Title

Digital Transformation in Product Development: Emerging Technologies between Engineering and Design

Proposers

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Motivation

The product development process is undergoing a radical transformation driven by the integration of emerging digital technologies. Among these, Artificial Intelligence (AI) is rapidly becoming a central element, alongside 3D modeling, Extended Reality (XR), and additive manufacturing. These technologies are not only improving efficiency but are fundamentally redefining how products are conceived, represented, and produced.

In this evolving scenario, traditional boundaries between engineering and design disciplines are increasingly blurred. Designers are required to engage with technical constraints and data-driven processes, while engineers are increasingly involved in creative and user-centered aspects of product development. This convergence calls for new frameworks, methodologies, and competencies capable of addressing the complexity of contemporary design challenges.

In particular, AI is enabling a shift from deterministic design approaches to **adaptive, data-driven, and generative processes**, where designers and engineers interact with intelligent systems capable of proposing, optimizing, and evaluating solutions. This transformation requires a rethinking of traditional workflows and roles, fostering a closer integration between engineering rigor and design creativity.

The session aims to explore how these technologies—especially AI—are reshaping the different phases of product development and to foster a multidisciplinary discussion on future trends, opportunities, and critical issues.

Background

Recent advancements in digital technologies have significantly expanded the capabilities of product development. Parametric and generative modeling tools enable designers to define geometry through rules and relationships, allowing rapid exploration of multiple design alternatives. At the same time, additive manufacturing introduces unprecedented freedom in realizing complex geometries, enabling the integration of structure, material, and function into a single process.

XR technologies (Virtual, Augmented, and Mixed Reality) are transforming design evaluation and collaboration by enabling immersive visualization, real-time interaction with digital prototypes, and remote co-design. These tools enhance decision-making and reduce the need for physical prototyping, contributing to more efficient and sustainable workflows.

However, the most disruptive change is currently driven by the integration of AI into these systems. AI-based tools are increasingly embedded within design platforms, enabling automation, optimization, and the generation of alternative solutions based on predefined constraints or performance criteria. This evolution is leading toward a **fully integrated digital ecosystem**, where modeling, simulation, and fabrication are interconnected within continuous feedback loops.

These developments are progressively leading toward a **data-driven, distributed, and highly customizable production model**, where digital and physical processes are seamlessly integrated. However, they also raise important questions related to design control, authorship, sustainability, and the role of human expertise.

Structure of the Special Session

The special session is intended as a multidisciplinary forum that brings together researchers and practitioners from both the engineering and design fields. Contributions may include theoretical frameworks, experimental research, case studies, and industrial applications.

Suggested topics include:

1. **AI in Concept Generation and Creative Processes**
 - Generative design and AI-assisted ideation
 - Human–AI collaboration in design
2. **Digital Modeling and XR for Advanced Representation**
 - AI-enhanced modeling tools
 - Immersive design environments
 - Virtual prototyping and evaluation
3. **Additive Manufacturing and Intelligent Fabrication**
 - AI-driven optimization for AM
 - Design for additive manufacturing (DfAM)
 - New materials and structural optimization
4. **Smart Products and Intelligent Product–Technology Integration**
 - Connected and adaptive product system
 - Smart materials and embedded sensors in product development
 - Interactive technologies in product development
 - Human-centred and experience-driven approaches for smart products
5. **Integrated and Data-Driven Workflows**
 - Digital twins and simulation-driven design
 - Automation and decision support systems
6. **Artificial Intelligence and Future Trends**
 - AI as a design partner
 - Automation vs. human creativity
 - Ethical and methodological implications
7. **Future Trends and Implications**
 - New roles of designers and engineers
 - Models of collaboration among design and engineering
 - Ethical, methodological, and educational challenges

The session will include paper presentations followed by a **joint discussion panel**, aimed at identifying future research directions and fostering interdisciplinary collaboration.