Cognitive Design: Deterministic AI Beyond Generative Design

Engineering teams are under increasing pressure to reduce weight, cost, and environmental impact while maintaining performance, requiring systematic comparisons across materials, lightweighting strategies, manufacturing processes, and suppliers. Yet such comparative studies remain difficult to perform in a rigorous and repeatable way, due to geometric complexity, limited automation, and poor adoption of advanced design technologies.

This talk presents how *Cognitive Design* combines implicit modeling, design automation, and artificial intelligence to enable a **deterministic** and industrially robust design methodology. Implicit modeling supports the rapid generation and modification of highly complex, performance-driven geometries that remain parameterizable and manufacturable across processes such as additive manufacturing and advanced forming. Design automation structures design space exploration, enabling objective and repeatable evaluation of design options across performance, cost, CO_2 emissions, and manufacturing risk.

Artificial intelligence is used not as a stochastic design generator, but to enhance exploration efficiency, usability, and decision-making. AI accelerates trade-off analysis while lowering the barrier to creating and industrializing complex geometries, addressing a key adoption challenge for engineering organizations. The talk concludes with a near-term perspective in which AI evolves beyond a co-pilot role to become an extension of the engineer's cognitive process—translating intent into software actions, structuring workflows, manipulating data, and guiding engineers toward the most effective design choices—while preserving the determinism, traceability, and repeatability required for engineering practice.