ENABLING CIRCULAR ENGINEERING BY REDESIGNING A DRIVER'S SIDE FRONT DOOR USING ULTRALIGHTWEIGHT THERMOPLASTICS COMPOSITES VIA SYSTEMS LEVEL DESIGN AND SIMULATION STRATEGY

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Greenhouse gases are one of the primary causes of human induced global warming wherein ~14% of the global greenhouse gas emissions are from the transportation sector. This underscores the vast potential and impact any sustainable paradigm might bring if tailored to the practical realities of the automotive sector. In this context a closed loop multicycle paradigm that goes beyond the reduce, reuse and recycle dogma and emphasizes on the redesigning and remanufacturing of vehicles aka Circular Engineering might just be the solution the automotive sector needs.

A great case for circular engineering can be presented in the context of lightweighting of the automotive structures that would: reduce the weight of the car and material usage, translating to greater fuel efficiency but come coupled with engineering challenges ranging from design to manufacturing. From a materials perspective carbon fiber reinforced thermoplastic composites offer an alluring premise as they provide high stiffness and strength while being lightweight and are recyclable when compared to their thermoset counterparts. However, a major constraint to their immediate adoption include: Understanding their failure behavior in nonlinear crash environments, cost of carbon fiber and cycle time for production.

This work looks into incorporating the principles of circular engineering by delving into the process of designing an ultralightweight thermoplastic composites door (a driver's side front door) and developing robust simulation methods to validate and optimize its crash response. This includes details on the development of robust material cards and their experimental validation at coupon and component level. These robust simulation methods form the cornerstone to rapidly iterate and develop a composite door frame that meets and surpass the crash performance of the baseline metal door.