

## 1 Executive Summary

Current automotive wheels utilize materials and processes that have been in use for many years. Hard lines are typically drawn around lightweight wheels being expensive and lower cost wheels limiting in terms of aesthetic freedom. It is clear that there is an opportunity for the steel wheel to increase market penetration within the automotive sector by focusing on a stylish, lightweight and low cost alternative.

In commissioning this project, the SMDI set forth an overall goal to develop a generic wheel design with the equivalent style, structural performance and mass, along with a 30% cost reduction, of a cast aluminum baseline wheel. Additionally, it was desired that the lightweight steel wheel architecture, although highly styled in its baseline form, would provide a means to be readily upgraded with additional wheel trim (i.e. trim rings, hub caps, accent strips and a full wheel cover). This would enhance the flexibility of the base wheel by providing industrial designers with a larger pallet of options in which to differentiate the wheels for a specific application.

The overall process applied included:

- Topology/topography optimization that provided:
  - Design inspiration for aesthetic shapes and spoke patterns
  - Definition of the optimal wheel construction from a choice of full face, bead seat and drop well wheel
  - Definition of the optimal load path shape for the chosen number of spokes
- Gauge and shape optimization to refine the wheel geometry to maximize performance while minimizing mass
- Consideration of a wide range of materials including advanced high strength steels
- Final material selection of SAE J2340 490Y grade steel for both rim and disc
- Ideation and depiction of alternative accessory wheel trim and dress items options

The results of this process:

- A design that can replace the GMC Terrain aluminum cast wheel (the design surrogate) without assembly and packaging issues
- Equivalent mass and performance to the baseline cast aluminum wheel with a 30% cost reduction.
- A high style, baseline wheel with an upgrade path to additional aesthetic differentiation through application of alternate trim options
- A guideline for engineers to develop lightweight wheel structures



Figure A: Lightweight Steel Wheel Concept

The Lightweight Steel Wheel Concept, at this stage in the design development process, shows promise as a means to develop lower cost, high style, steel wheel solutions with equivalent mass to typical cast aluminum wheel solutions. It is an excellent foundation for a Phase II design investigation. Phase II will be a necessary next step to evaluate vehicle level performance, via a prototype build and physical testing.