Wanted to introduce an interface that is open to optimization and FEA for those untrained
- accurate
- reliable
- utilize package of high end tools

Ability to do structural analysis and TO
- allows us to not have to build so many prototypes pre-testing
- virtually test structural soundness

Over designing a part almost as bad as under designing
ex. truck part that had 55% reduction in mass
ex. airplane door hinge – reduced design time and mass
ex. automobile part – reduced weight and allowed to add casting constraints
ex. antenna mount for satellite – reduction in weight and all design criteria satisfied

We assume linear, static analysis

TO: intelligent part design
- we want to make parts as light and as safely as possible

Topology Optimization Explained

Topology optimization cuts part development time and costs, material consumption, and product weight. Works with additive, subtractive, and all other types of manufacturing processes, too

- TO balances material use against the stiffness of a part
- TO shortens the design process
- starting with an ideal solution, from a mathematically efficient design —> ideal design already optimized for material consumption, product weight, and manufacturability

Analyzing Topology

- TO is a mathematical approach, selects elements in a finite element mesh (the design space) that best maximize the tradeoffs in both minimizing material usage and maximizing part strength for a given manufacturing process
- TO is all a FEA process —> creates material layout within a given design space, for a given set of loads and constraints, in the most efficient way to meet the required performance targets
- in FEA, part shape is imported, loads and constraints are defined, then a simulation confirms whether the shape satisfies the loads and constraints
- in TO, the loads and constraints are defined first, a volume that the part will occupy is defined, and then from the simulation, the software generates a part shape that satisfies the loads and constraints while minimizing the design goals of a minimum part weight and maximum part stiffness
- think of TO as a way of carving out excess material in a design, and probably be just as strong

What is TO and Why is it Useful?

TO takes a 3D design space and literally whittles away material within it to achieve the most efficient design

- the tech starts with regular FEA mesh occupying the design space you have defined; an initial FEA distribution through this design space, but also show which regions are working efficiently
- each element reports back its stress level and strain energy, essentially how hard it is working
- by choosing the volume fraction, you can control how aggressive the optimizer will be