Special thanks to Ronnie Wilson for being an excellent liaison.

What is a Thrust Reverser?
Thrust reversers are assemblies that take the exhaust from jet engines, which normally propels the aircraft in a forward direction, and reverses the flow in order to slow the forward momentum of the aircraft during landing. These devices are meant to be used in conjunction with the wheel braking assembly. Thrust reversers have an advantage when ground conditions are slippery. In icy or wet conditions, the wheels have a tendency to slip, resulting in added wear on the tires and braking assembly and longer braking distances. The braking power of thrust reversers is derived from the reversed airflow, thus runway conditions do not affect the efficiency of the thrust reverser’s braking potential.

Why Optimize?
The objective of airplane component optimization is to minimize mass while maintaining structural integrity, rather than optimizing for minimum material costs or for the greatest ease of assembly. This is because material and assembly costs are one-time costs that contribute to the initial cost of a plane, but the fuel costs are on-going. A plane with a lower mass requires less fuel to fly, and therefore saves its operator money on every single flight it makes, even if it is initially more expensive to produce.

Optimizing airplane components for mass while ensuring the part will still be strong enough to stand up to the heavy loads experienced during flight requires the use of powerful computational optimization software. This software must have the capabilities of modeling a part’s behavior when various changes are made to the geometric design that would affect the part’s final mass. Although this specialized software is very powerful, it can be complicated and difficult to use.

After exploring the optimization process, the Boeing—Olin SCOPE team identified areas of opportunities within the method, and decided to focus on the learning process. To that end, a series of Boeing—specific tutorials were created to

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Optimization Round 1
The final results of an FEA generally show a distribution of either stresses, strains, or displacements that can be used in the fine optimization stage. These results can be imported into an optimization solver to aid in improving things such as mass, thickness, etc. optimization steps. These results can be imported into an optimization solver to aid in improving things such as mass, thickness, etc.

During the first round of optimization ideal outcomes are defined for the solver to try and calculate. An example of this is setting a minimum and maximum thickness allowable and having the program try to find a value within that range. When designing airplane optimization solvers are almost always run to minimize mass because overtime cost is measured in how much fuel is necessary to move the plane, and fuel costs are directly proportional to weight. For this optimization, displacement is constrained and mass minimized. The second round of optimization also defines ideal parameters such as minimizing thickness and mass and also generally has manufacturing constraints. An example of a manufacturing constraint is making sure a hole stays the same on material is removed, because a certain type of screw has to hold to the part to the system. Another example might be to make sure the outer edge of a part maintains the same shape because it must fit with another part.

This second iteration of optimization takes into account the fine optimization and the FEA that was previously run. In a way this is a more refined optimization in comparison with the first iteration. During this particular optimization composite strain and composite failure were constrained and the objective of the optimization was to minimize mass.