Time Saving Tips for Sensors Designers

Reducing, Simplifying and Approximating Models for Faster Solutions

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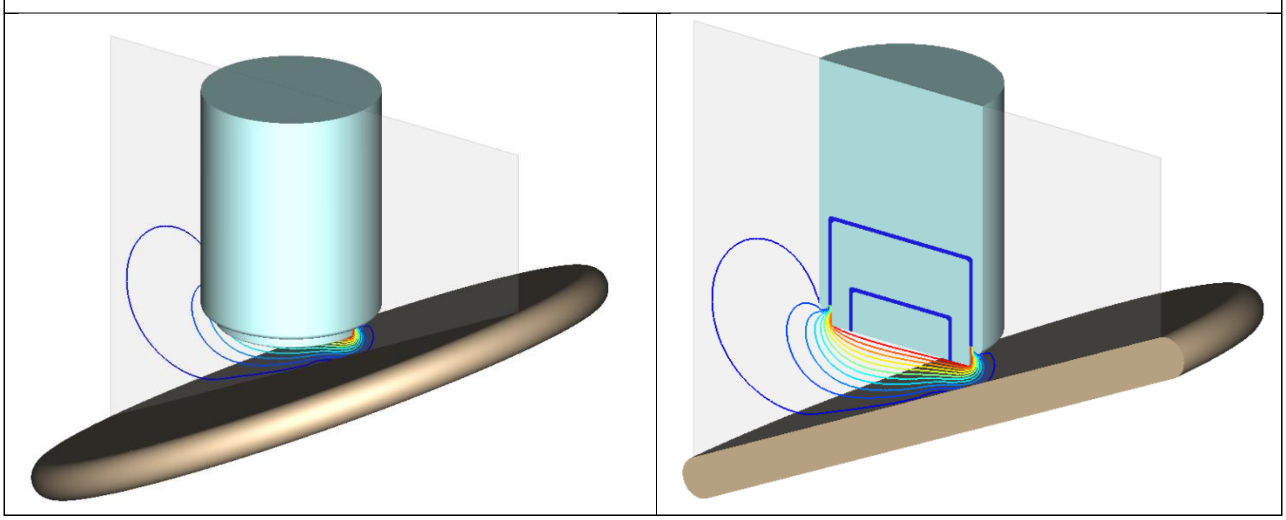
The advent of parallel processing to utilize multi-core processors, combined with 64-bit operating systems and ever more affordable RAM has dramatically increased the speed of PC based CAE simulation software. Even so, most sensor design projects typically entail the solution of a large number of models – often 3D models – which provides incentive to reduce solution times where possible. Simulation software allows professionals and companies to design and test product ideas and therefore solve potential problems before manufacturing begins.

The designer in many cases has the choice of modeling the device in three dimension or two dimensions. Of course, the real world is always 3D so ideally all problems would be solved in this way. Most designers will usually work in 2D whenever possible due to the far greater ease of inputing data and the radically faster solution times. To optimize a design thousands of solutions are often required. This is normally only practical for 2D models as the full equivalent 3D models often take hundreds of times longer to solve. For combined-physics problems, such as combined magnetic and thermal, the magnetic field may be solved in 2D but the thermal may require a full 3D solution.

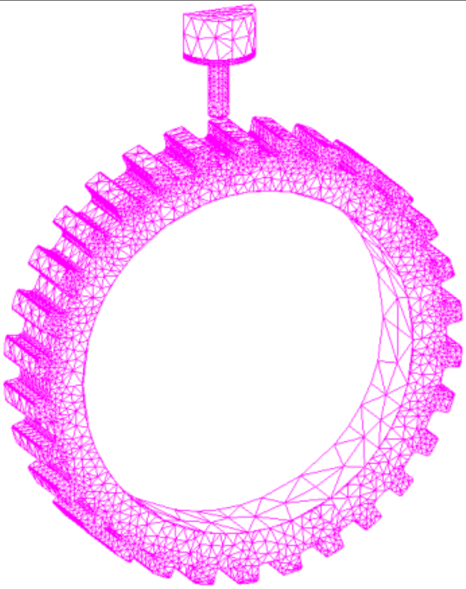
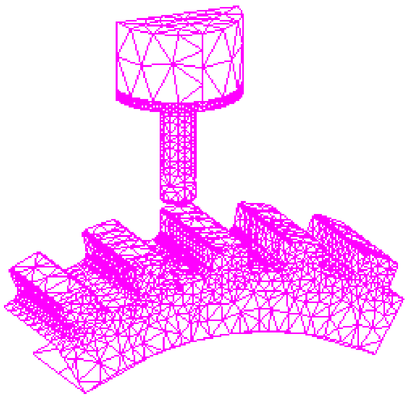
In this article we will show three time saving tips which will significantly reduce solution time.

Reducing Model Size using Symmetry

Below left we show a capacitive sensor above a tilted disk target. At right we show the resulting model that has been reduced by half using a symmetry condition. Note that we have not sacrificed any accuracy by this method, but the solution time will be greatly reduced.

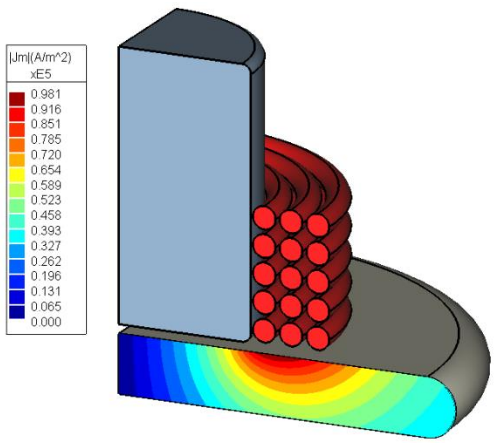


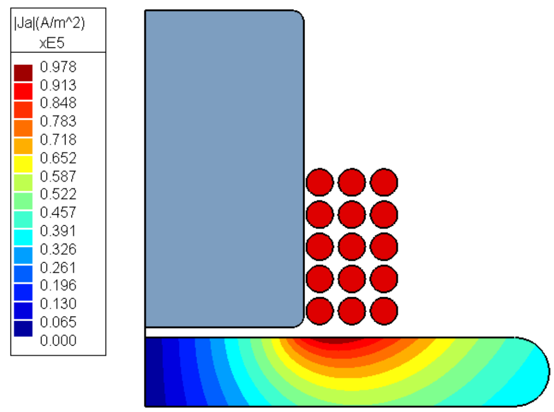
Simplifying Models by Eliminating Secondary Features

The picture at right shows a permanent magnet sensor above a gear. Note that a symmetry plane condition has been used so only half of the gear and sensor have been modeled. Because the flux density is greater for the parts of the gear close to the sensor we can reduce the model by omitting sections of the gear that are far from the sensor.	
The next picture shows a reduced model where only one sixth of the gear is simulated. This model solves considerably faster, but still produces results which are within 5% of the full gear model.	

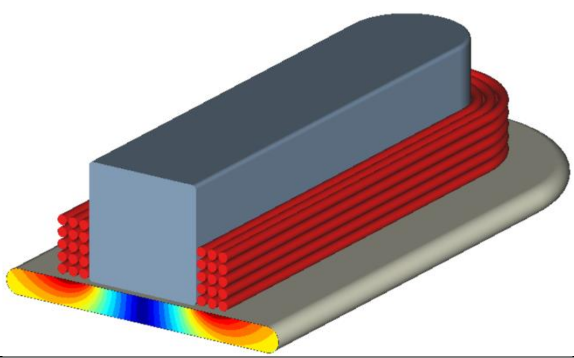
Approximating 3D feature as RS or 2D

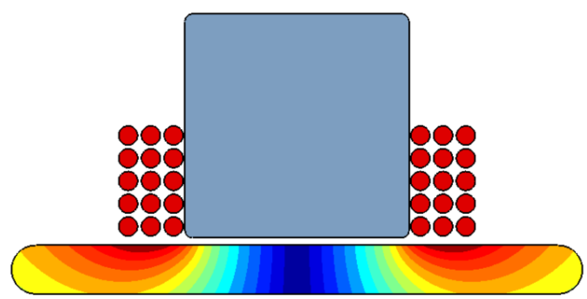
Below left we show a quarter model of a **3D** eddy current sensor. Though the exciting coil is actually helical, a **Rotational Symmetric (RS)** approximation will produce excellent results. The picture at right shows the equivalent **RS** model.





For models which are long in one dimension a **2D** approximation would be more appropriate. The **3D** and **2D** equivalent models for this situation are shown below.





The coil examples we have shown have relatively few turns, and could be modeled directly in **3D** software, though simulation times would become significant if multiple solutions for different gaps were required (as would usually be the case). Typical sensors may have windings consisting of hundreds of turns, which would at best lead to extremely long solution times, or at worst might even exceed available computer capacity.