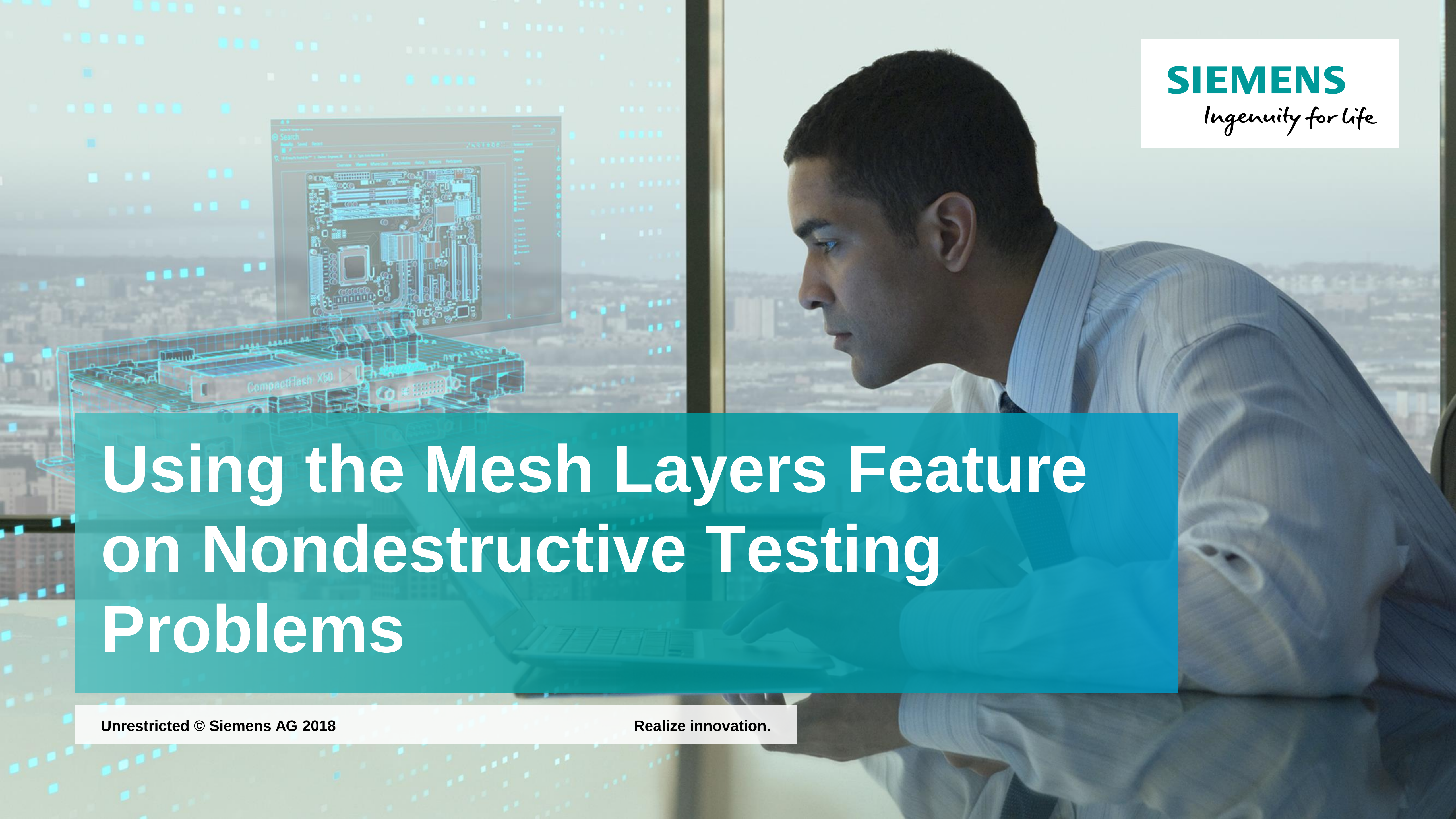

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Using the Mesh Layers Feature on Nondestructive Testing Problems

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Using the Mesh Layers feature on Nondestructive Testing Problems

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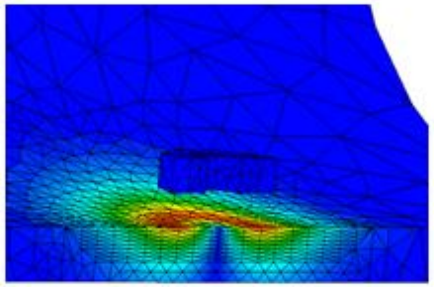
Infolytica's products have been used to generate reliable nondestructive evaluation (NDE/NDT) results for years. Our *Mesh Layers* feature makes these tasks easier to set up and faster to solve.



Often, an NDT problem involves the excitation of the material under test using one or more coils, and the detection of a change in impedance of these coils in the presence of a defect in the workpiece (the exciter and detector need not necessarily be the same).

There is a need to model the magnetic fields and eddy currents accurately in the regions under inspection. The fields decay rather quickly to zero in the surrounding regions. Further, the fields tend to change very quickly (exponential decay) with increasing depth into the test specimen (skin depth effects), and not nearly as rapidly in the two perpendicular directions.

The Mesh Layers feature allows the construction of a mesh that is optimized for these types of problems. This feature allows for anisotropic elements, which produce the best modeling of the fields, prevents "bleeding" of mesh refinement into areas where it is not required, and involves much less setup work than competitive techniques.

Mesh Refinement using Standard Contro

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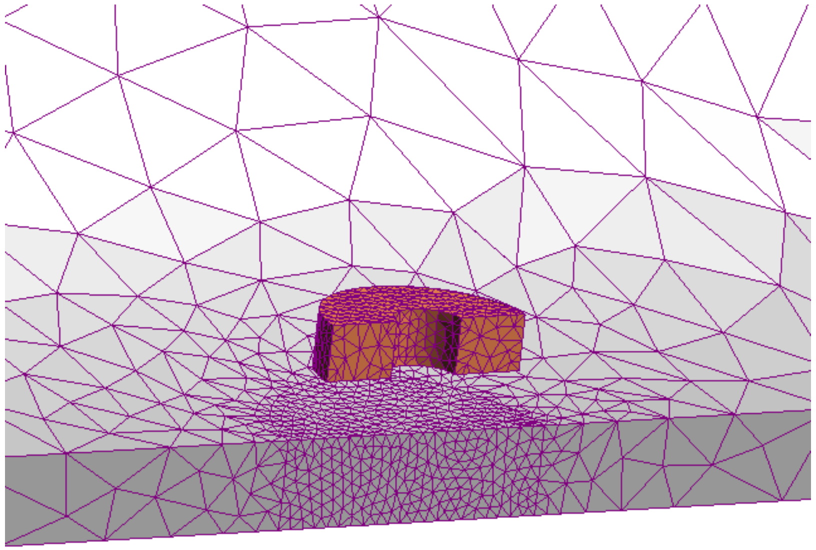
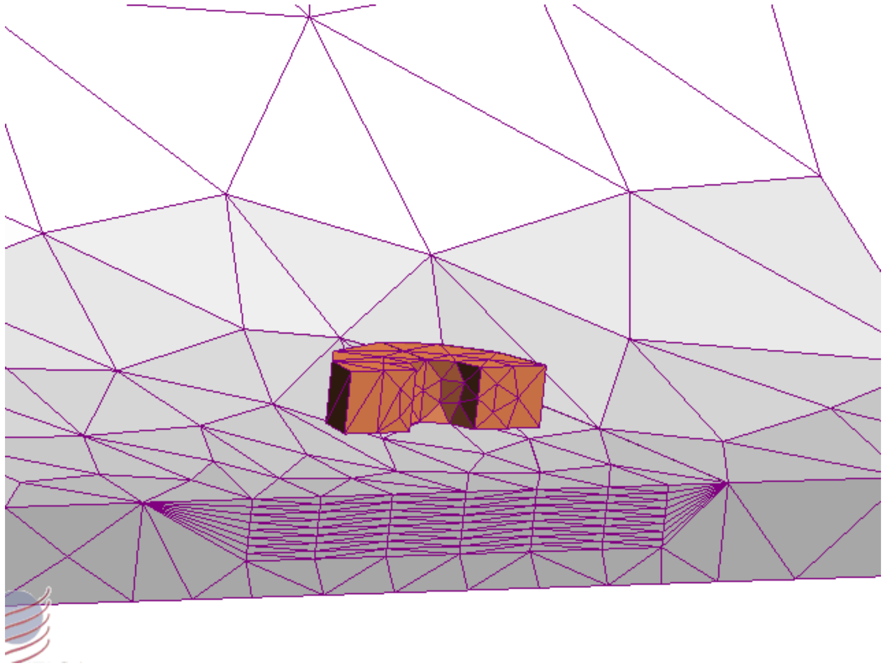
Starting from the WFNDEC Eddy Current Benchmark Problem 2, the region directly below the coil was remeshed with the Mesh Layers feature. All other mesh refinements were removed. The resulting mesh had only 42,274 tetrahedra, compared with the 243,068 tetrahedra generated by the previous mesh refinement techniques (nearly 6X smaller). The image to the left shows the initial attempt at mesh refinement using the standard controls that Infolytica provides. Note the refinement in the coil and the "bleeding" of the refinement into the tube region.



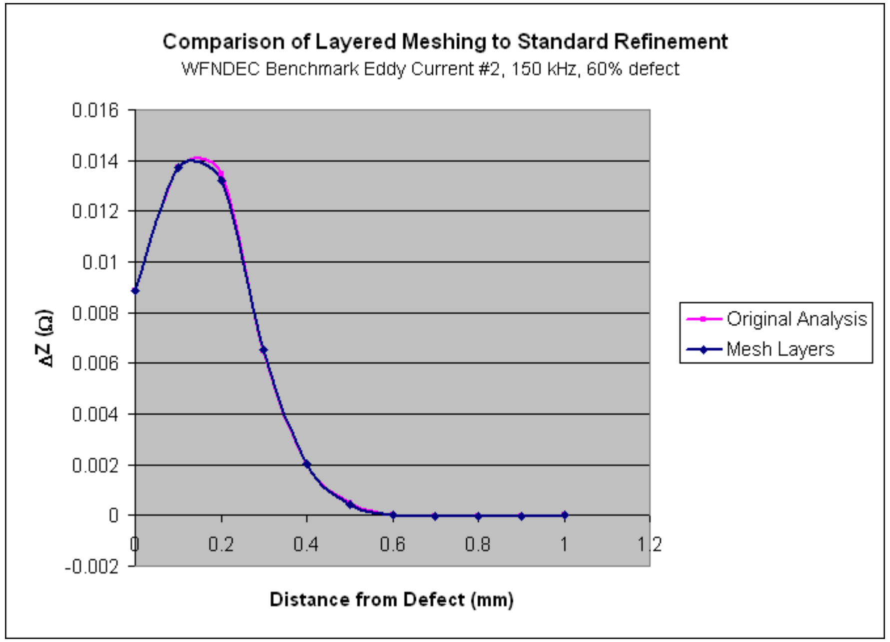
Refining the Mesh in the Region of Interest

As shown here, the layered meshing concentrates many elements along the depth of the tube (in the direction where the fields change fastest). It is also clear that this refinement has not "spread" into the surrounding air and tube regions as it did in the previous image showing the initial mesh used. The mesh is only refined in the region of interest (the section of pipe located directly under the coil). Third-order elements must be used to obtain accurate eddy current modeling.



Comparison of Layered Meshing to Standard Refinement

The reduced mesh complexity produced a 7X speed-up in solution time. After solving the problem, it was important to verify that the same accuracy of solution was obtained. The graph shows that this solution is comparable in accuracy to the original, which took 7X longer and 3X more peak memory.



Solution Improvement Factor

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The Mesh Layers feature allows the creation of a much smaller mesh, which is ideally suited to problems of this type. The problem is easier to set up (only one parameter is changed to refine the mesh as shown). The result is a faster solution time, less memory requirements, a smaller file size, all without any loss of solution accuracy.

Comparison	Layered	Conventional	Improvement
# of user parameters set	1	7	**7X smaller**
Average # of tets (scalar)	33,254	192,920	**6X smaller**
Average # of tets (vector)	9,020	501,148	**5.5X smaller**
Average # of non-zeros	345,259	4,622,031	**13X smaller**
Solution Time	0:37:57	4:09:49	**7X faster**
Average Memory Required (MB)	22.3	72.2	**3.2X smaller**

VELOCITY AND ACCELERATION OF THE ROTOR

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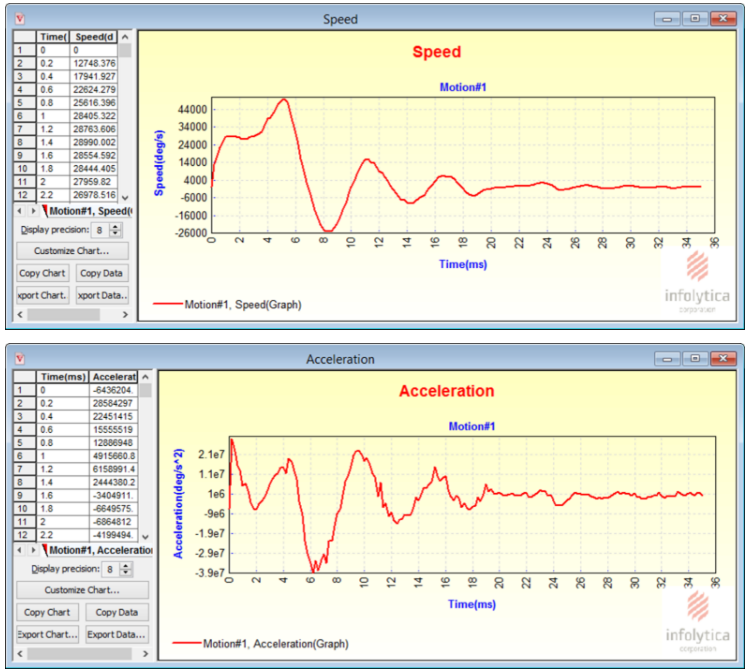

Other quantities of interest to the user are the velocity of the rotor and its acceleration as a function of time which is readily available once the solution is complete.

MAGNITUDE OF THE FLUX DENSITY

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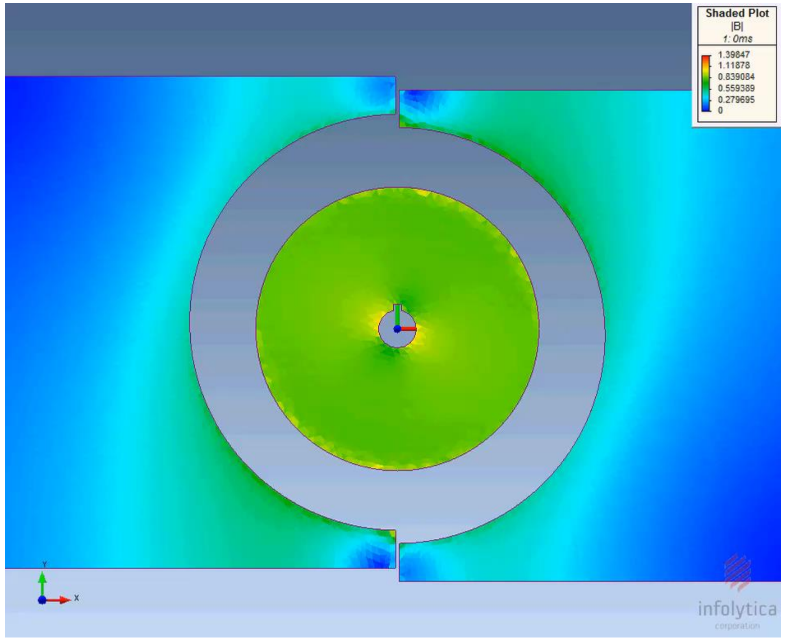

All field quantities can be animated and displayed in Simcenter MAGNET or exported to other video players. The illustration shown here is created from the magnitude of the flux density in a view that is zoomed into the rotor area.

When playing this animation, one can see the field changing as a function of time for different rotor positions. The notch in the shaft can be used to track how the rotor is changing position.

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MAGNETIC TORQUE IN THE STEPPER MOTOR

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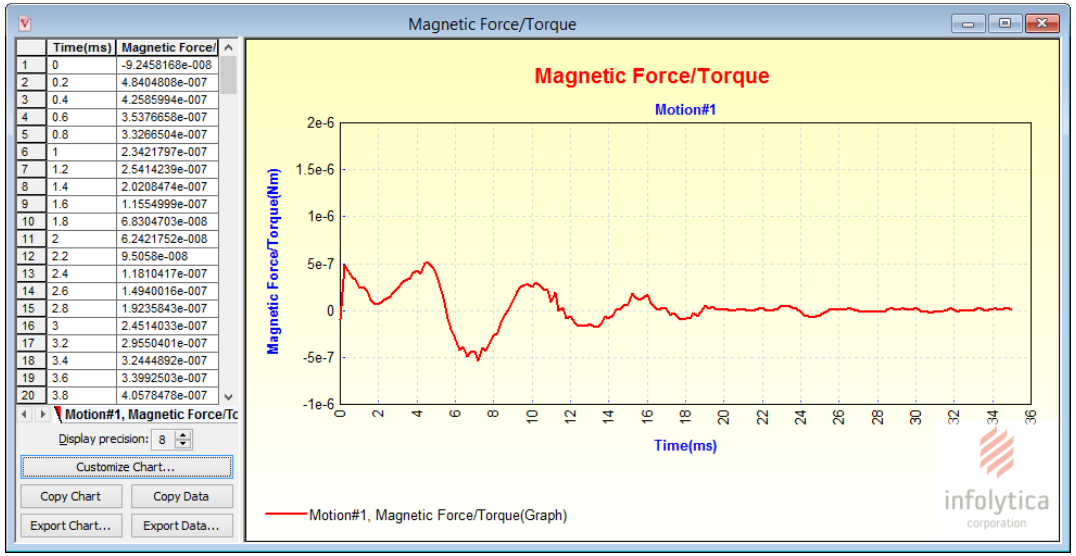

The graph of the magnetic torque vs time shows both the forward and backward torque that the rotor experiences for one pulse before it settles down in the new position. Initially, the magnetic torque is caused when the pulse is switched on. After the pulse is complete, there is a magnetic torque due to the permanent magnetism of the rotor trying to align itself with the stator pole faces. The oscillations seen in the graph are due to the overshoots, but there is a damping in the oscillations due to the bearing friction that is modeled in this simulation.