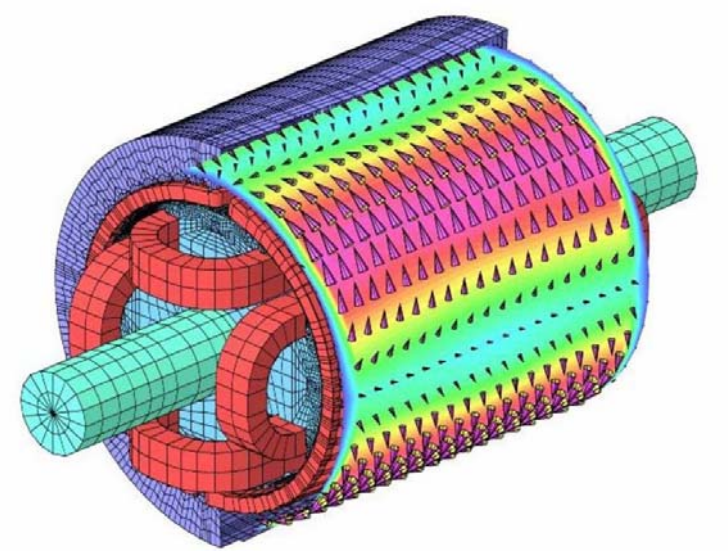
HIMARC Simulations

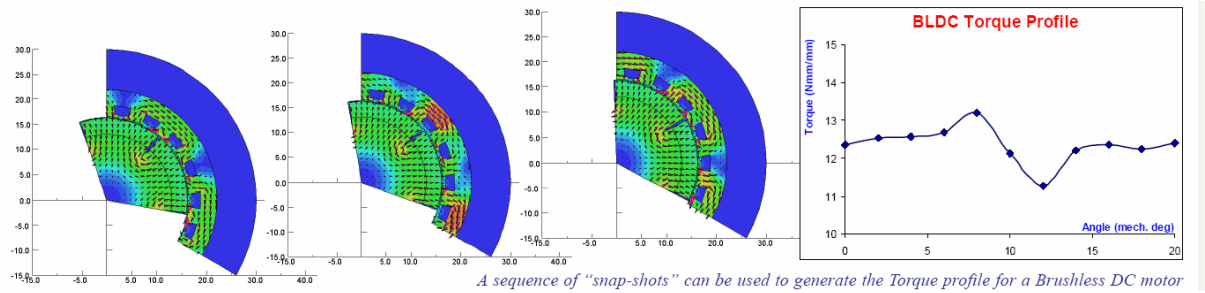
Engineering Solutions for Professionals

Provide Computer Analysis, Concept, Design, Prototyping

ELECTRIC MOTORS & GENERATORS

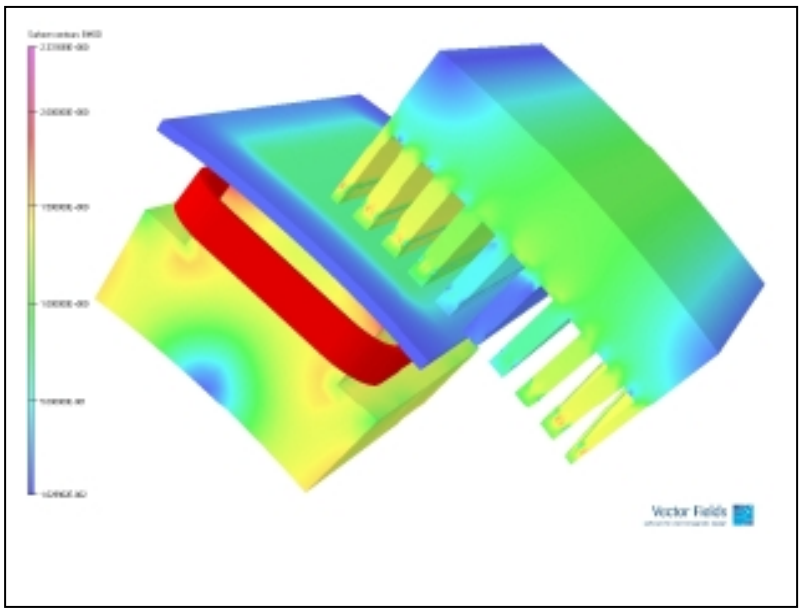


Modeling the operation of a rotating electrical machine (motors and generators) involves motion and, generally the designer is interested in the production of motion by the interaction of an electromagnetic fields (motoring) or the production of electricity by applying motion to an electromagnetic field (generating).

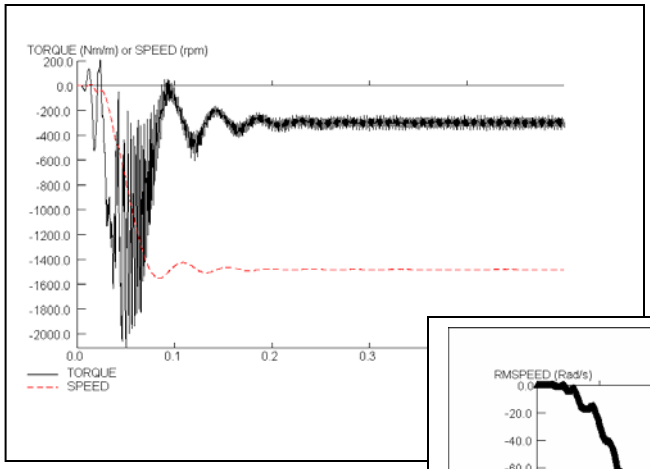


A sequence of "snap-shots" can be used to generate the Torque profile for a Brushless DC motor

Speed and Torque (including cogging torque) Profiles

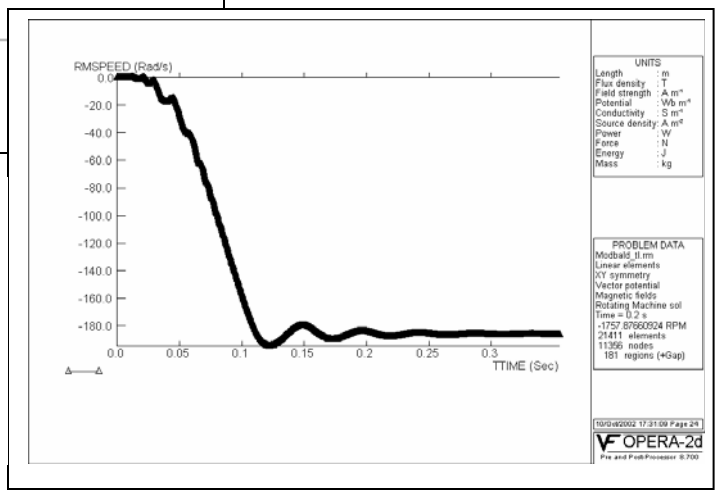


Simulating just a single pole pitch of rotationally symmetric components is helping the development a superconducting hydroelectric generator.



A mechanical load is connected to the machine

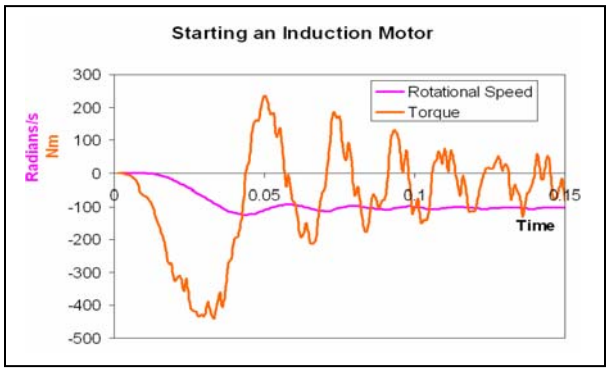
Great torque pulsations during the acceleration period



At 60 Hz, the speed builds up to a final value of approximately 1737 rev/min (synch. Speed is 1800 rev/min)

Dynamic simulation, including the effects of motion

Dynamic modeling is required to compute, for example, commutation effects, transient and unbalanced local effects in all types of machines.



The initial transients created when starting a motor can also be modeled.
Options to include mechanical load and/or use variable speed operation can be included
With voltage driven windings, the external driving circuit can also be taken into account

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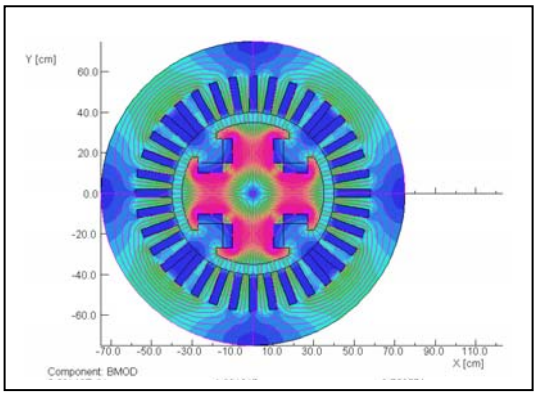
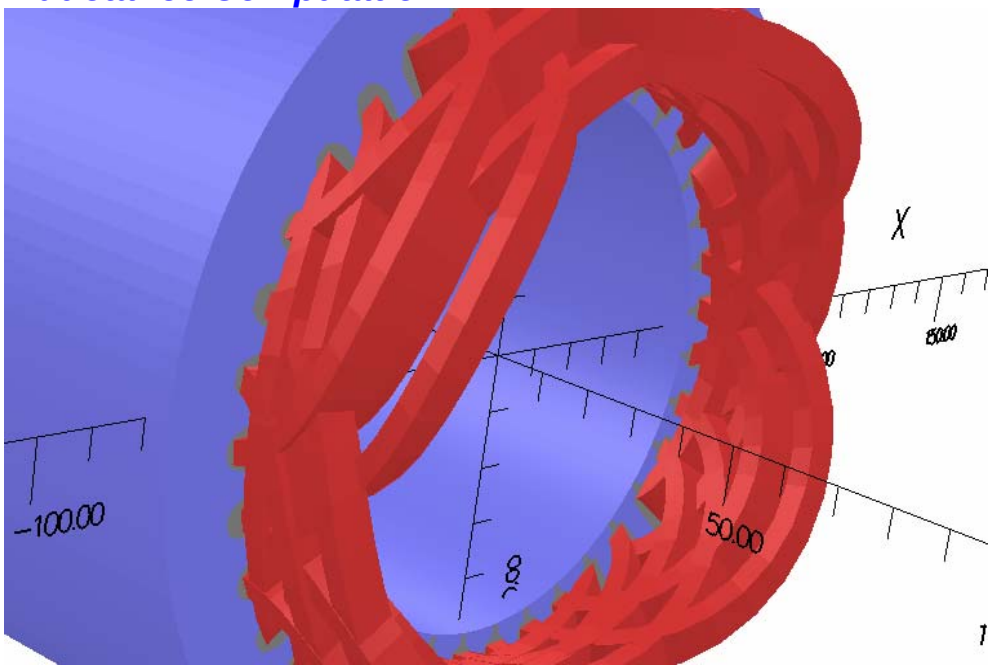


Open circuit simulation

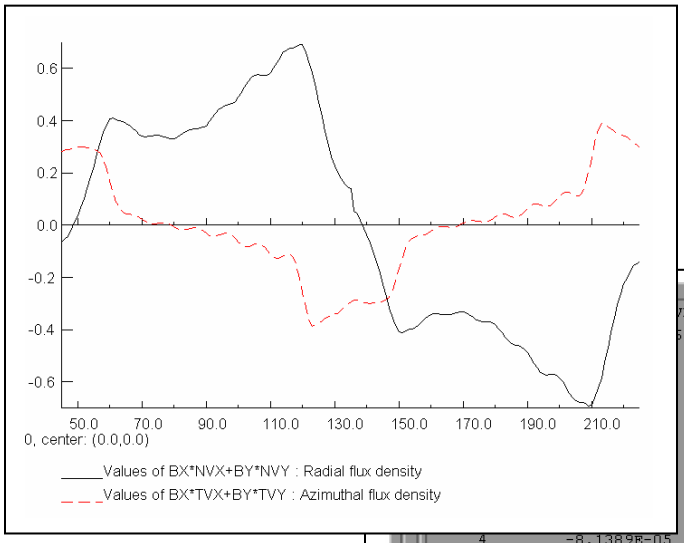
Inductance Computation

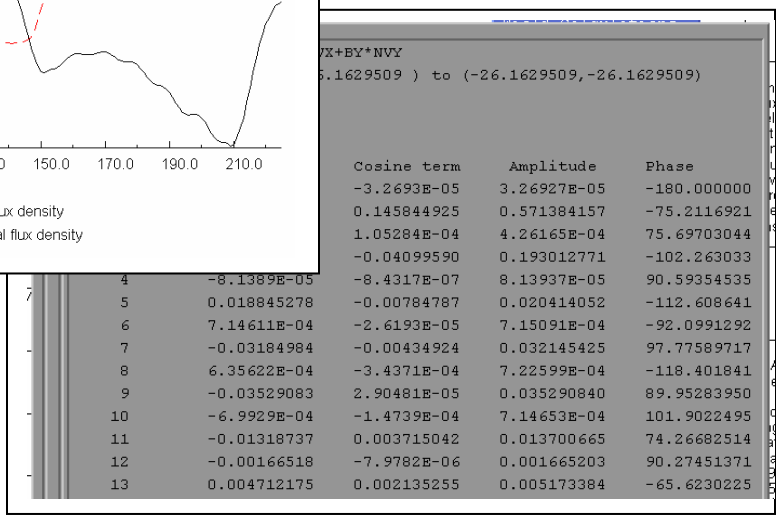


Stator winding proper definition

Harmonics Analysis

Harmonics Analysis is particularly useful for synchronous machines





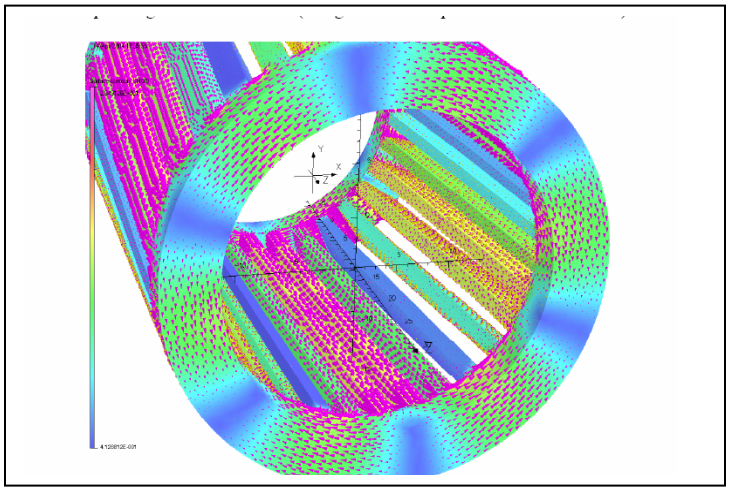
VX+BY*NVY
5.1629509) to (-26.1629509,-26.1629509)

		Cosine term	Amplitude	Phase
		-3.2693E-05	3.26927E-05	-180.000000
		0.145844925	0.571384157	-75.2116921
		1.05284E-04	4.26165E-04	75.69703044
		-0.04099590	0.193012771	-102.263033
4	-8.1389E-05	-8.4317E-07	8.13937E-05	90.59354535
5	0.018845278	-0.00784787	0.020414052	-112.608641
6	7.14611E-04	-2.6193E-05	7.15091E-04	-92.0991292
7	-0.03184984	-0.00434924	0.032145425	97.77589717
8	6.35622E-04	-3.4371E-04	7.22599E-04	-118.401841
9	-0.03529083	2.90481E-05	0.035290840	89.95283950
10	-6.9929E-04	-1.4739E-04	7.14653E-04	101.9022495
11	-0.01318737	0.003715042	0.013700665	74.26682514
12	-0.00166518	-7.9782E-06	0.001665203	90.27451371
13	0.004712175	0.002135255	0.005173384	-65.6230225

AC and Transient Analyses (Induced Currents)

When the coil is driven by a time varying current, eddy currents will be induced in the conducting parts of the motor assembly. This can have the effect of causing an additional variation on coil impedance with respect to displacement. This is due to the reaction field from the eddy currents.

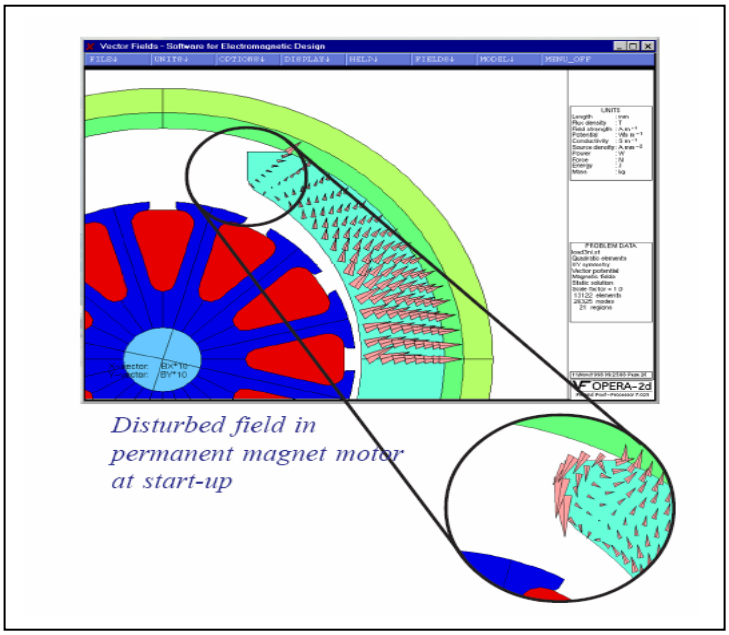
Eddy current losses in all materials including permanent magnets, fault conditions in synchronous machines, and dynamic behavior of induction motors can all be modeled successfully.



Rotor cage currents

Demagnetization

The ability to model the magnetization process of permanent magnets, the resultant remanent magnetization distribution in the permanent magnets when they are subsequently included within the application model and any in service degradation of their performance in operation is becoming increasingly important.

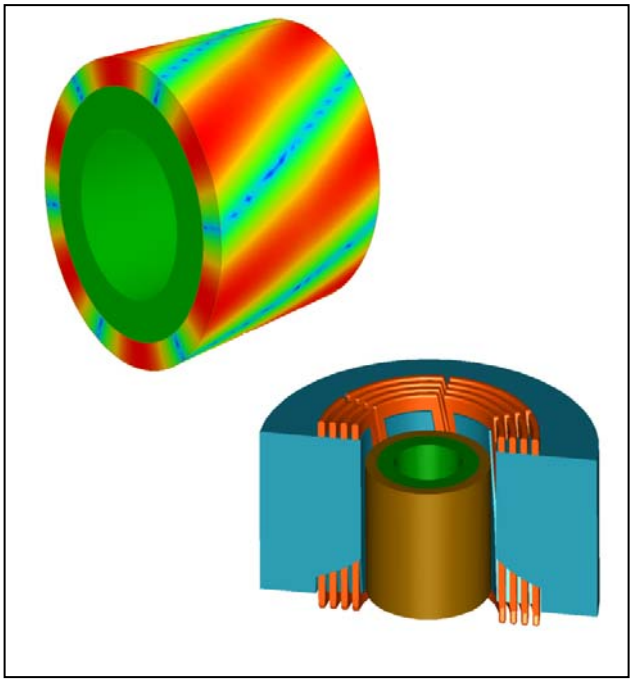


Disturbed field in permanent magnet motor at start-up

The effect of demagnetization of a permanent magnet motor, especially during the startup phase, can be modeled by including the 3rd quadrant of the material BH curve.

Hysteresis losses can be approximated using complex permeability.

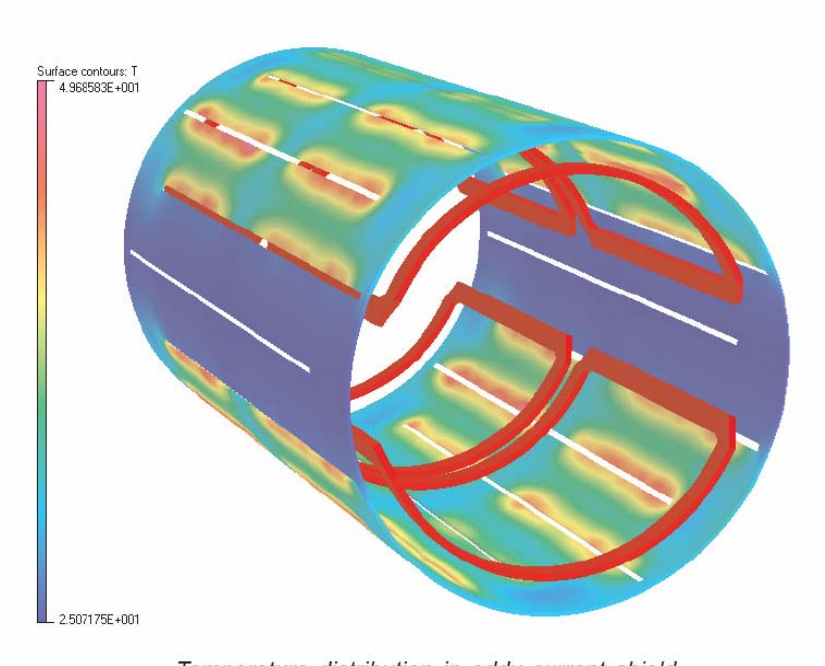
Simulation showing the magnitude of the radial component of magnetization on a 6-pole permanent magnet



Cut-away view of a magnetizing fixture designed to produce a 6-pole permanent magnet, with skewed magnetization to reduce cogging torque.

Thermal Analysis (Temperature Rise)

The input current and the eddy current densities induced in the motor assembly will cause the operating temperature to rise. This can be analyzed using the coupled thermal analysis where coils and the eddy currents are the heat sources.
Performing this coupled analysis leads to a prediction of the temperature distribution, ensuring the operating requirements are not exceeded.

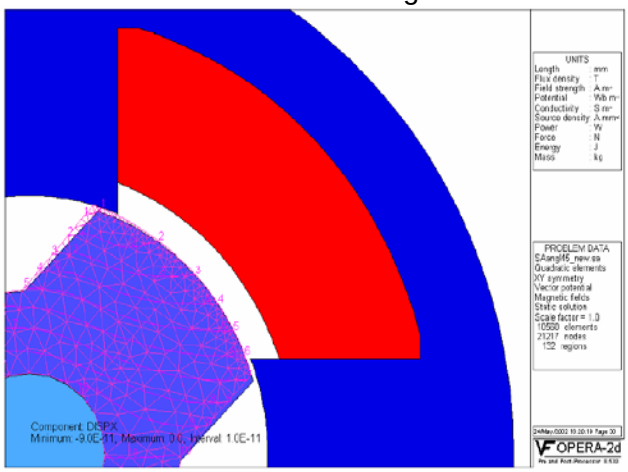


Temperature distribution in eddy current shield

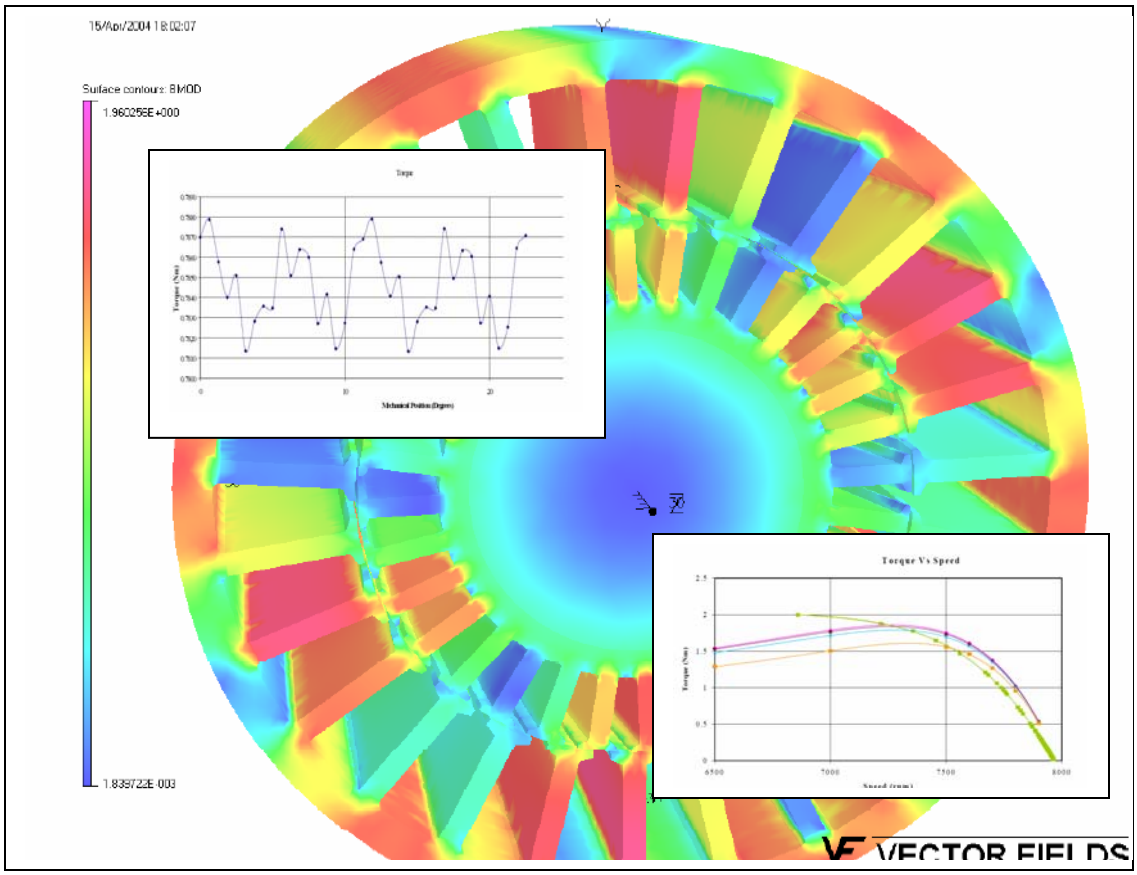
We can compute the three dimensional temperature, heat flux and thermal-gradient fields due to electromagnetic heating or external heat sources, using advanced numerical methods for accuracy and speed of computation. The temperature rise due to the heat generated by iron losses, winding and eddy currents can be computed

Coupled structural Analysis

Deformations, stresses and strains due to electromagnetic forces can be computed.



Deformation in rotor, shown as a displaced mesh



HIMARC Simulations
8117 W. Manchester Ave., Suite 504
Los Angeles, CA 90293
310.657-7992
443-583-0340 FAX
jmgery@aol.com