Oofelie::ElectroTechnics

Oofelie Multiphysics 2010

Oofelie::ElectroTechnics driven by SAMCEF Field, provides engineers and analysts with unique capabilities to analyze electrotechnic systems, such as induction heating, magnetic shielding, multi-phase inductors. With OOFELIE ElectroTechnics, driven by SAMCEF Field, you are getting at the core of the physics in one conveniently integrated simulation package.

Oofelie::ElectroTechnics is a Virtual Prototyping tool for the analysis and design of electrotechnic systems, taking into account Joule Heating effects and induced deformations. Through the use of its modeling capabilities, it becomes possible to start simulating the performance of such systems even before a single physical prototype is built. Design changes can be evaluated faster and in a more affordable manner, reducing the number of actual prototypes needed to achieve a required design maturity, thus accelerating significantly product development. Thanks to such a tool, the engineers acquire a capability to isolate and analyze the effect of each parameter. With such insight available at their fingertips, information can be quickly gained to correct or improve previous designs efficiently, knowing which are the influent factors.

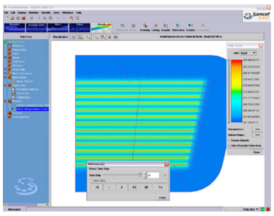
Reduced design time, improved quality and reduced costs are some of the benefits one can now obtain from using Oofelie::ElectroTechnics.

MODELING ENVIRONMENT

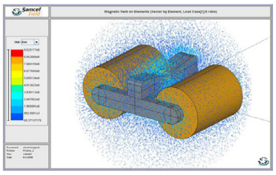
Oofelie::ElectroTechnics is driven by a user-friendly integrated graphical user interface, SAMCEF Field, for the modeling, the analysis and the post-processing of electrotechnic systems.

SAMCEF Field, a complete and interactive user environment providing all the tools necessary to design, simulate and analyze a range of configurations, has been tailored to approach efficiently the field of electrotechnics Its visual and hierarchically arranged layout will guide you through all the steps of model preparation, resolution procedure and analysis.

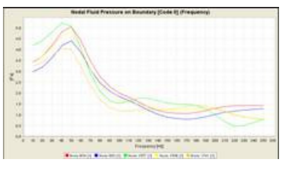
A CAD **modeler**, as well as **import capabilities** from other leading CAD providers, is integrated for modeling and **data preparation**. As data are directly defined on the geometry, users can easily switch system components modeling level from idealized rigid representation to full Finite Element description.



Parameterized data entry is easily done using contextual pull-down menus and pop up boxes using a wide selection of preprogrammed functions for the definition of time and frequency varying properties and boundary conditions.



As soon as the analysis is completed, the results are easily accessible from a simple click in the navigator. Results may be displayed in different forms over the whole model or through user's defined cross-sections to study detailed behavior. In addition to all the state-of-the-art **standard graphic outputs (i.e. X-Y plots, isovalues, animations, etc.),** results may also be inserted in tabular forms in the analysis report. SAMCEF Field is common to all the solutions provided by Open Engineering, allowing other analyses to be performed on the same model as for electrotechnic simulations.



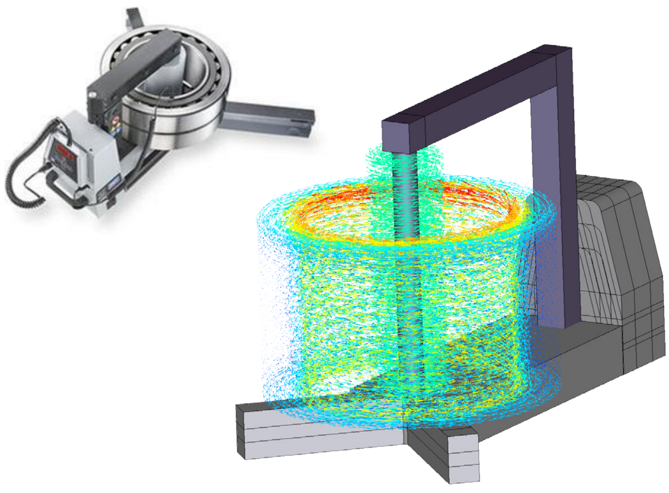
PLATFORMS

OOFELIE::ElectroTechnics, driven by SAMCEF Field, is available on Windows and Linux platforms.

ANALYSES

Oofelie::ElectroTechnics allows specific static, harmonic and transient analyses for systems in which conductive currents and their effects have to be taken into account. Concerning the electromagnetic aspects, two class of applications can be envisaged:

• **Magnetostatic** applications are problems in which magnetic fields are constant in time. These kinds of fields can be generated either by constant currents or by permanent magnets. In such problems, the magnetic field is then influenced by the electric field but the electrical field is not influenced by the magnetic field.



Bearings induction heater

• **Magneto-dynamic** applications are problems in which magnetic fields are variable in time. These kinds of fields are usually generated by variable currents. In such problems, the magnetic field is influenced by the electric field (it's often its source) and the electric field by the magnetic field. For example, in a conductor carrying an alternative current, this current tends to concentrate at the periphery of the conductor as the frequency increases; this phenomenon, associated with magnetism, is called **"skin effect"**. Also, the computation of **electromotive force** or **eddy currents** inside a conductor located in a variable magnetic field is also possible. The methods implemented in Oofelie for the resolution of magneto-dynamic problems are based on the electro-technical approximation. This approximation consists in assuming that the dimensions of the modeled devices are negligible compared to the wavelength associated to the studied phenomena. For example, at 50Hz, the wavelength is 6.000 km, which is much larger than the dimensions of any usual device.

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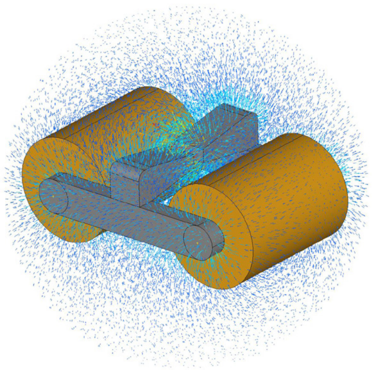
Couplings with the other physical fields are available in this product:

• The first source of coupling is the **Joule effect** induced by the heat power generated inside a conductor in which there is an electrical current flow. This effect is used in all induction heating systems. Here, the indirect thermo-mechanical coupling (mechanical expansion due to temperature change) is also taken into account.

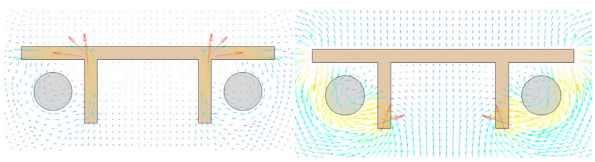
• The second source of coupling is the direct coupling with the mechanical field through the electromagnetic forces (including the **Laplace force**)

APPLICATIONS

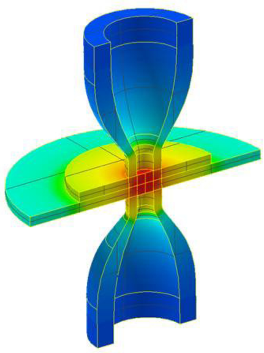
The general three-dimensional models offer generalized methods that can be used for many different applications in equipment design and optimization. Some applications are presented hereafter.



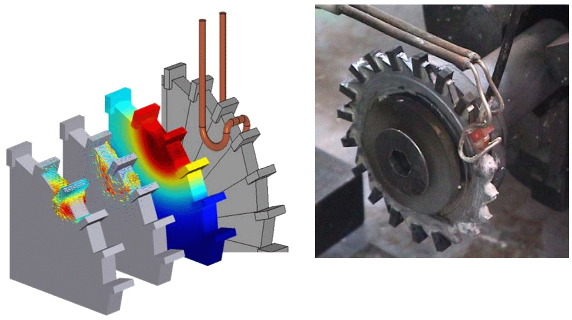
For **electromagnet DC**, made of a magnetic core and two winded coils, the magnetostatic solver is used to predict the resulting magnetic field at the air gap (the location where the magnetic field will be the highest).



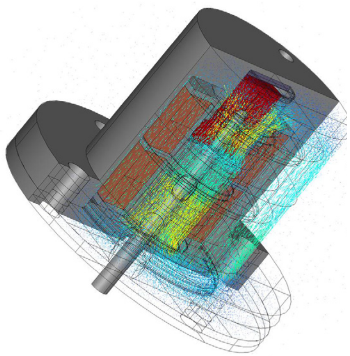
In **magnetic shielding** problems, one wants to reduce the intensity of the magnetic field in some regions. The non-linear magnetostatic solver permits to predict the positive impact of a ferromagnetic shield (here with a non-linear HB law) on the magnetic field generated by two conductor wires in which a current is flowing.



In the **spot welding** process, the transient response solver permits to predict the temperature and displacement fields in the system induced by the voltage applied between the two electrodes. Here, the higher temperature is achieved at the interface between the two plates at the end of the process.

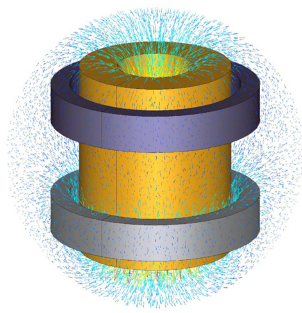


For the maintenance of a milling cutter, an **induction heating** system is often used to heat locally a tooth and its neighborhood. Here, the existence of an alternative current flowing in the wire generates a variable magnetic field and the resulting distribution of eddy currents is computed by the magnetodynamic solver. Then, the distribution of the temperature field is computed in the tooth's region by taking into account the Joule effect.



EM valve, courtesy of TECHSPACE AERO

In **electromagnetic valve** simulations, the total force on the mobile part is predicted using a non-linear magnetostatic solver since some parts are made of materials with non-linear HB law. Here, a parametric study was performed to retrieve automatically the «Force vs Displacement» curve.



In the upper example, an alternative current is imposed in the winded coil generating a variable magnetic field in the external medium. In this system, there are also two conductor rings. The first one (in light grey) is closed (shortcut) and some eddy currents are generated inside that pertubate the magnetic field vectors in its neighboorhood (have a look at the picture). The second one (in dark grey) is opened and we are then able to read an electrical voltage amplitude depending on the position of this ring in the system. It is the **displacement sensor principle**.

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