



FLUX®

ONE STEP AHEAD

Links to Main applications

Click on text and pictures

ROTATING MACHINES

LINEAR ACTUATORS

TRANSFORMERS

SENSORS

CABLES

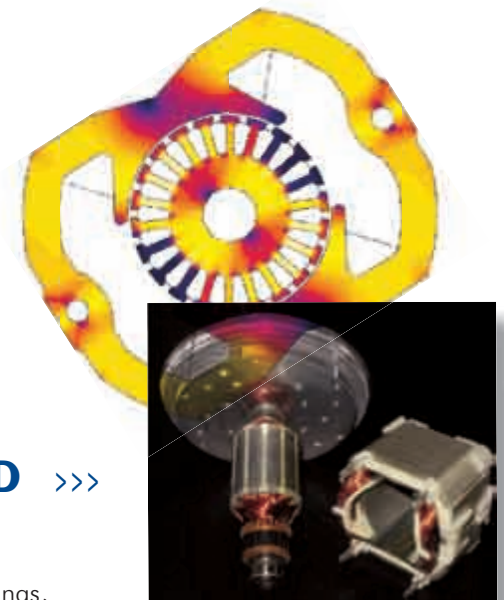
INDUCTION HEATING

EMC

Ship MAGNETISATION

☑ MAIN FEATURES >>>

- Multiparametric analysis,
- Extended import capabilities (STEP, IGES...),
- Mixed mesh generator,
- Co-simulation with MATLAB Simulink,
- Outstanding models for various types of cases.



☑ APPLICATIONS IN 2D AND 3D >>>

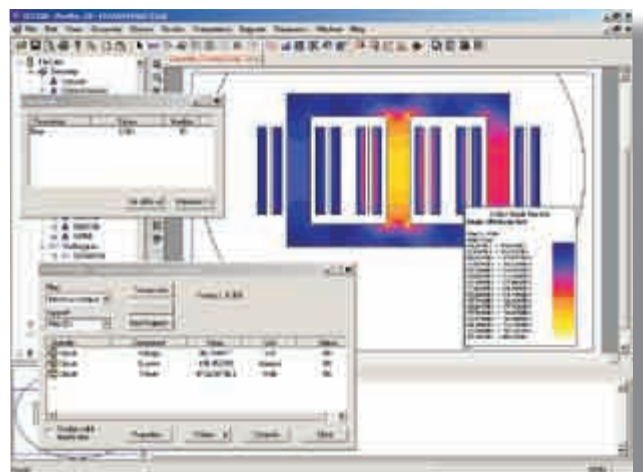
- Magnetic, electric and thermal fields,
- Static, harmonic and transient states,
- Magneto-thermal, Dielectro-thermal couplings,
- External circuit connection,
- Mechanical coupling: rotating and translating motion.

*Analysis of a Universal Motor:
Flux density distribution
(Courtesy of Hoover).*

☑ MODELLING EXAMPLES >>>

- **Rotating machines:** DC motors, synchronous machines, induction motors, stepper motors, coupling devices, brushless motors, switched reluctance motors, PM motors, generators.
- **Actuators:** linear motors, electromagnetic brakes, contactors, magnetic bearings, fuel injectors, electromagnetic launchers.
- **Sensors:** capacitive and inductive sensors, speed sensors, eddy currents non destructive testing, magnetoscopy, resolvers, electric meters.
- **Energy transfer and conversion:** transformers, power cables, overhead power lines, high voltage devices, insulators, connectors, fuses.
- **Industrial process:** induction heat ovens, thermal treatments, dielectric heating, magnetic sorting, magnetisers.
- **Field generators:** mass spectrometers, magnetic recording, polarisation fields, magnetisation devices.
- **EMC:** shielding, radiated fields, lightning rods.

*Transformer: Flux density in
the magnetic core under PWM
controlled supply.*



MODELS & PERFORMANCE

Adapted formulations, Kinematic coupling, Infinity region, DC & AC sources, Materials database, Various material property models.

Backed by over 25 years of experience in electromagnetic Finite Element software development, **FLUX** remains on the cutting edge of the electromagnetic modelling technology to ensure both performance and reliability to its users. A complete range of possibilities makes **FLUX** a powerful multi-purpose tool for 2D and 3D electromagnetic, electrothermal and electromechanical analysis.

☑ FORMULATIONS, MODELS AND TOOLS >>>

Adapted and automatic formulations for both 2D and 3D speed the design up and help to benefit from the best results possible. Depending on the application, 3D computations can use various formulations (vector or scalar potential, T-Omega, A-V, T-T0-Omega) to get the most accurate results in the shortest time.

FLUX allows the user to model peculiar non-meshed thin regions (surface eddy current regions, thin air gaps or laminated magnetic regions) modelling shielding, shell or surfacic effects.

FLUX features a kinematic coupling to the electromagnetic computation enabling the design of any rotating and translating electromagnetic actuator (motor, switch, electromagnetic launcher, circuit breaker...). **FLUX** then accounts for inertia, mass, friction and loads when computing the electromechanical state of the device. As well as the electromagnetic behaviour, the position, force, torque and speed characteristics are computed.

Infinity region (for open boundary problems with a reduced domain and computation of far field) as well as various types of boundary conditions (normal or tangent field, periodic, floating...) are available to increase the modelling capabilities of **FLUX**.

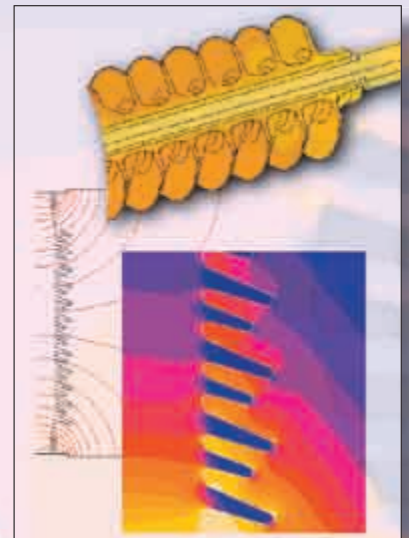
To extend **FLUX** models, more materials, physical properties, sources, boundary conditions or solving and postprocessing models can be defined with user subroutines and can depend on time, location and results.

☑ MATERIALS AND SOURCES >>>

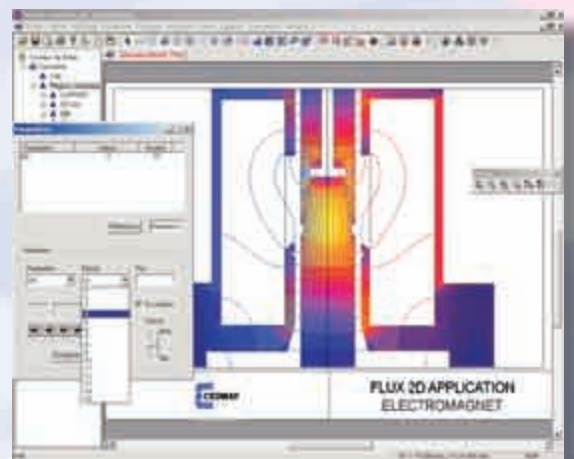
The materials and their characteristics are stored in a database that can be shared among users. Those characteristics include, among others, magnetic permeability, electric permittivity, specific heat, convective and radiative exchange coefficients and can be defined with several models (analytical, via tables, user defined). An already defined material database is available with **FLUX**. Linearity and non linearity may be defined for isotropic and anisotropic materials.

DC, AC or any time dependant source can be defined to describe charges, current or voltage supply, power, potential drops...

A library of ready to use and parameterise stranded coil shapes, that do not need to be meshed for its use, is available in 3D.



Insulator : Potential lines and electric field distribution.



Electromagnet computed using the kinematic coupling.

PREPROCESSING

CAD Interface, Dimensional and mesh parameters, Various mesh generator, Electrical circuit coupling, Objects import.

Via a full Windows interface, **FLUX** preprocessor is a powerful and interactive tool enabling an efficient and fast data entry.

☑ High performance modelling capabilities >>>

- Multi coordinates systems (global, local, cartesian, cylindrical, spherical),
- Automatic identification and building of faces and volumes,
- Import of already meshed and parameterised objects,
- Geometry and mesh duplication using geometrical transformation,
- Grouped selection of items by hierarchical relationship,
- Parameterisation of geometry and mesh,
- Control of input data: coherence of the parameterisation, line intersections...,
- CAD interface: IGES, STEP, DXF, and meshed geometries (IDEAS, PATRAN, NASTRAN, PRO-ENGINEER).

☑ Powerful mesh generators >>>

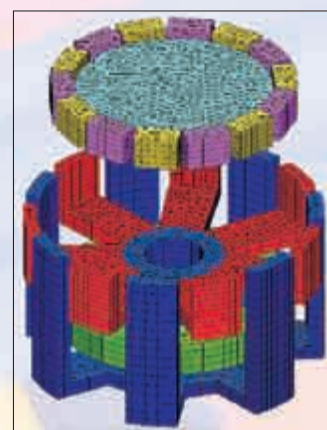
FLUX features advanced mesh generators enabling to generate and propagate an identical mesh on linked faces. These mesh generators, that can be coupled in the same case, include:

- Automatic mesh generator based on Delaunay algorithm: tetrahedral elements (or triangles in 2D),
- Layered mesh generator: brick elements (or rectangles in 2D),
- Extrusive mesh generator: prismatic and brick elements.

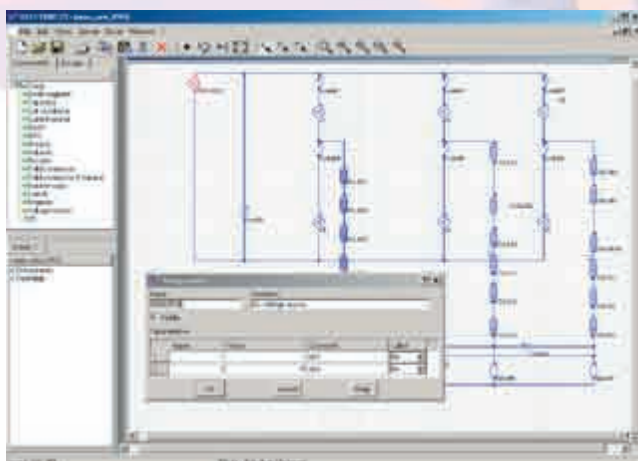
☑ Complex electrical circuits >>>

The supply, loads as well as connections between the conductors (stranded and solid) can be described in an external circuit, strongly coupled to the finite element model during the computation.

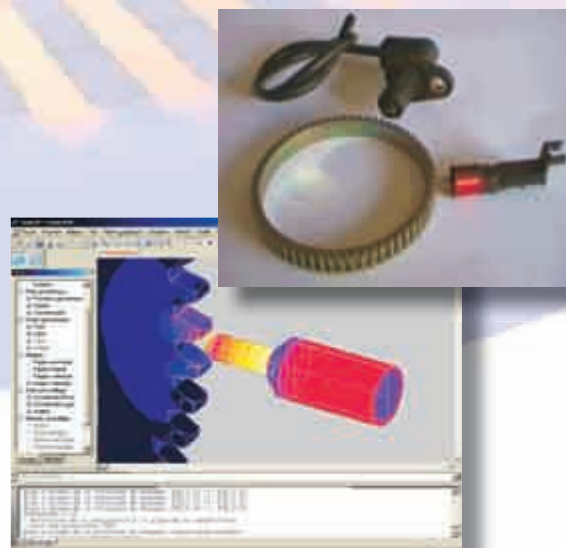
The electrical circuit can include passive components, sources (current and voltage), squirrel cage, brush-segment component, thyristors, diodes...



*ETA multipole generator:
3D mixed mesh
(Courtesy of ETA).*



Electrical circuit for the PWM control of a 2-phase filter reactor.



*ABS brake sensor - Device and flux density
(Courtesy of Snecma).*

PARAMETERS & SOLVING

Interactive parameter variation, Automatic remeshing,
Several variation methods, Sensitivity study, Tolerance influence.

Solving a case (both immediately and in batch mode-delayed solving-) is an easy game with **FLUX**. Complete and interactive features help the user to vary any parameter and solve new cases.

☑ Multiparametric Analysis >>>

Wide parametric studies can be completed both in 2D and 3D using the multiparametric capabilities of **FLUX**. By changing or varying the value of any parameter (with constant or varying intervals), the user can complete full sensitivity study as function of one or several parameters to fast and accurately optimise the device. Once the variation intervals have been set, no user interaction is needed to solve the case for every parameter set, to remesh the model...

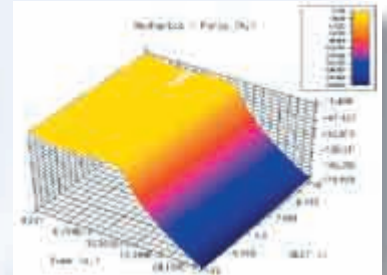
A virtually infinite number of parameter can be varied, among:

- Geometry: size and position,
- Mesh: size and density,
- Material properties: permeability, permittivity, remanent flux density, resistivity,
- Sources,
- Electrical circuit components,
- Boundary conditions,
- Frequency, slip (for induction machines),
- Time...

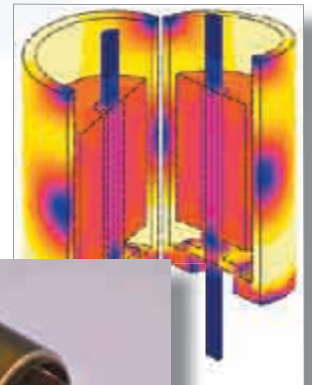
☑ Applications >>>

These multiparametric capabilities enable to complete various parameters influence studies such as:

- Optimisation of a slot opening,
- Temperature variation of a permanent magnet and its influence on the performances,
- Sensitivity versus the permeability of the lamination,
- Frequency dependency of an inductance,
- Induction machine characteristics versus slip,
- Inductance vs. position characteristic of a proximity sensor,
- Torque vs. position: cogging torque calculation.
- Force and inductance vs. position and current for an electromagnet.



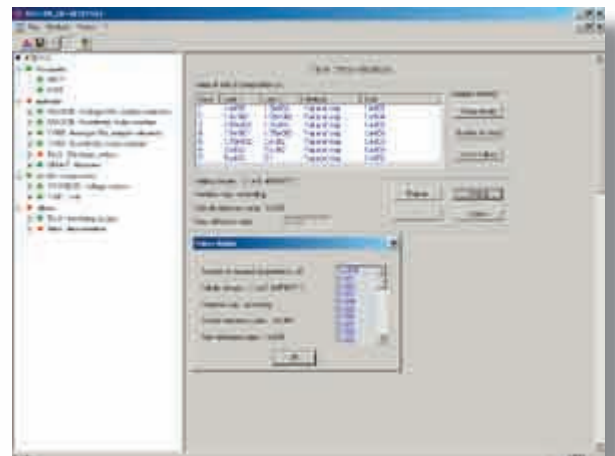
3D curve of the force as function of 2 parameters.



Modelling of a coil motor with FLUX:
Flux density distribution
(Courtesy of Fauhlaber).



Skin effects visualisation on a set of cables.



Parameters variations for a 2D case.

POSTPROCESSING

Extensive export capabilities, Colour shaded maps, AVI animations, MATLAB Simulink co-simulation.

FLUX offers a fully multiparametric postprocessor enabling to analyse the results from multiparametric solving.

✓ A wide RANGE of RESULTS >>>

FLUX gives access to various quantities such as:

- Potential, flux density, temperature, electric and magnetic fields,
- Iron losses,
- Electrical quantities on the components: current, voltage, power, inductance of a coil,
- Mechanical quantities: position, velocity, force, torque,
- Skin effect visualisation,
- User defined quantities.

✓ PRESENTED IN DIFFERENT FORMS >>>

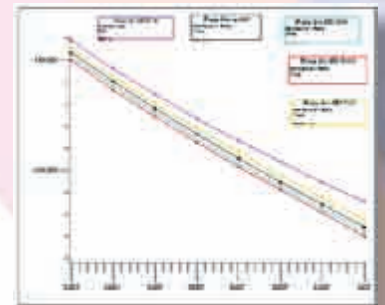
- Colour shaded maps and isovalues plots,
- Vector plots,
- 2D and 3D curves function of varying parameters, on a path, a grid...,
- Spectral analysis,
- Look up tables,
- Extensive export capabilities (Excel, Word, AMESim...),
- AVI animations,
- User defined postprocessing box.

✓ FLUX TO SIMULINK Technology >>>

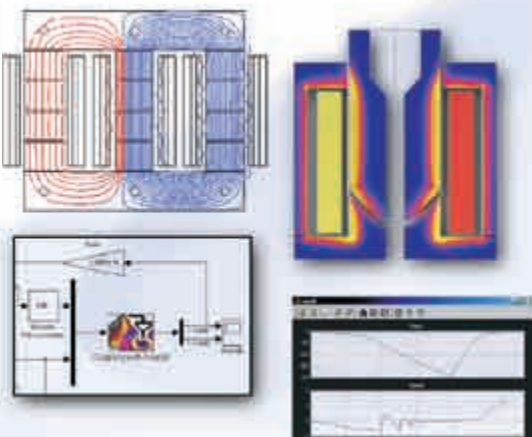
FLUX features co-simulation capabilities with MATLAB Simulink enabling to design at once the device and its drive and control part taking into account saturation, eddy currents, control loops...



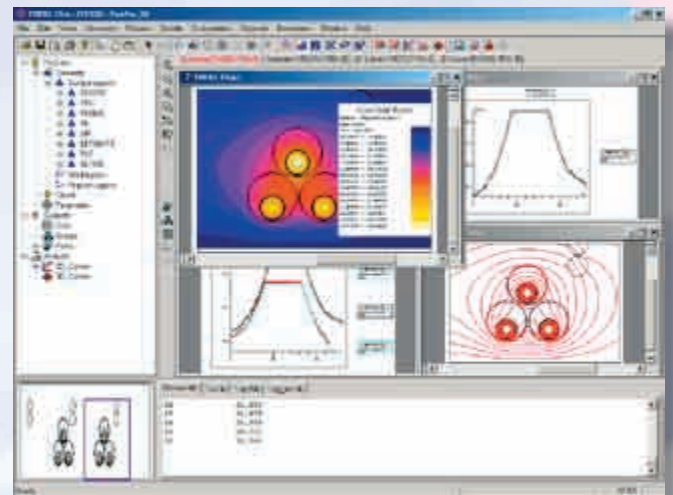
Power density in a loudspeaker driver (Courtesy of Celestion).



Variation of the force of an electromagnet as function of time for several geometric parameters.



Co-simulation capabilities with Matlab Simulink.



Thermal analysis of buried cables.

SUPPORT & REFERENCES

Links to Key features

Click on text and pictures

INTERACTIVE TOOL

POWERFUL & RELIABLE

EXTENDED & EXPERIENCED SUPPORT

MATLAB Simulink CO-SIMULATION

MULTIPARAMETRIC ANALYSIS

CAD INTERFACE

MIXED MESH GENERATOR

✓ USER SUPPORT AND TRAINING >>>

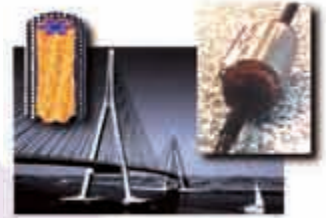
Long term experience in both software development and consulting work made CEDRAT and all its distribution network a valuable partner to support and train you when using **FLUX**. Its competencies in training and support regards:

- Use of the programs,
- Limits of the models's validity,
- Adapted methodology,
- Specific developments,
- Numerical methods.

FLUX is also accompanied with a complete and easy to use online help, both in French and English.



Part of a switchgear: geometry and flux density (Courtesy of Schneider Electric).



Strength sensor for bridges (Courtesy of Freyssinet).

✓ QUALITY ASSURANCE >>>

FLUX is controlled and developed under Quality Assurance procedures according to Electricité de France (French Historical Power Supplier) standard.

It ensures a constant and reliable checking of the capabilities and the results of the software.



Magnetothermal analysis of a crankshaft: power density (Courtesy of Prismeca).

✓ REFERENCES >>>

AUTOMOTIVE & TRANSPORT: Alstom, Borg Warner, Delphi, Federal Mogul, Globe motors, JCAE, Kone, Magneti Marelli, Michelin, Peugeot, Renault, Rockwell, Siemens, SNR, Suzuki, Valeo, Visteon.

AERONAUTICS & SPACE: Alcatel, Ametek, Angstrom sciences, CNES, Crouzet, DRS, EADS, Eaton, Esa Estec, Faulhaber, Goodrich, IEAV, ISRO, Kollmorgen, Rolls Royce, Snecma, Thales, TRW.

DEFENCE: Bath Iron Works, BEI Kimco, Curtiss Wright, DCN, DREA, General dynamics, Giat, ISL, Kockums AB, Lockheed Martin, MBDA, NUWC, US Army Benet Lab, WTD71.

ENERGY TRANSFERT & CONVERSION: ABB, Active Power, EDF, Framatome, GE, Hager, HydroQuebec, Hyundai, Iskra, Legrand, Leroy Somer, Nexans, Schneider Electric, Taiwan Power, Trafomec, Vatech.

FLUID POWER, GAS, PETROLEUM: Asco Joucomatic, Bechtel, Fluid Automation, Grundfos, ITT Flygt, Iwaki Pumps, Kvaerner, Parker, Robert Bosch, Schlumberger, Teco-Westinghouse, Total.

HOUSEHOLD APPLIANCES: AEG, A.O. Smith, Arcelik, Bosch und Siemens Hausgeräte, Brandt Cooking, Calor, Daewoo, Rowenta, Seb, Soler & Palau, Tecumseh, Tetra Pak, Zanussi.

INDUSTRIAL PROCESS: Celes, EFD Induction, Gauss Magneti, Inducto Heat, Picanol, RWE Piller, Saet, Saint Gobain, Sew Eurodrive, Sintef Energy, Termetal, Usinor, Walker magnetics, WEG.

INFORMATION SYSTEM & ELECTRONICS: Celestion, Densitron, ETA, Guzik, Hitachi, Iljin Electronics, ISA, KEF, LG Electronics, Maxtor, Northrop Grumman, Oce, PHS Mems, Ronda, Samsung, Seagate, Timex.

MATERIALS: Arelec, Carbone Lorraine, Dupont Nemours, Fermag, Fluxtrol, Imphy, Isliker Magnete, Kawasaki Steel, Ssangyong Materials, Taihan Electric Wire.

TESTING & MEASUREMENT: Actaris, Chauvin Arnoux, Contrinex, Hyab Magneter, Laboratoire National d'Essais, Laboratorio Elettrofisico, LEM, Omron, Sensorex.

RESEARCH INSTITUTES: CAT, CEA, CERN, CNRS, CRTBT, ESRF, Ikerlan, Indian Institute of Technology, KERI, LMN, Los Alamos Laboratories, Oak Ridge National Laboratory, Sandia National Laboratories, TNO.

UNIVERSITY LABS AND TEACHING INSTITUTES IN: Algeria, Australia, Belgium, Bosnia, Brazil, Bulgaria, Cameroon, Canada, China, Columbia, Finland, France, Germany, Greece, Hungary, India, Italy, Iran, Japan, Korea, Norway, Pakistan, Poland, Portugal, Romania, Russia, Singapore, Slovenia, South Africa, Spain, Sri Lanka, Sweden, Switzerland, Taiwan, Turkey, United Kingdom, USA, Venezuela.



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