Opera - Software for Electromagnetic Design
Cobham Technical Services
Vector Fields Software

The most important thing we build is trust
Opera

Accelerate and optimise your design with the Opera electromagnetic modelling toolsuite

Introduction

Opera is a world-leading software package for the modelling of static and time varying electromagnetic fields, and related multiphysics.

The software has been available commercially for over two decades, and embodies well over 100 man-years of development from electromagnetic experts. From the very outset, Opera has been engineered to provide extreme accuracy of simulation, and also efficient execution - allowing complex problems to be solved rapidly on a desktop PC.

Opera’s complete toolchain will not only accelerate your electromagnetic design — unique solvers provide maximum accuracy of results, providing you with a powerful virtual prototyping facility to achieve the optimal solution.

This brochure overviews Opera’s capability, and the various forms in which it can be supplied. We are happy to review applications, run benchmarks and provide free trials. Please contact us to discuss your requirements.

Opera is the ultimate electromagnetic design automation tool: it helps deliver design excellence on time, regardless of whether you are part of a large corporation or a small consultancy.
Overview

Opera provides the complete toolchain for electromagnetic with multiphysics design, simulation and analysis of results, for use on 32- or 64-bit platforms. It consists of a powerful 2D/3D modeller for creating design models (or importing from CAD), plus a choice of specialised finite element simulation tools:

- Static electromagnetic fields (the widely used ‘Tosca’ tool)
- Low-frequency time-varying electromagnetic fields
- High frequency time-varying electromagnetic fields
- Thermal and stress analysis (standalone or coupled)

Following simulation, a programmable interactive post-processor allows users to view and analyse the simulation, and perform additional calculations. Subsequent improvement of designs is easy. Model parameters may be changed at will to rapidly perform ‘what-if?’ investigations. Or, designs can be automatically improved with the aid of Opera’s Optimiser. This optional tool is uniquely powerful and fast, and will even optimise competing objectives simultaneously. Opera is available in 2D or 3D variants, for economy and speed of design.
**Powerful modelling capability**

Component or system models may be imported from a company’s existing CAD system, or created using Opera’s built-in modeller with its powerful ACIS geometry kernel.

Features include:

- Advanced model creation facilities in 2D and 3D
- CAD file import (many options)
- 2D sketching using the mouse (for ultra-fast model creation)
- Non-linear, anisotropic and multi-physics properties
- BH curve editor, plus library of materials
- External circuit environment including state machine definition
- Parameterised conductors in 3D for extreme accuracy
- Auto-generation of finite element mesh for simulation

**Model parameterisation**

A key advantage of Opera is the ability to change any dimension of a model to a parameter. This allows searching “What If?” investigations to be performed, to optimise a design simply by changing values. The Opera model file contains a complete history of the commands that created it. This allows users to modify files and ‘replay’ them — providing a template that can be used to automate the design variations of standard products.

**Problem-solver power**

Opera may be purchased in two or three dimensional (2D, 3D) versions. In either case the toolsuite will automatically generate the finite element mesh, with the option of adapting the mesh to achieve a specified solution accuracy in 2D and reporting the expected error in 3D. When your design model is finished, you are ready to simulate electromagnetic fields (and other physics depending on the problem). Opera offers a choice of ‘solvers’ to suit the spectrum of electromagnetic and multiphysics applications:

- **Static electromagnetic solver**
  
  Our careful formulation using a scalar potential algorithm gives precision combined with enormous speed of calculation and memory efficiency — boosting design productivity. The static solver is ideal for direct current (DC) applications, but is often helpful as a starting point for more complex designs too. **Typical applications:** permanent or electro magnet assemblies, MRI/NMR field calculations, magnetic signatures, initial design studies of rotating machinery...

- **Low-frequency, time-varying electromagnetic solver**
  
  Employs an advanced edge-variable finite element analysis technique for high accuracy combined with speed of calculation. This solver is ideal for problems where displacement current or radiation effects can typically be ignored. **Typical applications:** induced current effects, transformers, maglev, NDT, MRI gradient coils, remote sensing, induction heating, recording heads...

- **High frequency, time-varying electromagnetic solver**
  
  This finite element solver is ideal wherever precise calculation of high frequency electromagnetic fields is required, and is particularly suitable for eigenvalue calculations in cavities*. **Typical applications:** resonant cavities, filters, MRI RF coils...

- **Thermal and stress analysis**
  
  These two solvers can be used standalone or coupled with other Opera modules to study temperature related behaviour, and mechanical stress effects arising from thermal expansion. **Typical applications:** induction heating, MRI, electrical machines...

*Cobham Technical Services produces a dedicated package for RF and microwave electromagnetic design, concerto, with FDTD, FE or MoM solvers. The finite element solver used in Opera is optionally available, for design problems where extreme solution accuracy is needed.
Cobham will advise and help you choose the right solver, or combinations of solvers, for your application

Complete, application-specific, design solutions

Unique software providing ready-to-use solutions for specific problems:

- **Machines & actuators** powerful solution solving electromagnetic behaviour in combination with linear or rotational motion. Includes support for skewed shapes (even in 2D) and rapid simulation of a period in a symmetric design.

- **Superconducting ‘quench’** unique solution for superconducting magnets and coils (MRI, NMR) including coupled thermal behaviour to model quench, and coupling to eddy currents in support structures.

- **Space charge effects** our world-leading space charge solver takes into account the space charge effects of high current multispecies charged particle beams, including secondary emission/collision effects and charge build-up in low conductivity dielectric materials.

- **Permanent magnets** accurately simulates actual magnetisation/demagnetisation process including temperature effects, and allows magnet models to then be further simulated in operating environments.

- **Lossy dielectrics** static and time-varying solver add-ons for low conductivity dielectric materials such as those used for insulation in power transmission.

- **External circuits environment** allows graphical definition of circuits driving the magnetic model, with facilities for current or position sensing, as well as advanced state machines.

- **Magnetic hysteresis modelling** to predict the losses and field changes caused by material hysteresis.

Post-processing of results...

When simulation is complete, Opera includes a purpose-designed post-processor that simplifies analysis of results, and informs decisions on design refinement. As well as displaying the field, temperature or stress, there are numerous functions to prepare and display derived quantities in forms and units familiar to the user (including forces, power loss, stored energy), and also to compute and display particle trajectories through the computed electric and magnetic fields.

... and optimisation of designs

Refining designs is easy. You can manually change parameters and rebuild your model in seconds to view the effects.

Or, this action can be performed automatically using our optional Optimiser module. This tool is extremely powerful, and incorporates a number of algorithms that are automatically chosen depending on the problem. Optimisation problems can be set up in minutes, and the computer left to work out the best solution for one, or multiple, goals. This unique tool, conceived, designed and created by Cobham Technical Services, can save an enormous amount of the normal design effort needed to realise a company’s design goals – whether they are lowest cost, highest performance, simplest manufacture, smallest size (or other parameter).

Accelerate routine designs

Opera allows you to set up ‘macros’, to automate your design process. You can create, run and analyse your designs with user-defined dialogs and menus for inputting dimensions, material properties, and simulation options.

Elements of models can be saved to form a library of component parts. If these parts are saved in parameterised form, key dimensions can be set in minutes as they are loaded - giving you the means to produce designs quickly and cost effectively.
Losses and interference

The electromagnetic field surrounding shielded cables can be calculated using Opera. Distribution loses in the cables and shields can be predicted and minimised by optimisation. Exposure levels to electromagnetic fields can be determined and reduced to satisfy the latest international standards.

Insulation and grounding

Grounding grids in complex soil structures can be modelled using Opera, to predict step and touch voltages. The specialised modules for modelling lossy dielectrics can also be used to design stress reduction coatings used on high voltage insulators.

Components

The characteristics of transformers and fault limiters can be predicted, both on and off load, and under fault conditions. Models can include the shielding tanks and the calculated eddy currents in these tanks can be used to predict temperature rises.
Electromagnetic braking
Opera is ideal for designing a wide range of electromechanical devices with velocity induced eddy currents. Eddy current brakes use the dissipated power to slow the vehicle and, often, to act re-generatively for energy efficiency. Designers can use Opera to calculate braking force, dissipated energy and temperature rise.

Non-destructive testing (NDT)
Finding small cracks in metallic materials for safety-critical applications is often achieved using electromagnetic methods. Opera assists designers of eddy current and other electromagnetic NDT probes to optimise performance by giving accurate response characteristics as the probe sweeps past the defect.

Railways
The electrification of railway systems and the pressure to build closer to the trackside can lead to EMC issues. Opera allows complex infrastructure to be modelled before building starts, and design changes introduced to mitigate stray fields from power supply, track loop and signalling equipment.

Medical physics and Science applications

X-ray tubes
Accurately model space charge effects in quasi-static electromagnetic fields. For instance, electron beams generated from a thermionic cathode, as they are accelerated in an X-ray tube, before colliding with the anode. Multi-physics simulations will model effects caused by charging, as a result of current flow in imperfect dielectrics and secondary electron emission.

Electron microscopy/lithography
The program’s flexible finite element mesh algorithms support the accurate design of systems ranging from nanometre-sized field emitters to a complete column consisting of many lenses. Error fields introduced by eddy currents caused by in-lens deflection coils can be modelled.

MRI magnets
Coils can be modelled exactly and their fields calculated by integration to extremely high accuracy. Non-linear magnetic materials are modelled using finite elements, with the coils embedded in the mesh. This combination of integral and finite element methods makes the software ideal for analysing MRI magnets.

Superconducting coils
Opera contains a unique thermal and electromagnetic multiphysics simulation of the quench in coils as they transition from superconducting to normal. The coils may be co-simulated with protection circuitry and eddy currents in support structure and formers.
Opera
Software for Electromagnetic Design

At the forefront of electromagnetic design software for more than two decades, our products are easy to use, accurate, and capable of delivering results quickly - even for the most challenging of simulations. We are renowned for the support we provide, to both existing and potential customers. So, if you need electromagnetic design software, do not hesitate to contact us. We are happy to review applications, run benchmarks and provide free trials.

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