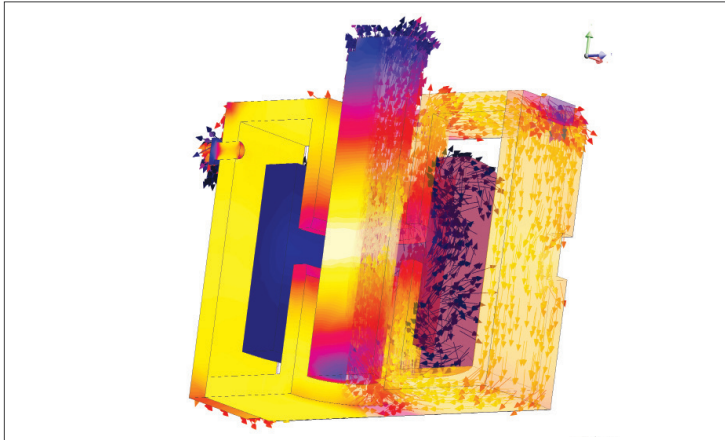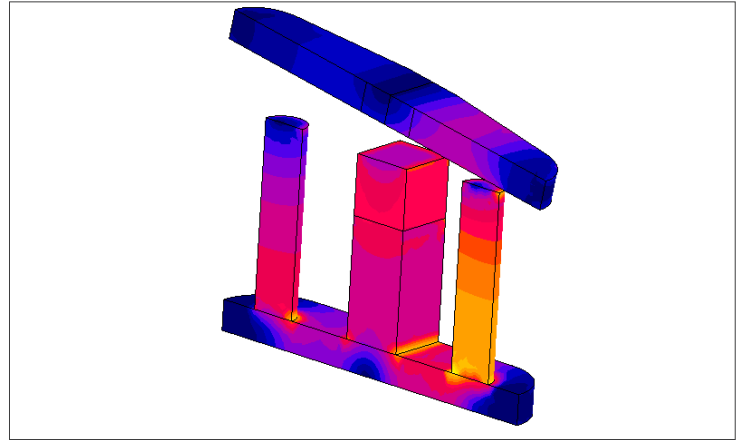# Actuators Design with Altair Flux™

Adaptive solving in 3D MS

Magnetic quantities in post-processing

Powerful Tools for Actuators Design

Electromagnetic actuation is widely used for control and safety in many different industries. Even if the technology is well known, the introduction of electronics or permanent magnets allows for performance improvement, for example to open/close faster or to reduce the energy consumption of the actuator.

For more than 30 years, Flux offers innovative solutions in the design, simulation and optimization of any magnetic actuator:
- Flux for the analysis of magnetic actuators using the Finite Element Method (FEM)
- Altair HyperStudy™ for performance optimization using Design of Experiments (DoE) and advanced optimization algorithms
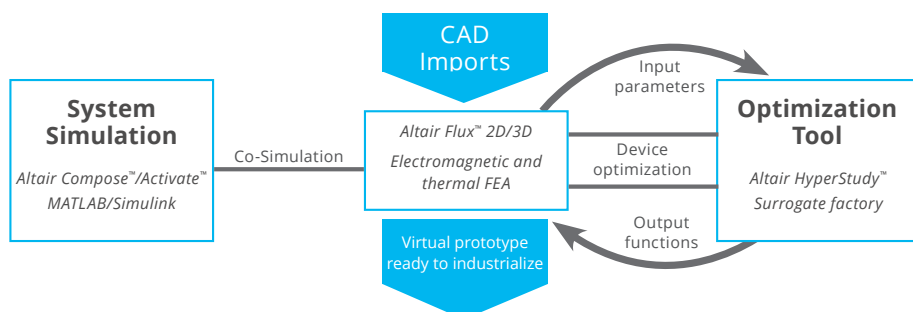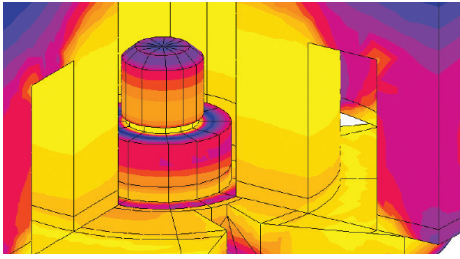
Actuator Design & Analysis

Advanced modeling techniques take into account material non-linearities, eddy currents, circuit coupling and motion with mechanical loads. Flux allows the behavior of actuators to be studied efficiently and completely. Easy to use, Flux gives direct access to results such as:

- Electromagnetic quantities: flux density, currents, losses, current density
- Mechanical quantities: speed, force or torque, acceleration, resistive force
- Electrical quantities: current, voltage, inductance with various formats: point values, color- shaded maps, isolines, arrows distribution, 2D/3D curves, animations, export to Excel, automatic report as well as other tools to go deeper in your analyses
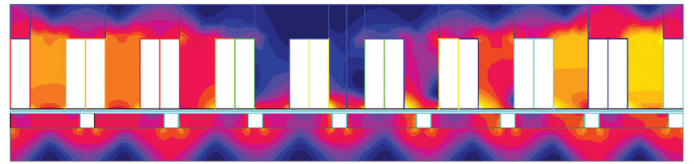
Tool Benefits

- Embedded 3D modeler and 2D sketcher for geometry creation
- Advanced CAD import & export capabilities from various formats (STEP, IGES, DXF, SAT, CATIA, Pro-E, ...) with healing and defeaturing tools
- Physics definition: material database, non-meshed coil in 3D, eddy currents in 2D and 3D
- Advanced embedded electrical circuit coupling
- Electromechanical coupling in 2D and 3D to take into account the linear and rotating motion of the sensor during computation
- Fully automatic mesh adapted to the geometry, possibility to mix tetrahedrons and mapped mesh in the same model to reduce the mesh size while increasing the quality of the results

System Simulation

Altair Compose™/Activate™ MATLAB/Simulink

Co-Simulation

CAD Imports

Altair Flux™ 2D/3D Electromagnetic and thermal FEA

Virtual prototype ready to industrialize

Input parameters

Device optimization

Output functions

Optimization Tool

Altair HyperStudy™ Surrogate factory

Actuators electromagnetic valves of Bosch injecteur

Linear motor

- Adaptive solving in 2D and 3D. Mesh adapted to the physics, based on energy or flux conservation criteria
- Adaptive time step size to accelerate transient simulations
- Multi-parametric studies with distributed computation, for an efficient search of the design space

Actuator Simulation

The actuator behavior can be simulated in magneto-static application to compute the force or torque on the mobile part versus position and current, taking into account the non-linear behavior of materials. From this computation, tables can be generated to create a reduced model of the actuator to be used in system simulation software. Hence the actuator can be considered as part of a bigger system.

To go further and simulate the full operation of the actuator in Flux, the transient application can be used. The circuit coupled to the coils and the movement will be simulated as well as the eddy currents in the conducting parts. An accurate evaluation of the operating time and the losses will be then available directly in the software.

The Actuator and its Drive

The transient behavior of an actuator is widely dependent on its drive. Modeling both the actuator and its drive gives a better prediction of the behavior.

Thanks to the advanced Flux to Altair Activate™ & Altair Compose™ or Simulink co-simulation technology, it is possible to model any complex drive. The co-simulation allows integrating the actuator in its mechatronic environment and improving its drive.

It also enables to account for saturation and Eddy currents (thanks to Flux) as well as motion and control loops within the same simulation run. The results can then be analyzed with the system software or with the fully equipped Flux multiparametric postprocessor.

Performances Optimization

To optimize an actuator, Flux features a multi-parametric solver allowing any parameter to be varied (geometric dimensions, mesh, material properties, electrical source, ...) and solving various scenarios in only one run.

To find the best configuration and reduce the computation time, Flux features the coupling with HyperStudy, an advanced optimization tool. This can be very useful in minimizing the losses in the actuators, to reduce the response time or to meet a force vs stroke curve. Thanks to its indirect optimization strategy and its ability to distribute the computations over several cores, HyperStudy will find an optimal configuration in a reduced computation time.
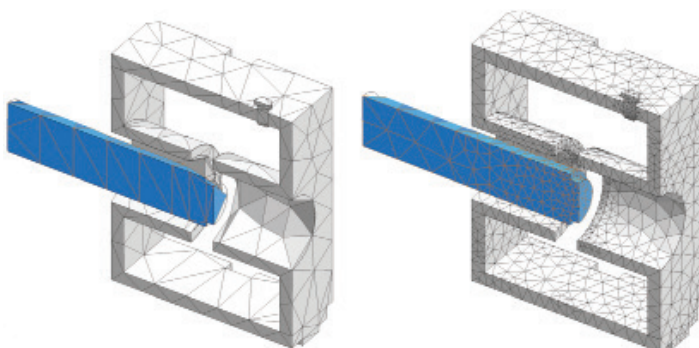
Mesh an actuator
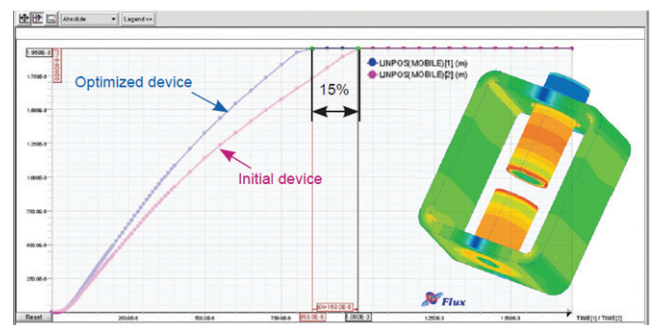
15% gain on response time - Actuator response time optimization

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