Use of FLUX2D and FLUX3D in designing electrical systems for positioning the flight command surfaces...

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Use of FLUX2D and FLUX3D in designing electrical systems for positioning the flight command surfaces in civil aviation.

The development of electrical actuators systems used to ensure the positioning of the flight command surfaces of civil airplanes is an essential element of the evolution towards devices offering better performances in terms of cost, reliability and maintenance.

For several years, the European Commission has been supporting the research activity in this domain by means of projects referring to the development of actuation systems of the following two types:

- Electro-hydraulic actuation systems;
- Purely electro-mechanical actuation systems.

In the first case, the actuation is carried out by a hydraulic jackscrew driven by a local hydraulic power station consisting of an electrical motor driving a pump. In the second case, the electrical motor drives a screw with balls or rolls by means of a reducer and a clutch system.
In both cases, the electrical motor is supplied from the board network by an electronic command unit. This unit comprises high power electronic components and a regulating local numerical system that ensures the positioning of the command surface function of the orders provided by the flight computer.

In order to satisfy the demands related to the static and the dynamic positioning of flight command surfaces, the required performances regarding the torque and the speed regulation of the electrical motor are high, requiring precise models of its electrical behavior.

There are mainly two types of motors that are considered:

- Synchronous motors with permanent magnets;
- Switched reluctance motors.

In the frame of the ELISA (Electrical Intelligent Surface Actuation) project financed by the European Community within aeronautic division of the Brite Euram program, a consortium of airplane and equipment manufacturers (CASA, Aérospatiale, Liebher Aerospace, Lucas Varity France, Lucas Aerospace Wolverhampton and SABCA) work on the development of:

- High power electro-hydraulic actuators for large size carrier airplanes;
- Electro-mechanical actuators for small size airplanes used for regional flights.

Sheffield University and the Catholic University of Louvain take part in the project.

For electro-mechanical actuation systems, the Catholic University of Louvain in close cooperation with SABCA, carries out studies related to the influence of the type of the motor on the high power electronic system that supplies it, and related to the regulation requirements in order to satisfy the requirements referring to the regulation accuracy of the torque and speed of the motor.

To carry out this study, FLUX 2D and FLUX 3D software packages are essential tools to characterize, in a precise way, the electromagnetic and electromechanical behavior of different types of motors taken into account.
As to the command of synchronous motors with permanent magnets, the FLUX 2D magnetostatic module is used to study the influence of space and slot harmonics saturation phenomena on the quality of the torque command.
Figure 1 shows an example of field computation for the motor with permanent magnets mounted on a surface, no load and on load rated current. One can see the low influence of the stator currents on the saturation phenomena with this type of machine. Consequently, an optimized command of this motor,

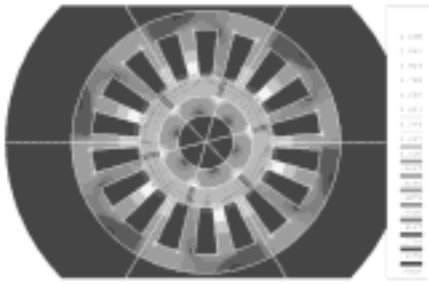

Figure 1a : Field distribution of an actuator with magnet, no load case.

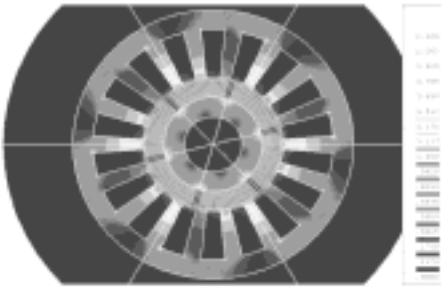

Figure 1b : Field distribution of an actuator with magnet, in on load rated current case.

computed on the basis of its no load characteristics shows, even at on load rated torque, a low degree of oscillation (figure 2).

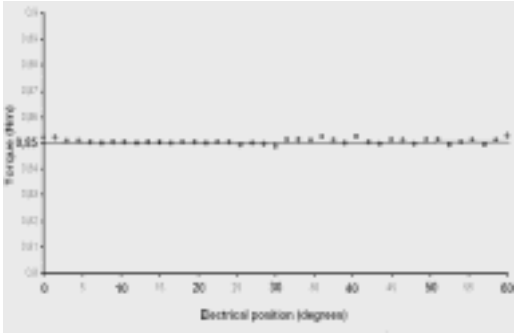

Figure 2 : Torque oscillation function of the position for an optimized command .

As to the command of switched reluctance motors, the software packages FLUX 2D and3D allow one to study the effect of local saturation phenomena on the torque regulation and the influence of processing allowance on the mass torque.

(continued on page 6)

ABB integrate FLUX2D into its future software ADEPT.

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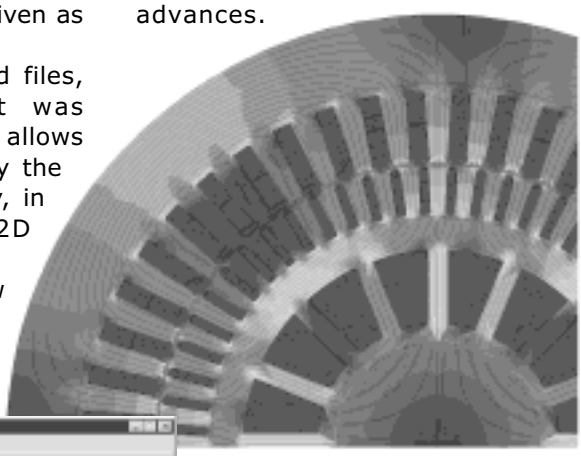
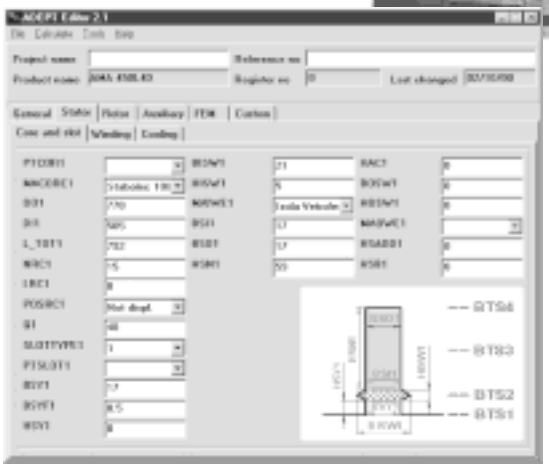
At the beginning of the year 2000, ABB decided to integrate FLUX2D into its future software for the electrical computation of asynchronous motors, ADEPT (ADvanced Electrical Design Program Tool).
ADEPT is intended to be the current computational tool common to all R&D departements working in this field. The objective is to offer to the designers the possibility of taking advantage from the finite element computational method for the "daily" dimensioning of machines.
ADEPT proposes a user interface allowing the description of the set of parameters of the machine to be dimensioned, as well as the type of analysis to be carried out: main working characteristics (voltage, power, frequency, polarity, site conditions,…), description of the laminated core (main dimensions, shape and number of slots), description of stator and rotor windings, description of the computation to be carried out (evaluation of the characteristics at the rated point, evaluation of the torque as a function of the speed, simulation of a motor start, etc.).
When launching the finite element computation, the different modules of FLUX2D are called sequentially, each of them being driven by a command file, automatically generated by ADEPT, function of the parameters given by the user. At the end of the solving process, the results post-processing is also carried out automatically function of the type of analysis, and the results are transferred to the ADEPT environment in order to be given as curves or tables of values.
Due to the use of command files, no specific development was required on FLUX2D, which allows the user to exploit or modify the studied problem interactively, in the standard FLUX2D environment.
The development of this new computation tool using FLUX2D, which endows the different units of the ABB motors department with advanced means, will allow a quicker, more precise and more robust answer to the new problems related to the dimensioning of asynchronous machines linked to the latest technological advances.





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Use of FLUX2D and FLUX3D in designing electrical systems for positioning... (continue)

Figure 3.a shows an example of field computation in a switched reluctance motor 6-4, and figure 3.b represents the torque computed as a function of the current and the rotor position.
For obvious confidentiality reasons, the figures shown in this article represent computing results obtained for machines that do not correspond to the machines studied in the project.

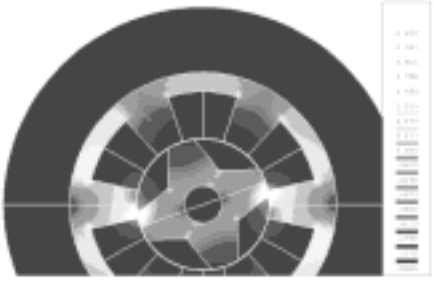

Figure 3a. Field distribution in a 6-4 switched reluctance motor

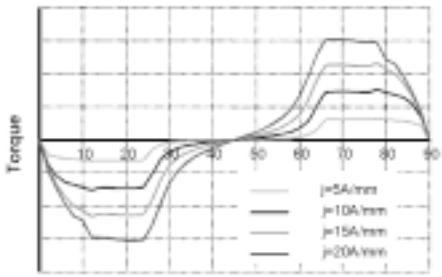

Figure 3b. Characteristics torque/position function of the current.

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