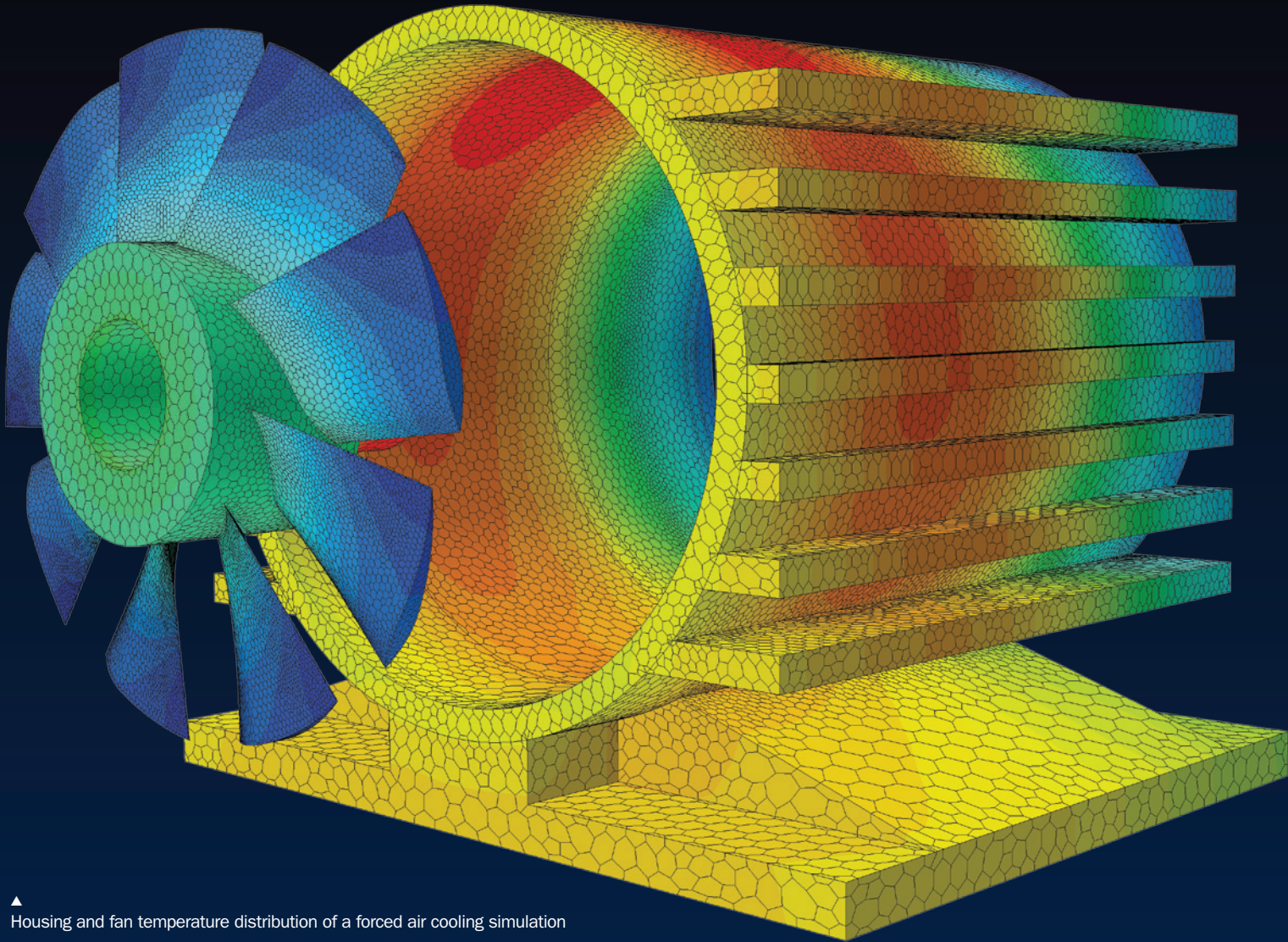


# Combining SPEED & STAR-CCM+

CD-adapco's unique capabilities for the design and analysis of  
.....  
electric machines





▲ Housing and fan temperature distribution of a forced air cooling simulation

## A Unique Process

**In the past 25 years, millions of electric motors have been produced with designs that have been developed using SPEED.**

However, as the required performance of electric machines is moving upwards, the designer has to embrace the vitally important aspect of thermal analysis alongside the fundamental electromagnetic design. Hence engineers demand more from their electric machine related design and analysis tools.

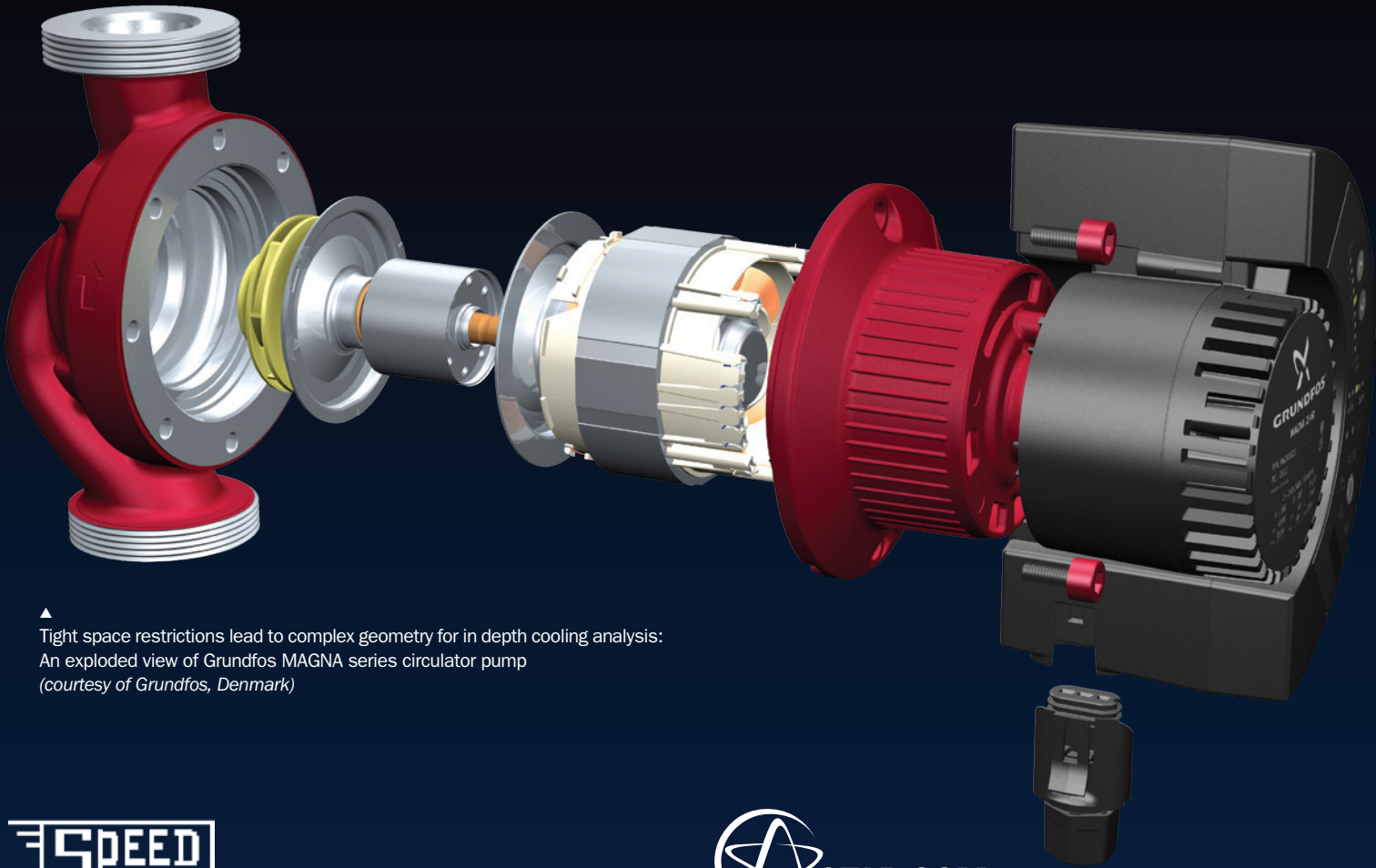
To enable them to remain competitive in today's world of ever-increasing performance and efficiency, CD-adapco has introduced a new and unique process for the design of electric machines by combining two highly-accomplished and market-leading codes: the electric/electromagnetic design tool SPEED, and the flow/thermal CFD-centric CAE software STAR-CCM+.

## A Successful Partnership

**In June 2011, CD-adapco acquired SPEED with the aim of combining CD-adapco's position in the CAE market with SPEED's leadership of electric machine design tools.**

From their joined experience and expertise, a cutting-edge technical strategy for the design and analysis of electric machines has been developed, offering design engineers the unique and powerful possibility to combine electromagnetic and flow/thermal capabilities in the same working process. The initial impact of this intense collaboration was the release of a new version of SPEED featuring 350+ enhancements in September 2011.

# The Toolbox



▲ Tight space restrictions lead to complex geometry for in depth cooling analysis:  
An exploded view of Grundfos MAGNA series circulator pump  
(courtesy of Grundfos, Denmark)



**SPEED is the specialized analysis tool for the design of electric machines such as motors, generators and alternators including the drive with inverters and their control. Backed by 25 years of experience within the SPEED Lab at the University of Glasgow, SPEED has 1500+ international users, including leading manufacturers, designers, developers and users of electric machines.**

Thousands of machines have been designed with SPEED, and millions have been produced. SPEED is a simple, intuitive, fast and efficient tool for:

- Sizing and preliminary design of new prototypes;
- Characterization of new / existing products: performance study and quick assessment of the effect of parameter changes.

Furthermore, its highly organized data in both numerical and graphical form facilitates communication between company sites, and often between supplier and customer.

Finally, SPEED can be used in conjunction with high-powered specialist CAE tools such as STAR-CCM+ for the exhaustive analysis of difficult electro-magnetic, mechanical, or thermal problems.



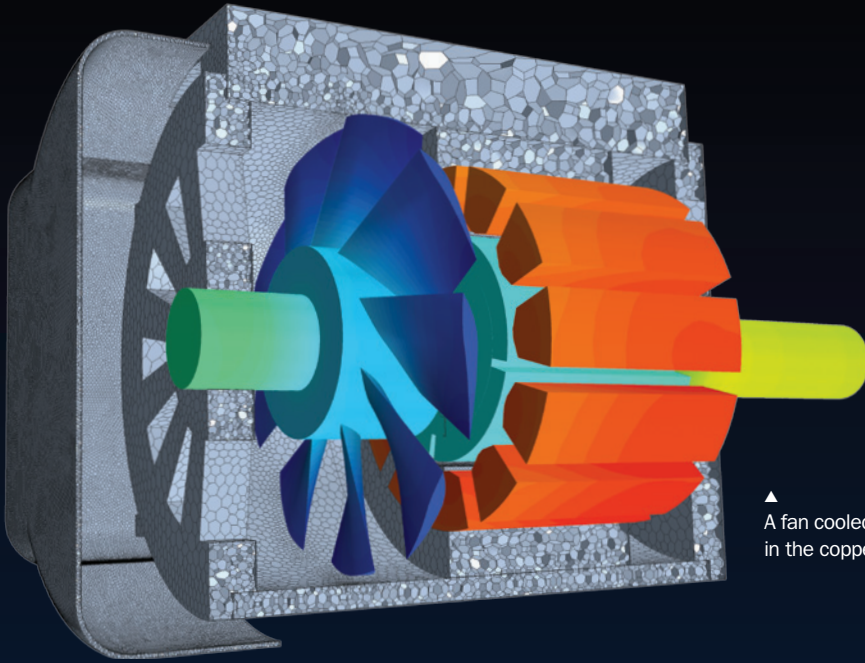
**STAR-CCM+ provides the world's most comprehensive engineering simulation inside a single integrated package. Much more than just a CFD solver, STAR-CCM+ is an entire engineering process for solving problems involving flow (of fluids or solids), heat transfer and stress.**

STAR-CCM+ is unrivaled in its ability to tackle problems involving multi-physics and complex geometries. It has an established reputation for producing high-quality results in a single code with minimum user effort. Designed to fit easily within your existing engineering process, STAR-CCM+ helps you to entirely automate your simulation workflow and perform iterative design studies with minimal user interaction. The net result of this is that engineers get to spend more time actually analyzing engineering data and less time preparing and setting up simulations.

STAR-CCM+ also now offers application specific tools, such as STAR-CCM+ Battery Simulation Module, which couples flow/thermal and electrochemistry analysis in one environment, providing a dedicated environment for battery performance analysis.



# SPEED: The Established World of Electric Machine Design



▲ A fan cooled machine example showing the flow induced temperature gradient in the copper filled slots openings

## Industry Highlights of SPEED's New Features:



### **Automotive (Hybrid & Electric Vehicles as well as Commercial, Industrial, Agricultural & Mining Special Vehicles)**

SPEED's finite-element embedded solver combine comprehensive analytical models covering all aspects of the design of these machines, including thermal, electromagnetic and drive control. Enhancements have been made in all aspects of the design calculations to improve accuracy and cover an even wider range of machine geometries. Of particular importance is the efficient utilization, and even elimination, of magnets.

The SPEED suite of programs is now structured to give seamless design capability over the entire range of permanent-magnet machines and the alternatives including hybrid combinations. SPEED covers the entire range of power, voltage, and speed used in vehicle systems. SPEED plays a key role not only in drivetrain engineering but also in auxiliaries such as starter-generators, many kinds of pumps, blowers, actuators, and even the KERS systems used in F1.

### **Refrigeration, Domestic Appliances & Water**

Efficiency requirements are driving these industries towards continual technological evolution, in a context of extreme cost pressure and material supply issues. SPEED is used as the main design tool in leading companies manufacturing compressors, washing-machine drive motors, pumps and fans worldwide. The technology covers induction motors (both 1-phase and 3-phase), permanent-magnet brushless motors, and line-start PM motors. Switched reluctance motors are also used in a few key applications. SPEED's ability to characterize products and not just concepts is one of its main assets in serving this sector. Improvements have been made in all programs in relation to machine geometry, loss calculations, drive control, and finite-element analysis.

### **Aerospace**

High power-density, high speed and fault tolerance are key requirements in aerospace. SPEED has been used for many applications including actuators, pumps, and starter-generators, including machines used in the most advanced aircraft.

Brushless PM machines and switched reluctance machines are the main technologies. In both of these areas, SPEED has new features improving the range of machine geometry, and the calculation of electromagnetic and thermal performance.

### **Industrial**

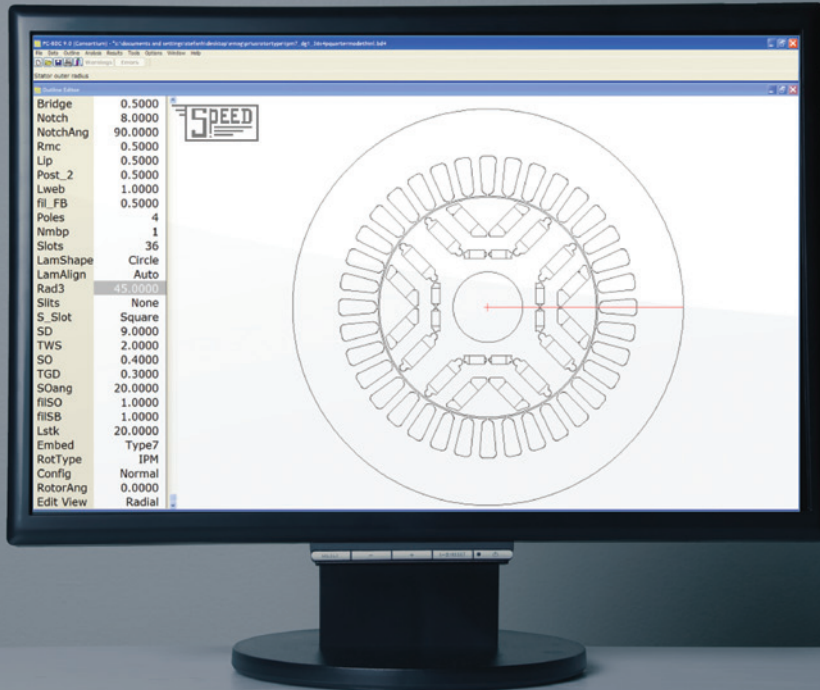
SPEED is behind the design of some of the world's most efficient AC variable speed drives, using brushless SPM and IPM motor configurations. The code is used not only in high-efficiency industrial drives, but also in precision servomotor systems. We've made special efforts to extend SPEED into generators, with a new embedded finite-element solver to cope with a wide variety of load specifications, and automatic calculation of generator characteristics for wound field synchronous generators. We've added the doubly-fed induction machine to the range. Improvements in machine geometry, finite-element analysis, drive control, and thermal modeling have been achieved. SPEED's technology covers all kinds of brushless PM machines, synchronous and switched reluctance machines, induction machines and DC machines. PM Axial-flux as well as PM linear machines can also be calculated. These programs are available on request (beta release).



- World-leading design program
- Thousands of customers worldwide

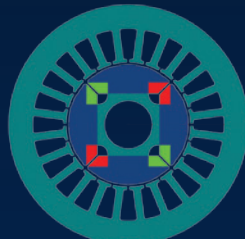
- Thousands of successful designs

Design Concept

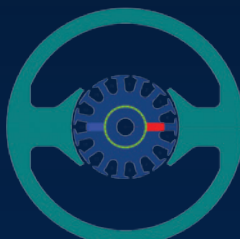


- Link to Motor-CAD for basic thermal analysis
- Link to PC-FEA and custom FE solvers
- High-powered links to FLUX, J-MAG, OPERA and SLIM
- Optimization & Automation

## Machines covered by SPEED software

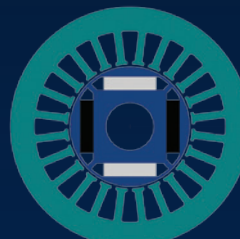


Wound-field AC



AC/DC universal

**Classical - Line-start or electronically controlled**

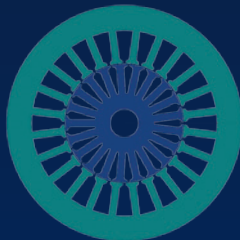


Brushless AC (incl. IPM)

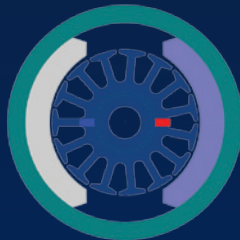


Switched reluctance

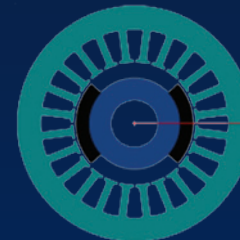
**Modern - Always electronically controlled**



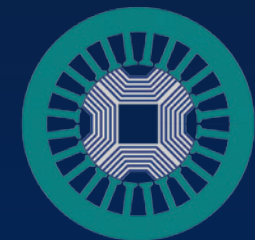
Induction



DC PM



Brushless DC



Synchronous reluctance

**SPEED software covers almost all the main classes of electric machines and drives**

A UNIQUE COMBINATION



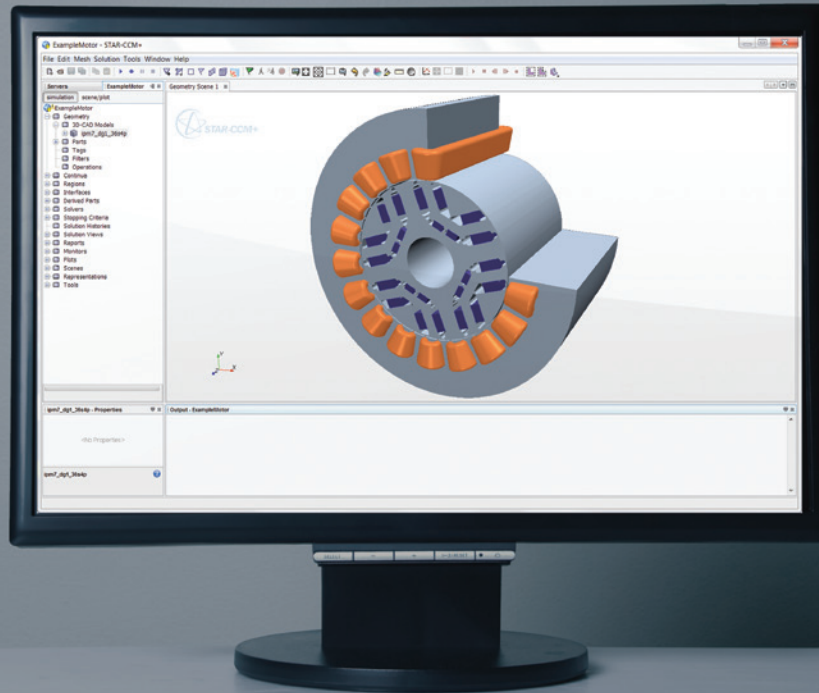
# STAR-CCM+: Advancing the 'Art' of Electric Machine Design

→ World-leading CFD & heat transfer analysis software

→ Thousands of successful cases

→ Thousands of customers worldwide

xGDF data transfer



Optimized Design

→ Advanced Flow/Thermal/Stress Analysis

→ Capability for Electromagnetic Analysis under Development

## xGDF Data Transfer from SPEED to STAR-CCM+

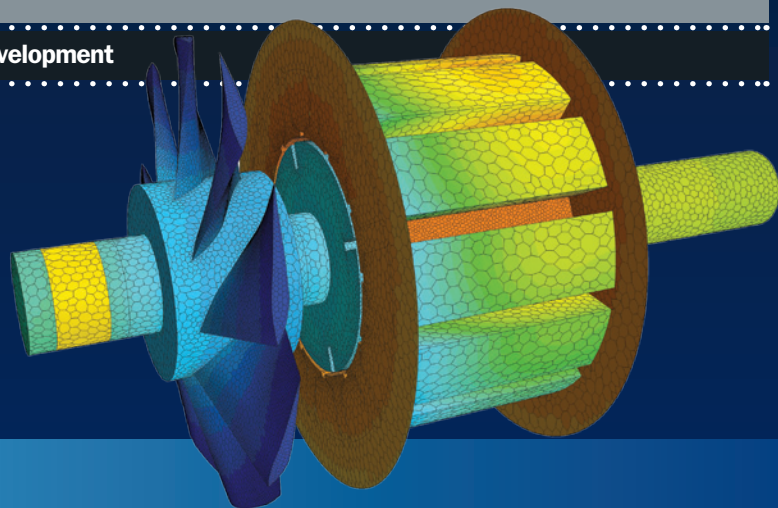
→ Parametric SPEED designs transfer into the STAR-CCM+ 3D-CAD Modeler

→ Permitting limitless further modifications

→ Mapping of loss data for detailed heat transfer analysis in STAR-CCM+

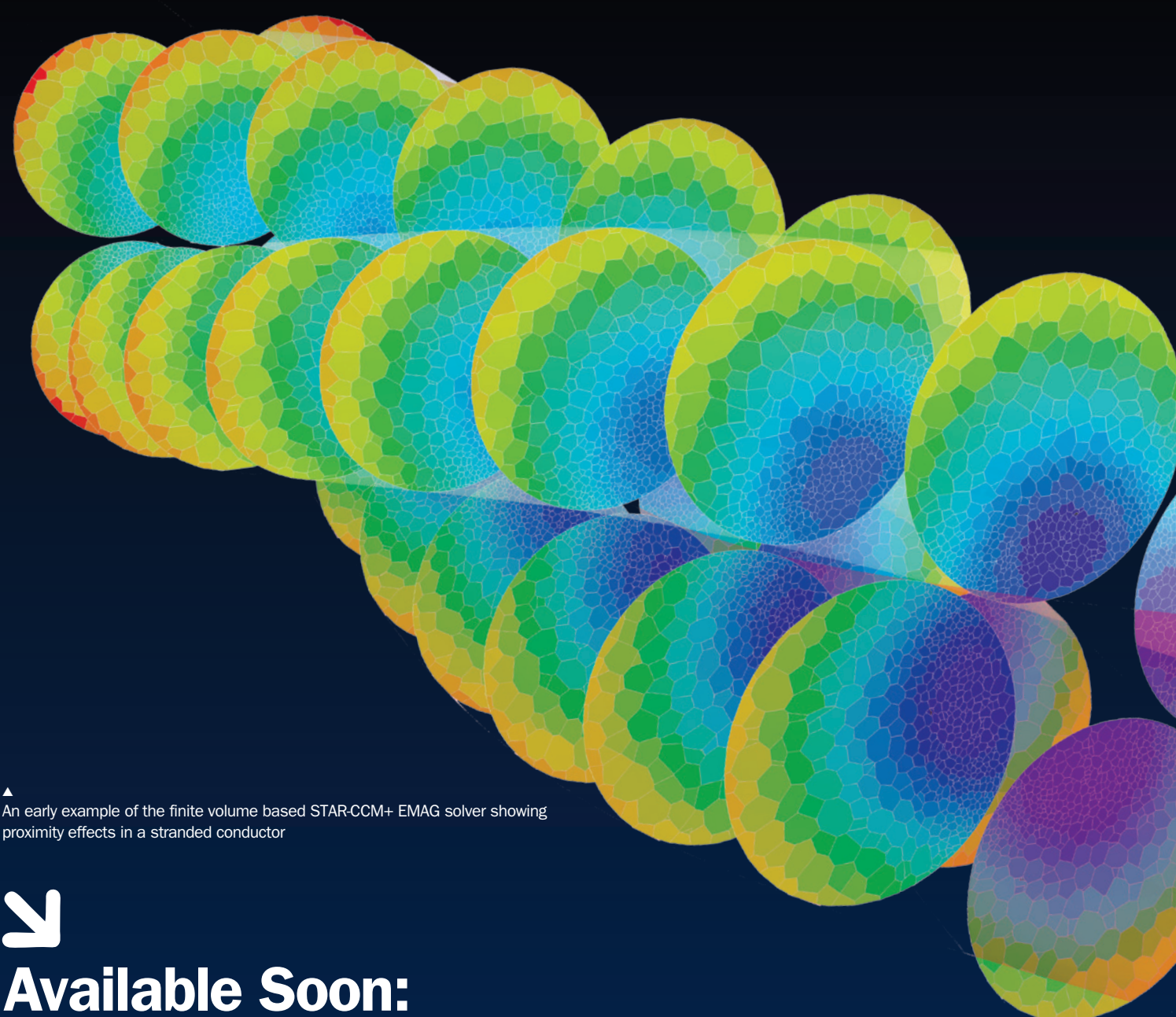
→ SPEED export to STAR-CCM+ now available

→ Detailed electric machine winding exchange also in development



UNIQUE RESULTS





▲ An early example of the finite volume based STAR-CCM+ EMAG solver showing proximity effects in a stranded conductor



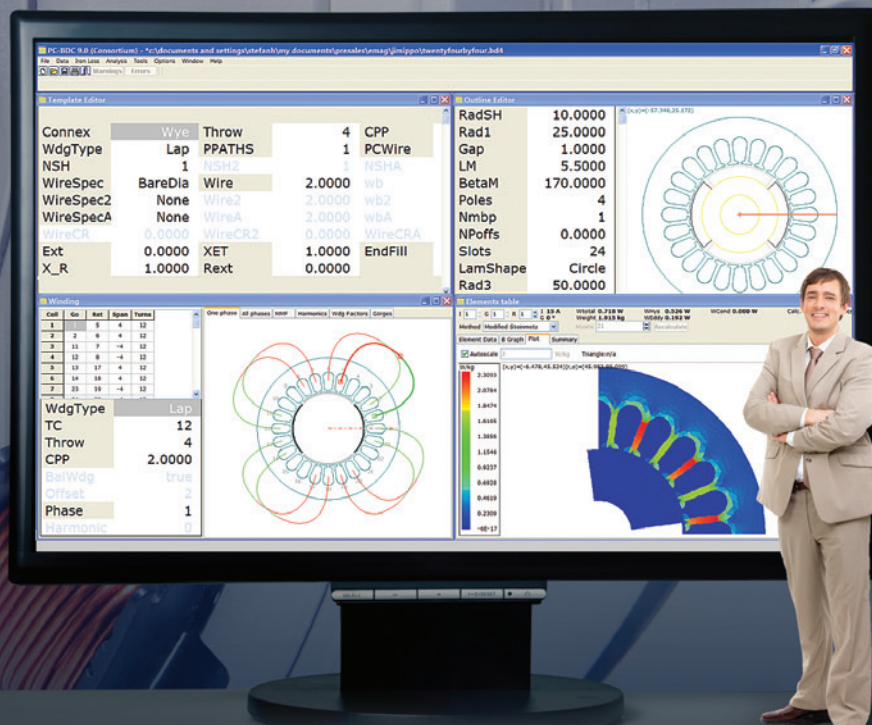
## Available Soon: CD-adapco's New EMAG Solver

**Understanding the thermal and electromagnetic phenomena that are operating in modern high power density electric machines is vital to achieving a state of the art design. As cooling systems becoming more sophisticated to address thermal design limitations, a new capability which combines both electromagnetic and flow/thermal phenomena in a single code is needed to deal with temperature-critical and high power density designs.**

For this reason, CD-adapco is rapidly developing a unique 3D finite volume electromagnetic solver (EMAG) within the market-leading flow/thermal/stress code STAR-CCM+. This development, which will offer the exclusive benefits of a fully coupled analysis, continues apace and will initially be available in STAR-CCM+ in spring 2012.

This comes in addition to continued support for SPEED's existing FEA electromagnetic links with packages such as FLUX, J-MAG, OPERA and SLIM, as well as third-party Finite-Elements (FE) solvers (including SPEED's FE program PC-FEA).

# SPEED Distributors



## UK

**Motor Design Ltd**  
Lloyds Bank Chambers  
4 Scotland Street  
Ellesmere  
Shropshire  
SY12 0EG  
[www.motor-design.com](http://www.motor-design.com)

## FRANCE

**CEDRAT S.A.**  
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Inovalée  
38246 MEYLAN cedex  
[www.cedrat.com](http://www.cedrat.com)

## GERMANY

**MACCON GmbH**  
Aschauer Strasse 21  
81549 München  
<http://www.macon.de>

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**Magsoft Corporation**  
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NY 12065  
[www.magsoft-flux.com](http://www.magsoft-flux.com)

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Yenikoy Kampusu, Yenikoy  
Sapagi, Vatan Caddesi,  
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Basiskele-Yenikoy / Kocaeli  
[www.mdsmotor.com](http://www.mdsmotor.com)

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**Spin Applicazioni Magnetiche S.r.l.**  
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29011 Borgonovo Val Tidone  
(PC)  
[www.spinmag.it](http://www.spinmag.it)

## SWITZERLAND

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Grand-Rue 84  
1110 Morges  
[www.maglink.net](http://www.maglink.net)

## SPAIN

**INDIELEC - Ingeniería de Diseño**  
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5, Pont Sec  
46116 Moncada (Valencia)  
[www.indielec.es](http://www.indielec.es)

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[www.ae-magnetics.nl](http://www.ae-magnetics.nl)

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560042 Bangalore  
[www.emsac.de](http://www.emsac.de)

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