

No. 1, 2001

## The **goal** is in sight

**Until recently**, and despite much energy, cost and thought devoted to its fulfillment over many decades, the idea of a functional electric car capable of matching acceleration with internal combustion engines was just that – an idea.

This cherished goal has now come much closer to reality thanks to Voith, one of the world's leading manufacturers of drive train and power transmissions. Their latest innovation is an electric passenger car drive motor that came to fruition in a project conducted together with VW and Siemens Automotive.

Called OKOFEH (the German acronym for Optimised Components for Electric Hybrid and Fuel Cell Vehicles), the project is funded by the German ministry for research. The motor is unique in that it combines the torque necessary to compete with the acceleration of internal combustion engines, and the environmental and economic benefits that define electric engines.

**Voith's design is a** Transverse Flux Machine (TFM) – a high-power electric motor that utilizes a unique magnetic arrangement by making full use of the three-dimensional flux-carrying capabilities of SMC materials. The TFM's high torque density makes it realistic and feasible to produce electrical machines with improved efficiency output levels that are far higher than existing conventional induction motors of the same size and mass.

The major advantages of this TFM are:

- Significantly reduced manufacturing cost
- Improved cooling of the stator winding,



- High-quality winding insulation, due to integrated manufacturing process.

**The OKOFEH project involves** a 58 kW TFM traction motor, integrated planetary gear stage and differential case. It offers high continuous torque and reliable behavior that ensures the acceleration needed to overtake other vehicles. On each side of the engine is an adapter for cardan shafts, which provide a mechanical means to transmit driving power to the front wheel drive.

The motor's performance is as follows:

- 58 kW continuous power
- 500 Nm max torque
- 420 Nm continuous torque
- 4000 rpm maximum
- 55 kg weight
- 300 mm diameter
- 300 mm motor length

**The TFM drive train provides** a much higher level of efficiency than comparable asynchronous solutions. It also provides a multitude of safety benefits that other PM designs cannot provide. In case of failure, the motor terminal can be shorted

Servomotor redux

Transformer powders

Motortech & PM<sup>2</sup>TEC

SMC people

Upcoming events

**Höganäs**

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## Keep the changes coming

**How many of our readers** have not yet begun to pursue serious development in soft magnetic composite technologies? To be honest, the percentage is quite large.

We're trying to change that. Though we can't alter your priorities, we can help to increase your soft magnetic development momentum. We've got the R&D history, production background, application contacts and commitment to support each promising new development. In a field as new and challenging as soft magnetic composites it's collaboration between developers, researchers and producers that creates progress.

**SMC-based electric drives** for passenger vehicles may soon be a working reality if the German OKOFEH project continues its successes. Likewise, in the hands of companies such as Optelec, the application of molded SMC compacts is transforming transformer technology.

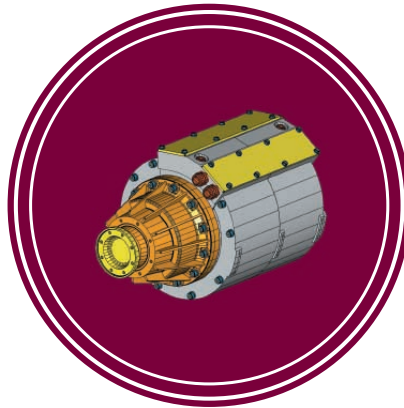
The efforts of our colleagues in academia also deserve notice. Large advances are being made in application development, with new and exciting designs for permanent magnet electronically commutated motors.

**We've done a little** personnel shuffling at the Höganäs SMC team. Read about SMC People on the back page of this newsletter. Have an enjoyable summer. We look forward to seeing you at one or more of the soft magnetic events this summer and autumn.

Sincerely,



Mats Persson  
Editor



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► without the risk of causing fire or producing dangerous braking torque. This safety feature is a major advantage over other PM designs.

The high continuous torque provides reliable behavior that allows the driver the ability to overtake other vehicles with confidence. This technology allows the TFM drive to reliably produce the torque necessary to overtake a vehicle. Most other drives involve the inherent risk of power reduction when reaching the thermal limit.

**Though the motor is not yet** in commercial production, it is anticipated that

major automotive manufacturers will be employing the technology soon. The SMC team at Höganäs extends a congratulatory salute to their associates at Voith. This innovation in the electric passenger car engine will only enhance the reputation of Voith as a progressive leader in its field.

### OKOFEH project participants include:

Voith Turbo AG

Siemens Automotive AG

Volkswagen AG

RWTH Aachen

Funding: German Ministry for Research

**The Electric Vehicle Symposium & Exhibition** is to be held at the International Congress Center Berlin, from 21–24 October.



This annual meeting, now in its eighteenth year, brings together developers and promoters of electric and hybrid drive technologies from around the world. It will be the first public exhibition of the OKOFEH project, including a working prototype of the car itself, with a technical presentation led by Jens-Peter Altendorf of Volkswagen AG.

## Transformers in the limelight

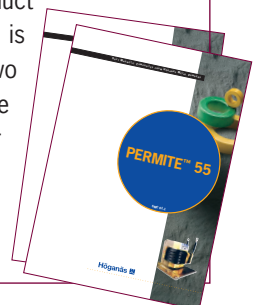
Produced by Optelec of France their application is power electronics for converting energy in frequency ranges from 15 to 50 kHz. These products are well adapted as inductance for Power Factor Correction (PFC) and exit of inverters, as well as in any boost-buck transformer construction. They can also be used as smoothing inductance for exit forward- and push-pull converters.

"The advantages of the Permite™ insulated powders are many", says M. Natale of Optelec. "Economically, they are better than laminated iron or ferrite, because weight and overall volume can both be reduced. They also simplify the structure of command

by their linearity and low attenuation, while their flexibility allows the same product to be used for different applications."

SMC powders have a well-established use in iron powder cores, ignition systems and transformers.

The Permite™ range, is one of the Höganäs SMC product families. The data is presented in two brochures that can be ordered from your nearest Höganäs representative.



# Long **LIVE** the servomotor

They help fulfil modern civilization's striving towards automation. Servomotors do everything from animating industrial robots to fulfilling the instructions of remote controls.

**Does SMC technology have** a role to play here? Definitely!

SMC constructions using materials like the Höganäs Somaloy™ family offer performance and price that beat steel laminations – especially when motor design utilizes isotropic material characteristics and powder metallurgy's manufacturing benefits.

## **How to fully utilize these factors?**

Researchers at the University of Newcastle upon Tyne have further developed ideas highlighted here in October 1998. Permanent magnet servomotors, with features such as: core back axially extended over end windings; sub-divided armature core components; stator coils are pressed to form a solid component with a fill factor of 78%.

**The photo at right shows** an SMC tooth segment. The material's isotropic properties reduce stator and machine dimensions, shorten copper winding and reduce the need for an insulator between tooth and winding. Better thermal performance, a higher rated torque and more cost-effective production are other important benefits.

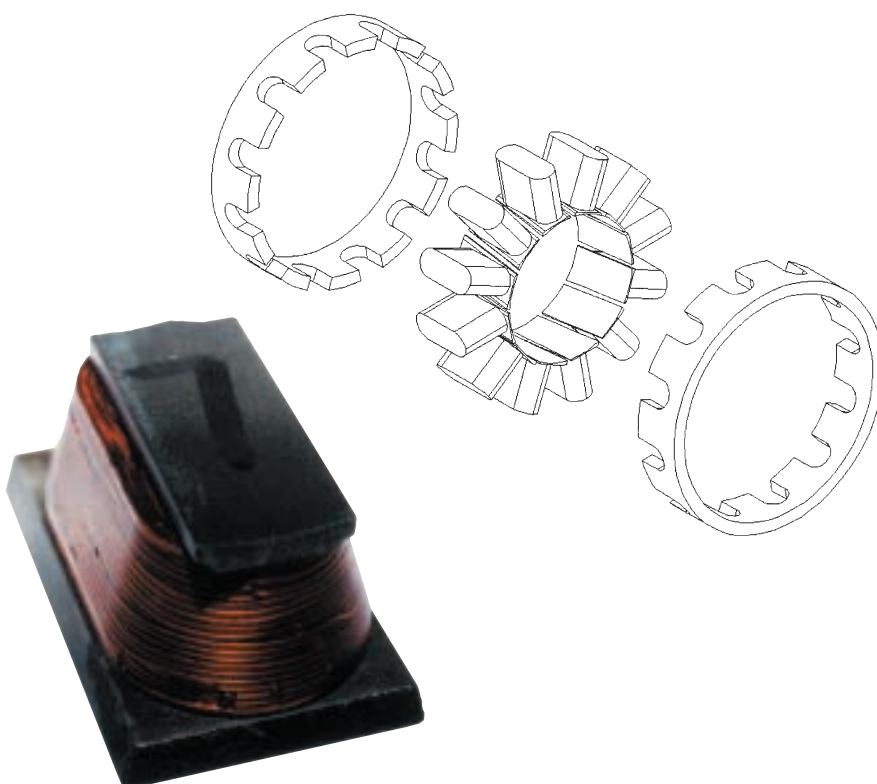
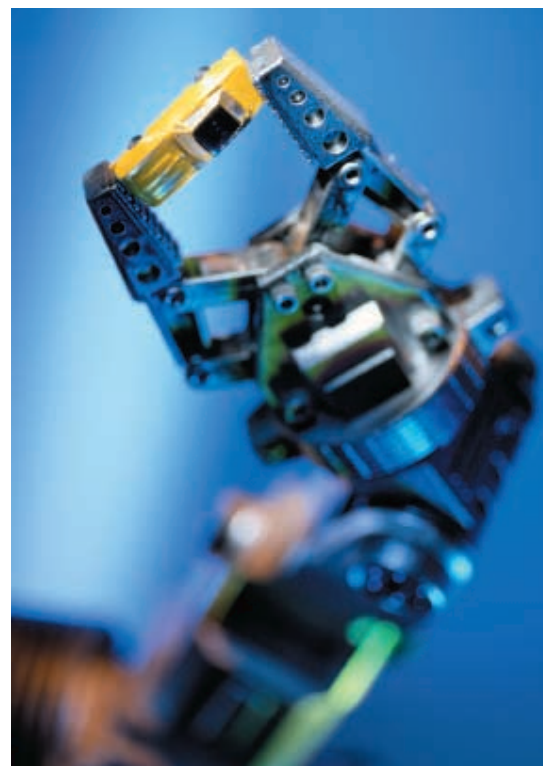
With segmentation, winding can be done away from the core. This also facilitates very high winding fill factors. The ability to pre-form and press windings also improves thermal performance.

Researchers have successfully designed, built and tested an SMC-based servomotor that produces 1.9 times more torque at thermal limit than a commercial laminated machine with the same rotor and 3.7 times more torque per unit vol-

ume in the same frame. In short, superior performance at a lower cost.

**The illustration below** depicts a further development currently under study at the University of Newcastle upon Tyne. With the core back produced in two axially divided pressings, coils can be wound away from the core, and skew can be designed right into the stator.

SMC's potential benefits, in terms of design and construction as well as manufacturing flexibility, are clearly numerous. For servomotor technology, they signal a potential for manufacturers to capture whole new market segments with more capable, more cost-effective technology. Contact Mats Persson at Höganäs for more information.





## Upcoming events

In the next few months, you can meet our SMC team members at two different industry events. We look forward to seeing you there!



EPE 2001 – 9<sup>th</sup>  
European Conference  
on Power Electronics  
& Applications; 27–29  
August – Graz, **Austria**

<http://epe2001.unileoben.ac.at/>  
Researchers from the University of Newcastle upon Tyne will present a paper on the latest generation of direct drive BLDC motor. Utilized in the Höganäs electric bike, the concept employs ferrite magnets with deep flux concentration features in the stator core.



EVS-18 – 18<sup>th</sup> Annual  
Electric Vehicle Sym-  
posium & Exhibition

21–24 October – Berlin, **Germany**  
<http://evs18.tu-berlin.de/>  
First public exhibition of the OKOFEH project, including a working prototype of the car itself. Project members are to give a technical presentation describing progress to date.



by Höganäs

# Fair showings

Höganäs and its subsidiaries were strongly represented in two important arenas this spring: the Motortech fair in Tokyo end-April, and the PM2TEC conference held end-May in New Orleans.

### Motortech

Led by Höganäs Japan KK's Mr. Koki Kanno, we were strongly represented at Motortech. A good thing, considering how many visitors we had.

Höganäs entertained over 300 visitors during the three-day fair, a 60% increase from last year. Part of the Techno Frontier Week, Motortech grows larger every year. "Universally interesting" was the theme of our stand, and we featured information on universal motors and the design freedom that SMC materials offer to this and other motor types. These ideas spurred many long and interesting discussions on motor design, both during fair hours. After all, breaking away from traditional thinking in motor design is one of the keys to taking advantage of the SMC technology.

### PM<sup>2</sup>TEC

Only 6 of this year's more than 300 technical papers dealt directly with magnetic topics, but this annual powder metallurgical conference is an important venue for developers and producers of soft magnetic components, not least because North American auto makers and their suppliers are so strongly represented there.

Höganäs's SMC team was out 'in force' at the North American Höganäs exhibition stand. Ola Andersson represented us at the technical seminars, receiving a positive response to his paper titled "Iron powders in electrical machines – possibilities and limitations".



**Motortech visitors practice 3D thinking by assembling the Höganäs cube.**

## SMCpeople

We've strengthened the Swedish SMC organization, both in the marketing and development areas:

### PATRICIA JANSSON

As Höganäs's Senior Researcher for soft magnetic materials, Patricia has shepherded most of our SMC powder development from idea to reality. In April 2001, Patricia moved across the street from the Central Laboratory to join the Höganäs marketing organization as application manager, with the motivation to help ensure that customers are able to fulfil SMC's commercial potential.

### LARS HULTMAN

As manager of the Höganäs Magnetic Research and Development group, Lars is a key member of the SMC team. His strong marketing talents, developed in part in our marketing division, give him a unique perspective that will enhance the group's efforts.

### LARS-OLOV PENNANDER

In March 2001, Lars-Olov brought his engineering talents to Höganäs Magnetic Research and Development. With a doctorate in Engineering, Lars-Olov is well equipped for the challenges that await him.