

# Simulation Software Helps Build Electric Motors

Computer simulation was recently used to design and validate a less expensive method of building permanent magnet electric motors. Until now, the magnets used in nearly all such motors have been secured in place with adhesives or spring clips.

Webster Plastics (Fairport, NY) developed a plastic carrier that can securely hold magnets with a single component. Webster's design has the potential to substantially reduce motor manufacturing costs and improve reliability.

Called the Magset, the carrier holds magnets in place without adhesives, spring clips or any type of metal fastener. The plastic injection molding process provides an unlimited choice of shapes. Multiple parts can be integrated into one component and more efficient and compact motors can be designed, while improving manufacturability.

The carrier features molded-in cavities that

conform to the magnet's shape. The carriers can accept multiple magnets in virtually any shape and placement configuration. They can be molded with end caps on one end and connectors on the other, making it possible to eliminate additional components. The connector end can include various snap-fit, locating or mounting features to simplify assembly. Carriers can also be molded with mounting features for other motor components, such as electrical brush cards, timers, pickups, sensors and conductors. The operator simply places the magnets on the plastic carrier and slides the assembly into the motor housing. Labor and overhead are estimated at only \$0.60 per motor, and no capital expenses are required.

The Magset can also improve motor reliability and performance. The motor carriers are molded to tight tolerances. This provides a highly stable unit that improves motor efficiency by allowing more precise placement of magnets in relation to the flux ring. The cavities cradle the magnet and protect its brittle edges from damage during assembly. It also prevents minute fragments or an entire magnet from dislodging and falling into the armature assembly.

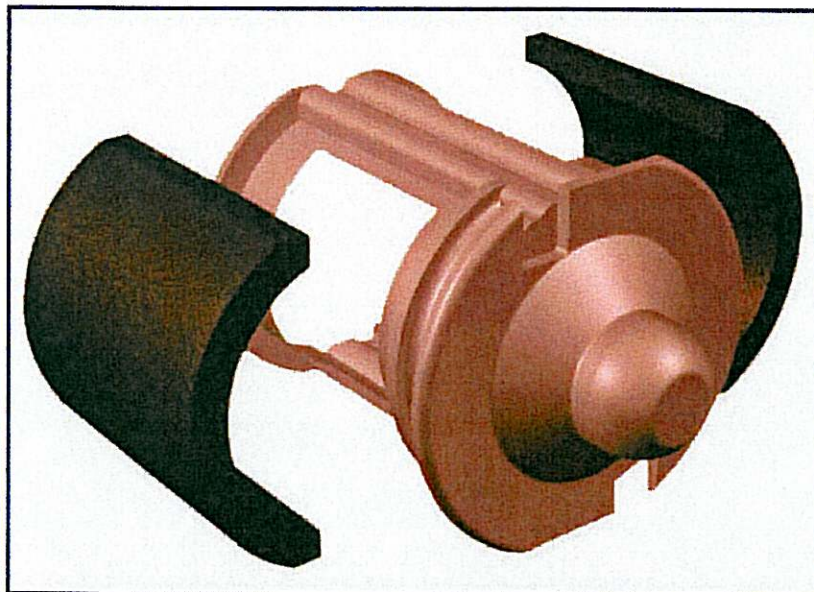
Webster Plastics contracted with Yeadon Energy Systems Inc. (Iron River, MI) to overcome several design challenges, such as evaluating the ability of the carrier to resist the significant side pull forces generated by newer permanent magnet materials.

Building prototypes of each of the motor designs and magnet materials for which the carrier was being designed would have been expensive and time-consuming. Instead, Yeadon used the Opera 2D and 3D electro-

magnetic simulation software program from Vector Fields (Aurora, IL) to determine the forces generated by each possible design configuration, which were used as loads in finite element analysis to finalize the design of the carrier.

Yeadon engineers modeled the geometry of the magnet assembly and armature in Opera using the software's computer-aided design features. They defined the material properties of the magnet and steel housing using the library of material data contained in the software.

The program automatically divided the model into finite



Yeadon Plastics contracted with Yeadon Energy Systems Inc. to overcome several design challenges for its Magset carriers. Yeadon used the OPERA-2d and 3d electromagnetic simulation software program from Vector Fields to determine the forces generated by each possible design configuration.

elements. The engineers defined the armatures by defining the slots as copper conductors and specifying the direction of current flow. The mesh in the area around the air gap was refined to improve the accuracy in the highly transient region while maintaining relatively coarse mesh density in the rest of the model to keep computational time at reasonable levels.

They went through the same process for each motor, armature currents and magnet materials. When each model was ready, they actuated the analysis module, and it went

through calculations that ended by presenting a wide range of results. The results included graphs and histograms of the solution and contour plots that showed the magnetic field values superimposed on the surfaces of the model. The key results were tables that showed electromagnetic forces in each direction at nodes that had been defined in advance. This information played a critical role in the design process by making it possible for Webster engineers to ensure that the magnet carrier had the strength needed for each application.

### **For More Information Contact:**

## **VECTOR FIELDS**

**Software for Electromagnetic Design**

### **USA, South America, Central America, Canada & Mexico**

Vector Fields, Inc.  
1700 N. Farnsworth Avenue  
Aurora, IL 60505

Telephone: (630) 851-1734  
Fax: (630) 851-2106  
Email: [info@vectorfields.com](mailto:info@vectorfields.com)  
Web: [www.vectorfields.com](http://www.vectorfields.com)

### **UK & Rest of World**

Vector Fields, Ltd.  
24 Bankside, Kidlington  
Oxford OX5 1JE  
ENGLAND

Telephone: (01865) 370151  
Fax: (01865) 370277  
Email: [info@vectorfields.co.uk](mailto:info@vectorfields.co.uk)  
Web: [www.vectorfields.com](http://www.vectorfields.com)