Building Sustainability: An R&D Story

How and why a small company spent more than four years improving one of its products.

This is the story of a small company (40-person staff) that invests in research and development, in-house production, and local manufacturing. The company believes this investment will improve its own sustainability and the sustainability of its customers, the environment, American manufacturing capacity and the U.S. economy.

One of the company's latest accomplishments is the creation of a new, innovative product that is more durable and uses fewer natural resources and less energy to manufacture than its predecessor, but performs just as well if not better. The product does not have a large market, so it will not result in a surge of sales or quick dollar return. The product took more than four years to develop and test, a process financed from the company's limited profits during a period of recession.

The product is an electromagnetic impact rapper for electrostatic precipitators, designed and manufactured by Neundorfer, Inc. in Willoughby, Ohio (just East of Cleveland).

For nearly 25 years, Neundorfer has designed and manufactured rappers in-house. Virtually all aspects of production are done at the Willoughby, Ohio shop: winding magnetic coils, fabricating most weld parts, assembling components, and testing individual rappers.

Design of the new rapper, dubbed "EMR Impact" to distinguish it from previous model "EMR-2," followed that same pattern. The rapper was developed through teamwork, technical expertise and years of experience by engineers working with manufacturing, assembly and testing people.

When this R&D project got underway in mid-2006, the price of copper—used for magnetic rapper coils—was soaring. To avoid passing that cost on to customers, Neundorfer chose instead to design a new model using

Comparison: Rapper Exteriors

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significantly less copper wire—without compromising performance. Secondary goals were to make the rapper more durable, and reduce environmental impact by using fewer materials.

Each iteration of R&D, leading up to the final product, was conceived, designed, prototyped and tested in multiple environments by a development and manufacturing team that included Senior Design and Development Engineer Karl Artz, Mechanical Engineer Pat Horvath, CAD Designer Dan Quirk, Assembly and Testing Expert Don Kral, Shop Supervisor Joe Chabail, Machinist Jim Sabol, and Fabricator and Assembler Luis Santiago. People on the team talked to each other, exchanged ideas, designed test procedures and ultimately created an elegant new product.

Design process

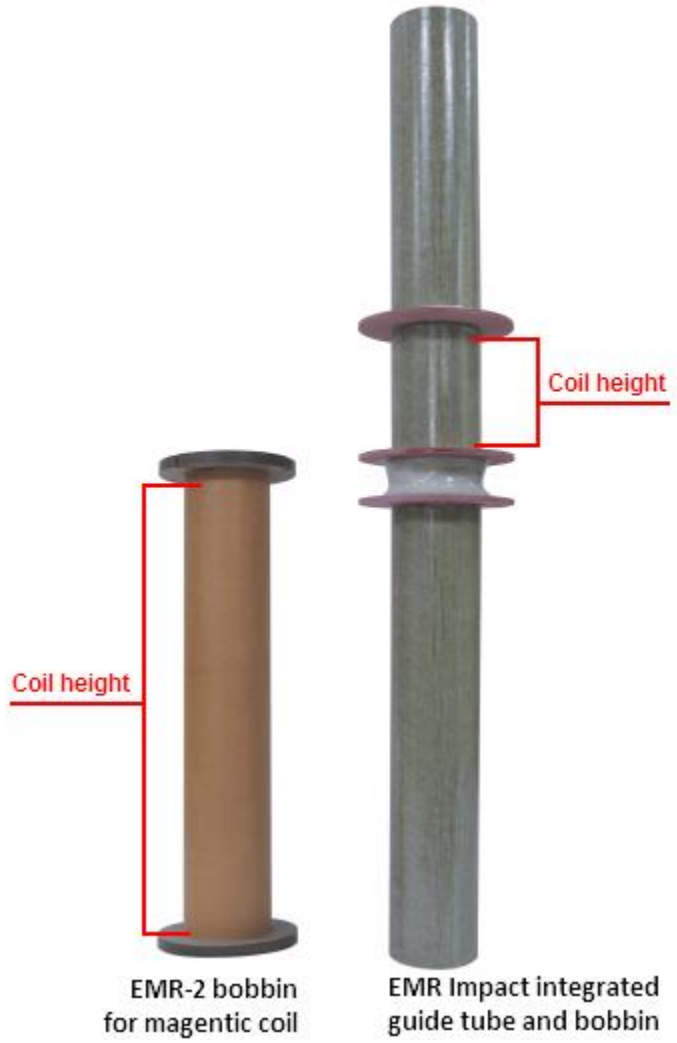
It all started when Artz began working with a summer intern (Ed Steinke) on ideas for a new, improved rapper design. Their goals: reduce the amount of copper used and increase rapper lifespan by developing a more durable guide tube. First, they considered and tested wide range of possible materials for the new guide tube, including various plastics and fiberglass.

"In going through all these wild material ideas, we came to the realization that our EMR-2 rapper design was a good mechanical package," says Artz. "This validated our focus on improving the design with a much lighter coil and a new guide tube."

Initial R&D efforts for a new rapper focused on improving Neundorfer's 240 volt, 20-foot-pound EMR-2 rapper model. Changes were later applied to other rapper models.

Ultimately, the design team decided to go with fiberglass for a combined guide tube and coil bobbin, integrating these components into a single unit. Artz then designed a new coil using significantly less copper. Based on some initial tests, he developed a spreadsheet to automatically calculate the effect when different geometry variables were changed.

Comparison: Rapper Coil Bobbins



"The lifting force of the magnet is related to the amount of current and the number of turns of wire on the bobbin," Artz explains. "The spreadsheet calculates that based on the geometry. When a geometry variable changes, the spreadsheet re-calculates the total magnetic strength and magnetic strength per unit of coil length. I used this to explore ways of achieving the same results using less copper."

Taking the time to do it right

R&D for the new rapper took more than four years because Neundorfer is a small company and at times resources were needed for other priorities—such as production runs of EMR-2 rappers. In typical Neundorfer fashion, the project was paused when necessary to ensure quality outcomes.

"Development of the EMR Impact was a long, drawn-out process of iterative trial and error," Artz notes. "We tried a lot of things that didn't work. But we kept at it with determination that we weren't going to compromise."

About two years into the process, Mechanical Engineer Pat Horvath got involved. His role was to fine-tune the design, so all components fit together, taking into consideration a list of electrical and mechanical constraints. For example, the coil size was set, and component expansion and contraction had to be adjusted for over a 160-degree temperature range (-20F to 140F).

After making calculations and creating plans on graph paper for the rapper, Horvath handed drawings over to CAD designer Dan Quirk who re-created the design in SolidWorks and verified that everything fit.

Two iterations of physical prototyping ensued. On the second round, a few finishing touches were added, including new type of top bushing to keep internal components in place despite the effect of thermal expansion and manufacturing tolerances. By late 2010, design and prototyping of the EMR Impact rapper was done. The first production run started in October.

Comparison: Rapper Features

EMR-2	EMR Impact
Aluminum guide tube. Separate bobbin clamped over the tube.	Fiberglass guide tube and bobbin, all one piece.
Aluminum guide tube required lubricating the piston.	Guide tube is much more durable; piston lubrication no longer needed.
13 and 16 pounds of copper wire for coils in the 240 and 120 volt models respectively.	4 and 6 pounds of copper wire for coils on the 240 and 120 volt models respectively.
Metal plug with O-ring at top (removable so operators can measure lift height) required tapping powder from threaded hole; caused rusting.	Metal plug replaced with a plastic plug and rubber gasket; no longer requires removing powder coat from threads on rapper housing. Added benefit: plastic plug is more durable, costs half as much, and can be removed with screwdriver or wrench.
Top bushing did not protect internal components from shifting due to thermal expansion and manufacturing tolerances.	Superior top bushing that "gives" in response to thermal expansion and manufacturing tolerances; keeps components in place, extends life.

Thanks to perseverance, ingenuity and innovation, the R&D project's main goals—reduce copper while maintaining excellent performance, avoid raising prices, increase durability—were realized. Although the cost of steel and other components has risen, that is offset by the new design's requirement for less copper. Overall, the EMR Impact costs about the same to manufacture as the EMR-2.

"A primary goal of this R&D project was to keep costs down for customers," notes Mike Neundorfer, founder and CEO of Neundorfer, Inc. "We succeeded in that effort, and created a rapper that not only maintains the excellent performance characteristics of the EMR-2, but is also longer-lasting and more environmentally sustainable."

Made in America

All of this was done in America, by Americans. The EMR Impact's major components are fabricated in the U.S. To the people involved in developing a new rapper design, the benefits of keeping things local are obvious.

"The advantage of developing and manufacturing the rapper here is we're giving jobs to Americans," Artz says. "And, we're building a quality product, not something that's going to break."

Horvath appreciates Neundorfer's flexibility and emphasis on excellent outcomes.

"The rapper design team had flexibility and did not have to go through a huge process of ROI financial analysis to justify decisions or explore possibilities," he notes. "That's the biggest advantage of being a small company."

That focus on quality is apparently paying off.

"Right now, we cannot keep parts in stock," Horvath says. "We'll have inventory soon, it will just take us a little while to get there because everything we're building right now is going toward an order."

Finishing touches

Although the EMR Impact is now shipping, Artz, Horvath and others on the development team continue to improve production processes. For example, some of the rapper manufacturing equipment is being upgraded, and a different, more durable coating for the EMR Impact's metal housing is being investigated. Plus, quality assurance and monitoring of all coils wound to date is ongoing.

To verify the EMR Impact's durability, Horvath is monitoring one of the rappers as it runs continuously, the goal being to get it up to a million cycles (equivalent to about a ten-year lifespan). This is the second time the test, which includes going through heating and freezing cycles, has been run on an EMR Impact rapper.

About Neundorfer

Since its inception in the early 1970s, Neundorfer has partnered with industrial plants and power utilities to identify, define and act upon opportunities for improving energy efficiency, reducing costs, cutting emissions and building sustainability. Mike Neundorfer believes in a cooperative approach to product development, and the team he's assembled supports that vision.

"Having under one roof all the resources needed for developing and manufacturing innovative, awesome products like the EMR Impact can result in long-term dividends for our customers, for our company, and for the United States," says Steve Ostanek, President at Neundorfer.