Commentary

The Automotive Future of Thermal Spray Manufacturing*

Anne Stevens, Ford V.P.
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Anne Stevens

It's been a fascinating morning, and I applaud my colleagues for their insightful comments. But let's be honest. It's also been a *long* morning. And now it's my turn. A great public speaker once advised me that the most effective speeches are short—especially when you're last on the agenda. He said: "Be accurate. Be brief. And then be seated!" So I promise you this: I shall be as brief as possible, no matter how long it takes me!

Back when I was an injection molding supervisor, my plant boss had a way of discouraging us from attending engineering conferences like this one. He'd simply say, "The great thing about conferences is that they tell us how many of our people we can actually do without." I disagree. In fact, I encourage my people at Ford to take advantage of these opportunities whenever they can. That's because I believe conferences are a tremendously enriching break from the hectic pace of manufacturing life. It's good to get away, compare notes with peers, and think beyond our daily tasks and deadlines to the larger implications of our work. So I'm happy to be sharing this time with you—at this event that is designed to recognize the past, support the future, and nurture prosperity in this field—a field that is so critically important to the broader discipline of manufacturing.

Today I'd like to tell you about a significant Ford innovation in thermal spray die making—one that promises to change the process of product development, allowing us to provide more unique products in less time, at lower cost and complexity. But first, I'd like to place this innovation into the context of a new age—an age that has demanded that we change more quickly, more completely, than at any other time in our history. To really understand what this new age means to us at Ford, it's vital to look back, to take a longer view of our industrial heritage.

I admit to having an ulterior motive for putting this into historical perspective. Ford Motor Company celebrates its 100th anniversary this summer. As I like to say, a hundredth birthday doesn't come around every day, so it's a significant event. Yet it's not just history for its own sake. As everyone knows, Henry Ford refined and went a long way to perfecting large-scale, low-cost mass production. By 1920, more than half of all the cars in the entire world, not just in North America, were identical Model T Fords. Henry Ford literally put the world on wheels and defined the next hundred years of American mass-market culture. If you had asked practically anyone at that time, they would have told you that Henry Ford invented the automobile. He was not only the richest man on earth, but one of the most popular. The New York Times did a national survey that ranked him among the top eight Americans who ever lived, right up there with George Washington and Abraham Lincoln!

The man who brought the world the freedom and mobility of a personal car was a folk hero. And he was publicly credited as the inventor of the moving assembly line, vertical integrated manufacturing, and flow-through production.

Yet the truth is, Henry Ford invented nothing whatsoever. What he did was bring the most advanced ideas together from other industries to create a mass production process. A process that could produce high-volume, high-quality, and low-cost vehicles. His contribution was more like that of a manufacturing engineer—not the father of ideas but the one who sees their potential in infancy, then nurtures them to maturity.

Maybe I'm prejudiced, because I happen to be a manufacturing engineer. Still, I believe the one who nurtures an idea often has the more difficult and demanding task. My point is that while we engineers may not be interested in history, we certainly make a lot of it. Because we're busy shaping the tools—and forever after, those tools shape our lives.

As a noted biochemist once said, "Science can amuse and fascinate us all, but it is engineering that changes the world."

As you'd assume, Ford Motor Company's research efforts have come a long way since Henry Ford shared his first brilliant ideas with the world. We're still developing our own ideas—as well as building upon the best ideas within manufacturing today. As a great innovator, Henry Ford created a culture within our company that encourages creativity and growth. One-hundred years later, our best assets continue to be the inquisitive minds of our engineers and other employees.

Some of our most exciting work happens within our Ford Research Lab, which was established in 1951, after Henry Ford's death. It was in this lab that our teams recently developed the rapid tooling technology that I am so excited to share with you today. Anticipate,

*This is the script of Anne Stevens that was formally presented at the Plenary Session of the International Thermal Spray Conference in 2003 (Orlando, FL). It has been formatted and edited by the Editor of JTST to fit within the general guidelines of a text journal; i.e., several video segments cannot be presented, and the formal text has been adjusted.

innovate, and incorporate. That's what the Ford Research Labs, and good product or process development, is all about. And that's great, because we need all those things now—perhaps more than ever before.

If you've been reading the business and trade press, you probably know that our company is in the midst of a massive revitalization effort. Many factors have brought us to this point in our history—geopolitical tensions, a turbulent economy, the war in Iraq, and the ongoing war against terrorism have taken a toll on most all industries and sectors. So, too, have shifting market and consumer demands. As you know, manufacturers, especially domestic automakers like Ford, have been hit hard. Industry-wide overcapacity, intense competition, and customer expectations have transformed our business.

In order to regain profitability, we know that we must rethink and remake the very way we work. Like many organizations today, we're rightsizing our operations—cutting out the fat and becoming more lean, flexible, and responsive to our consumer markets. We know it's the only way we will survive into our next century. Our future is all about change and our company's ability to adapt to it. Agility, robustness, nimbleness, responsiveness, resilience, and flexibility: these are the only viable strategies in an era of unprecedented, and unpredictable, change.

As a result, we've been moving from mass manufacturing to lean production—and in one decisive effort we soon will go to fully flexible manufacturing. This transformation will cut waste and improve quality and efficiency. It will allow our plants to change the mix of products within their existing capacity and convert to new products with minimal investment and changeover losses.

All this needs to turn on a dime, of course; we must be ready to meet any market demand or condition in the shortest possible time. In preparation for this, we have examined all our processes—the very way our cars come together—to cut out time without sacrificing quality, accuracy, or durability. If we can find a way to reduce costs at the same time, well, that's a tremendous bonus. These are the massive challenges we have presented to our Research Lab engineers. Talk about pressure! But they've done very well under the weight of it and have achieved some great work.

I'm pleased to say our new rapid tooling method is one of their more brilliant innovations. It cuts tool production time from 20 weeks to less than a week. That's tool making without any machining! It delivers a 30% reduction in costs and a 50% improvement over existing technologies. What a major breakthrough! Better yet, there's no sacrifice in quality, accuracy, or durability. To accomplish this, our research engineers did nothing less than change the basic premise of tool making. They didn't throw out the mold, as the old saying goes—instead, they invented one!

You see, the traditional method of die-making is as old as the sculptor's art. It's a *subtractive* process. As the artist says, "You start with a block of stone and chip away everything that is not your statue."

For more than a hundred years, we've made tools by starting with a hunk of steel, then chipping and grinding away at what we don't want. Oh, a lot of sophisticated new grinding and chipping technologies have been added, like computer numerically controlled machine tools and high-speed five-axis machining. These innovations have helped to accelerate things quite a bit—from nearly a year in Henry's time to five months today.

But our new flexible processes required us to do much better, and the answer was to go in the opposite direction entirely. Unlike the old subtractive method, Ford's new thermal spray method is an *additive* process. In it, a ceramic master of the working die surface is spray coated with molten wire, then backfilled with epoxy to create a working die. These dies can hold production tolerances and be delivered in a fraction of the time and cost required for more conventional dies.

No machining. No heat treating. No chips. In short, here's how it works. We get a part master from REN boards, stereolithography models, silicone rubber, or plaster. Then the part is cast in ceramic and frozen.

After we separate the master, the die is dried in an oven prior to spray coating. Once the ceramic is on the model, freezing it sets up a crystalline structure on the surface—almost like ice crystals. Subsequent baking drives the water out, leaving small voids in the place of the crystals. These small voids provide something for the steel to bite into. The ceramic is never fired, in the sense of traditional ceramic processing. The result is a low-cost process that accurately replicates the patterns with excellent surface and thermal shock properties in a ceramic mold.

Metal spray deposition happens courtesy of an industrial robot with four spray guns mounted on the end of the arm. Our system uses a computer-based thermal compensation software and programmable logic controller and infrared camera on the spray unit. It is a closed-loop system that can make instant, in-process adjustments.

We've developed this technology for small, as well as large dies. Our largest part to date is the inner hood mold for the Mercury Mountaineer, with measurements of 36 by 36 in. By 2004, we hope to be working on 96 by 96 in. surfaces. Better yet, we've taken this technology from concept to production level in just two and a half years. The process has proven so robust that we can now deliver prototype parts from spray formed dies in as little as six days, from master model to stamping press, depending on the configuration.

Okay. Sure. I know what you're thinking. I can just hear some of you saying that thermal spray deposition isn't a new process. And you're right. But in the past it has been a flawed process. It traditionally made dies that were prone to surface imperfections and cracks.

We don't, of course, want to go into the tool-making business. Our goal is to quickly get this enabling technology into the hands of vendors who make tools. We're beyond the stage of innovation now and well into implementation. We already are licensing the technology to make dies, punches, and other tools by this thermal spray process. The first license went to Praxair Surface Technologies of Indianapolis, which not only does a volume business in automotive and aerospace, but also sells thermal spray coating equipment through one of its companies. Another initial vendor is Atlas Tool of Michigan, one of the world's leading independent stamping die makers. We believe our licensees—the vendors who are directly connected to production tooling—will find more ways to adapt and advance the technology than we ever could. And in the end, we all will benefit.

This rapid tooling technology is an excellent example of Ford's century-old approach to research and development and a giant step, among many, into a new century of flexible manufacturing.

Henry Ford was a manufacturing pioneer whose approach to problem solving was both inclusive and direct. Much of the methodology he established is still in use today and will help us address the challenges of a new age. It is our goal to be a leader in that new age, using our collective talents to develop even more new methods and technologies. What we need now is more of Henry's pioneering spirit, understanding the challenges and employing both inspiration and perspiration to meet those challenges.

I'd like to end with a thought from Henry Ford on pioneering efforts. Once, late in his career, he said "Our great pioneering has not been in covered wagons but in laboratories and workshops and in better ways of living together as a human society." It's my hope that we all see this new age of whirlwind change as an opportunity to leave a similar legacy of pioneering achievements, both small and large.

Anne Stevens
Vice President
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Biographical Information

Anne Stevens was appointed vice president, North America Vehicle Operations, Ford Motor Company, on 1 August 2001. She is responsible for overseeing the operations of 21 assembly plants and eight stamping and tool and die plants, in Canada, Mexico, and the United States. Previously, Stevens was vice president, North America Assembly Operations, a position she held since April 2001.

Stevens received an Outstanding Business Leader award from Northwood University. In 2000 she received the prestigious Shingo Leadership award and later was appointed to the Shingo Prize Board of Governors. Stevens was recently named to Fortune Magazine's list of "50 Most Powerful Women In Business," Crain's Magazine's "Most Influential Women" and "Michigan's 95 Most Powerful Women" by Corp! Magazine.

Stevens joined Ford Motor Company in 1990 as a marketing specialist in the Plastic Products Division, Vehicle Exterior Systems. In 1992, she was named manager of the Quality Services Department at the division's Saline (mizh.) Plant.

In 1995, Stevens became manufacturing manager for Plastic and Trim Products Operations. Later in the year, she was named plant manager at Ford's Enfield (England) Plant and became Ford's first female plant manager in Europe.

In 1997, Stevens was named assistant vehicle line director, Small Car Vehicle Center, for Ford Automotive Operations in Dunton, England, with responsibility for Fiesta, Ka, and Puma vehicles.

Stevens returned to the United States to assume the post of director of the Manufacturing Business Office for Ford in North America. In this position, she was responsible for global capacity planning, new program coordination for manufacturing, business, and manufacturing labor strategy. Stevens also served for 15 months as an executive director in Vehicle Operations in North America.

Before joining Ford, Stevens held various engineering, manufacturing and marketing positions at Exxon Chemical Company.

Stevens holds a bachelor's degree in Mechanical and Materials Engineering from Drexel University in Philadelphia and did graduate work at Rutgers University in New Brunswick, N.J.