Siemens VDO Automotive Case Study
Fotofab
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Shrinking the Engineering Design and Cost Envelope

Evaluating precision metal parts designs can be costly and time consuming. Siemens VDO Automotive found a cheaper, faster and more efficient prototyping solution: Photochemical Machining

Tier-1 automotive parts and systems suppliers are under tremendous pressure. Vehicle OEMs carry much clout and wield it with a heavy hand, relentlessly demanding suppliers deliver higher-performing systems and parts but at lower prices. Ultimately this means carmakers and other vehicle manufactures can keep prices competitive and profit margins from disappearing altogether.

It's a tough game and at the center of it are the design and system engineers who are handed the unholy task of weighing myriad factors to achieve the ultimate balance between reliability, performance-related design goals and cost efficiency.

And it doesn't just stop at developing cheaper-to-produce designs either. Competitive time-to-market pressure is another dynamic that is constantly working to compress vehicle, and vehicle system design cycles into tighter and tighter timeframes. Not only do design engineers need to drive cost from their designs but they are compelled to drive time, and therefore cost, out of the design process as well.

Jim Wynn, a design specialist for Siemens VDO Automotive's fuel components division in Newport News, Va. knows first-hand just how challenging it can be. Recently Wynn and his department colleagues were tasked with designing a key component within a particular device as part of a new fuel-delivery system. Proprietary considerations prevent directly identifying the device or its components, but suffice it to say it is a simple, yet highly engineered thin-metal part that is critical to the function, reliability and overall performance of its portion of the fuel delivery train.

The Timely Pursuit of Performance
When Wynn and the other department engineers first began considering the overall device and its function, they began their search in the off-the-shelf parts bin. It soon became apparent that what was available from various suppliers would never satisfy a number of the functional goals the Siemens VDO design team had in mind for the part. What the situation called for was a new component, engineered from the beginning to fulfill its simple, but important mission.

Trouble was the engineering resources it would take to design, prototype and test a part that ultimately must cost only a few cents per unit to manufacture, would have to be managed extremely well if the effort was to succeed on all levels. "That means we had to do a whole lot of things really well in a short time frame," says Wynn speaking for the team and offering an easy-to-say, but hard to do analysis of the situation.

As a member of the Siemens VDO engineering team tasked with creating the company's next-generation fuel delivery system—it's Wynn's job to help sort it all out and get the part off the CAD screen and into preproduction as fast and as cheaply as possible. Remember though, neither the system, nor the part is going to deliver any kind of return on Siemens VDO's development investment—that is, not until its performance and price targets are met and an OEM vehicle maker decides to sign a long-term supply contract for some upcoming vehicle platform.

"Once we eliminated finding an off-the-shelf solution," says Wynn, "we started thinking about designing something totally different. We felt that if we did it right, not only would it trim the number of parts in the assembly, but we would realize better performance and reliability at a lower per-unit cost."

According to Wynn, the part functions within the fuel flow so fluid dynamics come into play. Its simple mechanical operation also has to survive literally billions of operational cycles during its service life. Initial CAD engineering work yielded several prospective designs that would likely manage the various packaging constraints, flow characteristics and physical, operational dynamics that the Siemens VDO team needed to achieve for the part.

Proof-of-Concept and Beyond

Although computer modeling is a proven way to evaluate the physical and operational attributes of a proposed part design, "For such a small part it's hard to justify the resource allocation," says Wynn. "Computer modeling also doesn't always tell the whole story; stresses can balance out, and no matter how accurate the calculations are, the data still can only *suggest* how the design *might* perform in the real world."

To prove the concept it was necessary to bring the part's design into the physical realm for testing and evaluation, but the team's dilemma was how to do it quickly without incurring a great deal of expense. As with any flat, thin-metal part, stamping is an obvious first choice as a fabrication method, but at this point in the engineering process it would cost way too much to create tooling and take too much time to produce viable prototypes in the quantities and variations for Siemens VDO's engineers required to conduct the testing regime.

Rapid Prototyping in Real Time

"I had read about etching [photochemical machining, see sidebar] on the Internet and understood it was an alternative to stamping as a way to make thin metal parts in low-to-medium volumes," recalls Wynn. "I also remembered that some of my colleagues had used etching for prototyping parts designs and making pre-production supplies of parts for new systems as well." According to Wynn, his colleagues referred him to Fotofab, a supplier with an established relationship with Siemens VDO located in Chicago. As a veteran supplier of photochemically machined parts for applications in an extremely broad range of technologies and industries, Fotofab was a perfect resource to accomplish the rapid prototyping of Wynn's part in real time.

"The plan," explains Wynn, "was to try out as many ideas as possible and rule out a whole lot right away." Wynn explains that the initial 2D CAD design work had suggested 20 possible configurations. "Because the etching method requires no hard tooling we were able to lay out all 20 proposed configurations so that they would be reproduced on one sheet of metal." To get the ball rolling says Wynn, all he had to do was simply e-mail Fotofab the CAD file.

The inherent economies and efficiencies of photochemical machining continued to play a critical role. "We had Fotofab process our designs and fabricate the parts using four different thicknesses of the same metal," says Wynn. "They turned the order around quickly, and within few days we had 80 variations to try."

With the parts physically in hand, Wynn and the Siemens VDO design team were able to quickly and confidently eliminate about 95% of the prospective designs after testing them in the prototype device. "If we had relied on computer modeling to evaluate all these designs it would have taken several weeks and many man hours to vet each one. As it was, within a week we were able to focus in on the most viable designs and narrow down the choices for the right thickness and best material for the part."

Wynn says that what emerged from the team's initial testing regimen were three promising designs—ones they wanted to test further so they could get an even better understanding of how material choice and thickness would affect the part's functionality and reliability. The three designs were laid out in multiples of 12 this time and etched from two thicknesses and alloys of metal. "Again, Fotofab's turnaround of our order was quite fast," says Wynn, "which meant we were able to focus the design very rapidly." Once this series of evaluations were completed the team had a good handle on the best design but still had open questions about the best material.

"We were very close at this stage," Wynn notes, "but we had found that we were experiencing durability problems with the materials we had been using so far." The next step, according to Wynn was to upgrade the material to a particular stainless steel alloy that would not only help maintain critical tolerances once the part moved into high-volume stamped production, but at a thickness proven through testing to likely offer the best overall balance between cost, performance and reliability.

“The twist here was we were the ones to supply Fotofab with the new alloy,” explains Wynn, ‘because their regular suppliers didn’t have it. We have a little pull in this area so we were able to get the material and ship it to Fotofab, who again, worked with us to turn the order around as quickly as possible so we could proceed with the finalization of our design.”

Within days, 20 identical copies of the heir-apparent design were reproduced with extreme precision, within exact tolerances and free from any sort of manufacturing induced flaws or variations. “At last it looked like go,” says Wynn, as the near parallel tracks of design, prototyping and proof-of-concept wound to a close. “We felt the last iteration had really nailed it, and our last several orders have been based on that design, material and thickness.”

Free to Innovate

Wynn agrees that the inherent speed, flexibility, cost efficiency and precision of the photochemical machining technique played a dominate role as design and engineering process enabler. “It allowed us to be innovative and let us quickly gather enough proof for management to get behind the project and justify the resource allocations it would take to move forward with the new system. It’s definitely become a best practice and I’ve been sharing our success with it across the organization.”

At this point Siemens VDO is moving forward with its plans to market the new fuel delivery component, shopping it to OEMs as they prepare to launch new model-year 2007 vehicle platforms. “Our intention,” says Wynn, “is to ramp up production of this part into the 2 million-per-year range and that means we will have to stamp it. But what we are finding out now is that the flexibility of the etching process is letting us produce the part in pre-production quantities, enough to fill initial orders and allow us to postpone a major tooling expense as long as possible.”

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