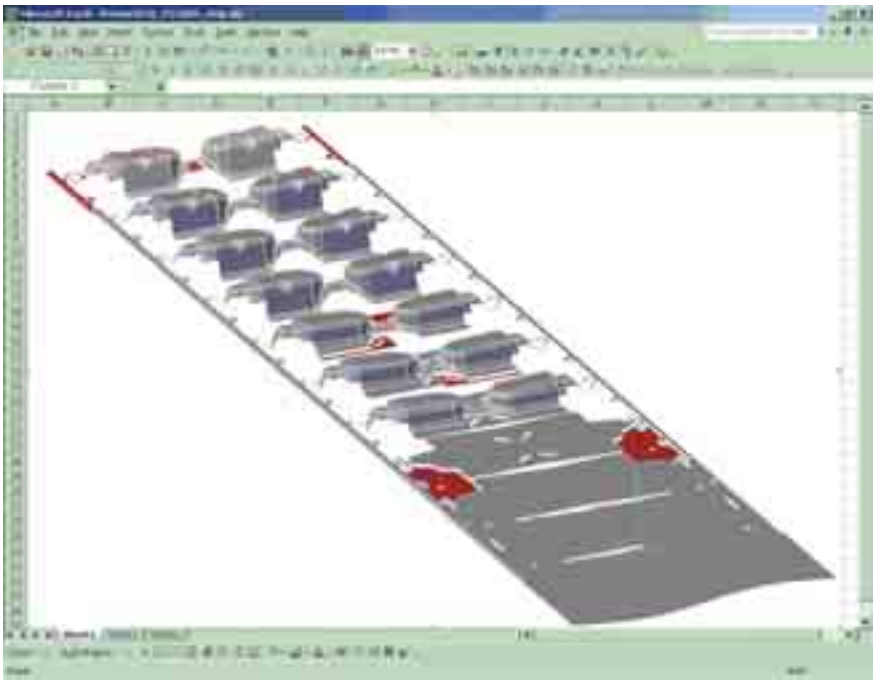
# Simulation Slashes Die-Tryout Costs and Time

The need to eliminate a stretch carrier in production of a drawn automotive part provided a perfect opportunity to test computer forming simulation. Cutting die-tryout cost from $18,000 to $3600 demonstrates that simulation passed with flying colors.

Precise Engineering, Lowell, MI, had to design a progressive die to handle a narrow stock width that made it difficult to accomplish a successful draw. Originally, the part, an automotive component, had been designed to run two across with a stretch carrier on each side and one in the middle to avoid the risk of thinning. As a cost-reduction measure, the customer requested that the stock width be reduced by 2 in., making it necessary to eliminate the middle stretch carrier.

To design the die based on experience, Pat Quinlan, Precise Engineering president, estimated 100 hours of press and labor time at $125/hr. and 100 hours of machine and labor time at $55/hr. to overcome the inevitable thinning problems during startup. Instead, the company's engineers simulated the drawing and forming process using Pam-Stamp 2G software from ESI Group, Bloomfield Hills, MI. Using simulation, engineers spent 60 hours at $60/hour evaluating alternative die configurations until perfecting the die. That meant a die tryout cost of $3600 for computer simulation versus $18,000 for the trial-and-error method.

Precise Engineering, which designs and builds complex progressive dies, is well aware of the benefits of simulation in the process. Engineers simulate every die to validate the process before actual design begins. CNC technicians program individual blocks directly from the die design, utilizing VISI software, the same software used in the original



**Simulation software provided the information needed for Precise Engineering engineers to develop a progressive die strip for an automotive part and test its performance prior to actual die build and tryout.**

design process. Personnel then assemble, tune and test each tool in coil-fed production presses. Runoffs are held at Precise Engineering prior to shipment and then again at customers' plants for training and validation. Customers receive up-to-date detail drawings of each die component, important should a component need to be replaced quickly.

## Deep Draw Creates Thinning Risk

The automotive part is challenging to produce because the combination of a deep draw and a tight material allowance makes it difficult to absorb the stretch during the drawing operation without thinning. Precise Engineering engineers originally set out to carry the parts two across with three stretch carriers. The original strip provided to the customer for approval had a stock width of 27 in. and a pitch of 12.1 in. The customer asked Precise Engineering to reduce stock width to 25 in. to comply with the material usage that the customer had quoted to the original equipment manufacturer. The material, a bake-hardened steel alloy with a low n value, further increased the chances of excessive thinning.

The only way to reduce stock width: remove the inside stretch carrier located between the two parts. Why the need for stretch carriers? The depth of the draw requires a pad on the blank to hold the material during drawing. Standoffs on the pad apply pressure to control the material as it is drawn over the post. The two parts stay attached during drawing to provide additional stability. The stretch carriers are created by a trimming operation that precedes drawing and creates a weaker area that allows the blank to pull in, compensating for the stress of the drawing operation and avoiding damage to more critical areas. A later operation trims the carriers.

Challenging die designers was the need to accomplish a successful draw without the luxury of the middle stretch carrier and without exceeding the 20-percent thinning allowance.

## Simulation Versus Trial and Error

Typically, die designers would rely on intuition and experience—build it, try it out on a press and hope for the best. But on this 12-station progressive die, given the complex issues, the initial design most likely would have failed, probably due to thinning in the end parts. After engineers would have created a new die design, the existing die would have to be sent to the machine shop for repairs and then tried out again on a stamping press. This process might have to be repeated five to 10 times, substantially driving up die cost and tying up presses and metal-cutting machinery.

Recognizing these inefficiencies in traditional die design, Precise Engineering management opted for Pam-Stamp software for simulating metalforming operations. The software models the initial part and simulates all metalforming operations up to the finished product in order to develop trim lines and forecast potential material thinning, wrinkling, twisting and springback. Modules in the latest software version, Pam-Stamp 2G, include Pam-DieMaker for rapid die creation, Pam-QuikStamp for rapid stamping evaluation and Pam-AutoStamp for forming process validation, quality and tolerance control.

**These computer-simulation screenshots show how the automotive parts would appear in the progressive two-out die.**

## Steps to the Perfect Die

On this project, Precise Engineering die designers developed the initial die configuration and strip geometry using VISI die-design software, then exported the strip geometry to an IGES file for import into Pam-Stamp. The company's engineering manager, Gary Wysocki, then simulated the first drawing operation to determine how much of the forming process could be accomplished in the first hit without excessive thinning—important because the part needed to be finished within a limited number of stations. In a series of iterations, he changed drawing depth, binder pressure, percentage of standoff and other controllable parameters. He even tried forming the part into a cavity as an alternative to drawing, but that caused wrinkling. Even simulation iterations like this, where the proposed design failed, provided diagnostic information that helped engineers develop an optimized design. For example, when Wysocki found difficulty in achieving the required draw depth, he changed the blank geometry, adding several slots to provide enough extra stretch to properly form the part.

With the first drawing operation optimized, Wysocki simulated the retrim operations in the second and third stations. The most critical issue here: positioning the legs of the bracket, subject to relatively tight tolerances. For each iteration of the retrim station, Wysocki simulated the entire strip to determine how the retrim design affected the geometry of the finished part. He changed the retrim until the finished part met needed tolerances. In simulating

the fourth station, Wysocki was uncertain whether to make it a forming or a drawing operation. Fortunately, his ability to use simulation to maximize the depth of the initial drawing operation made forming possible at the fourth station.

With every simulation run, Wysocki also evaluated springback, critical due to the need to hold a ±0.4-mm form tolerance on the legs. In some cases, overbend must be added to compensate for springback but not on this part.

## Simulation Proves its Worth

"Simulation pointed us in the right direction and helped us determine the drawing depth, pad pressure, how much to retrim and where to place the slots to achieve the right amount of stretch," summarizes Wysocki. "The next step was building the die and evaluating its performance on a real press. The very first iteration of the die worked perfectly."

Building the right die the first time proved the advantage of computer simulation.

"The key to time and cost savings was the use of Pam-Stamp to simulate the performance of a wide range of die designs," says Rick Barnard, Precise Engineering general manager. "Creating a virtual-reality progressive die takes the tryout process off of the shop floor and into the engineering office where it can be carried out faster and without tying up presses. We determined the process, developed the initial blank, accurately determined the flow of material during the first draw form, evaluated the impact of springback on finished tolerances and monitored thinning percentages before we even began building the die." **MF**

*Information for this article was provided by ESI North America, Bloomfield Hills, MI. tel. 248/203-0642, www.esi-group.com.*

**Through its reliance on computer simulation, Precise Engineering can spend less time and money on physical die build and tryout.**