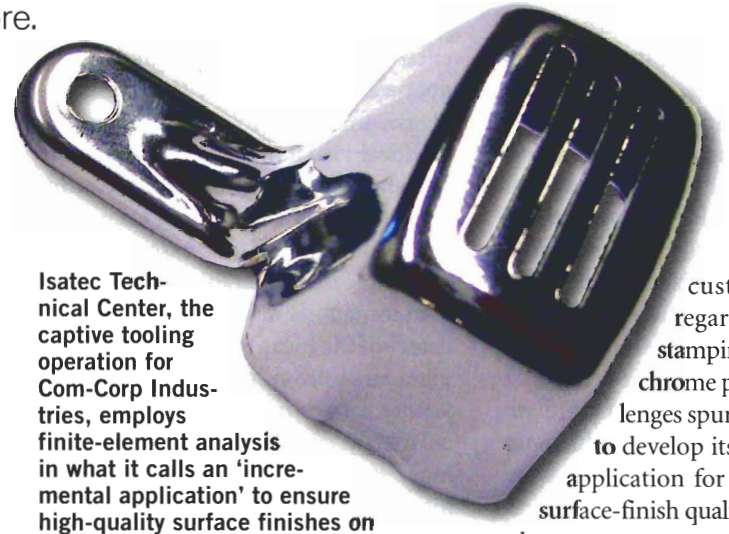
New Ways to Use FEA Data

Die designers routinely employ finite-element analysis (FEA) for forming analysis or die simulation, but FEA data can provide much more. Using FEA 'incremental applications,' this company simulates part surface-finish quality and more.

BY AL FOOTE



Isatec Technical Center, the captive tooling operation for Com-Corp Industries, employs finite-element analysis in what it calls an 'incremental application' to ensure high-quality surface finishes on automotive bulb shields.

"Today in the metalforming industry, if you're not performing some form of finite-element analysis (FEA), either forming analysis or die simulation, you're not in the game," says Michael Strazzanti, owner of the Isatec Technical Center, the captive tooling operation for Com-Corp Industries, Cleveland, OH, and user of FEA die simulation. "What really differentiates us from our competitors are what we call our 'incremental applications.'"

What Strazzanti refers to are the lesser known secondary FEA applications and services typically not offered in the die-design industry. One of them, the simulation and prediction of surface-finish quality, Strazzanti and his company developed themselves.

Surface Quality Vital in Bulb-Shield Production

Among other parts, Isatec produces bulb shields—bullet-nosed chrome-plated sheetmetal parts suspended in front of the bulb in an automotive headlight assembly. They're designed to protect a person's eyes from the direct rays of the light source and to control the photometric output of the headlamp. While functional in their origin, the shields also contribute to the aesthetics of the headlight assembly as well as the entire automobile. Therefore, Isatec customers are sensitive to the surface quality of these parts.

Sometimes a customer looks for a gleaming part, or the next step up—dazzling. Other times it's looking for just the right matte finish with a high-tech overtone. But difficulty arises in dealing with customer requests regarding tool design, stamping production and chrome plating. These challenges spurred the Isatec staff to develop its first incremental application for the prediction of surface-finish quality of chrome-plated parts.

Using FEA to Predict Surface-Finish Quality

"Many factors contribute to the surface roughness of a part and, therefore, its surface quality," reports Strazzanti. "These factors include the material, its grain size and uniformity, forming properties, and strain distributions that occur during manufacturing. Because we operate in a deep-draw progressive-die environment, we deal in cup sequences followed by multiple form stations."

Isatec personnel realized that most of the variables contributing to surface roughness were already available for analysis within the company's Dynaform die-simulation system, from ETA

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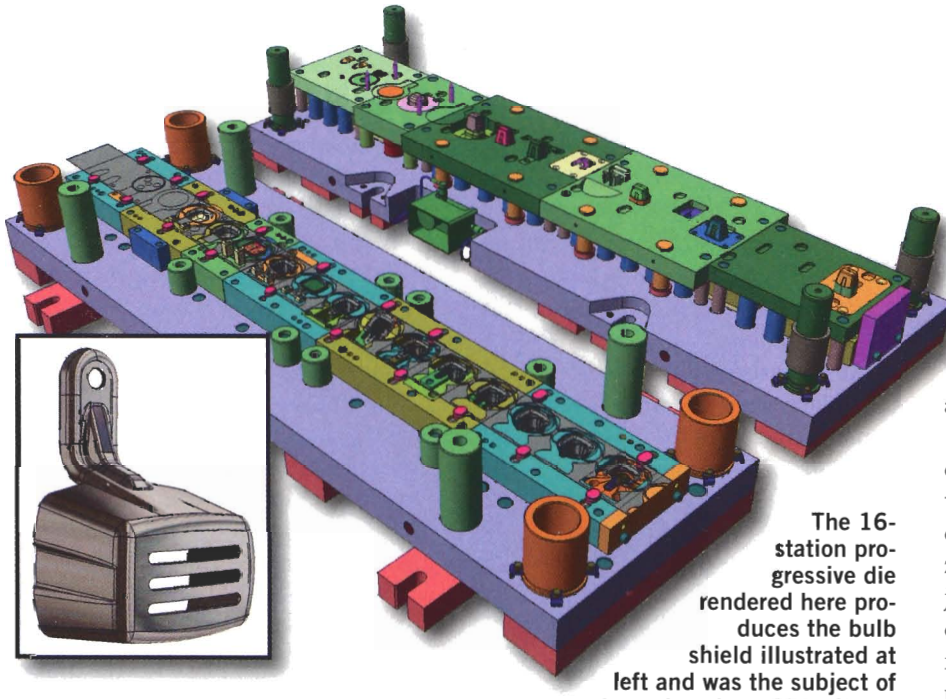


The 16-station progressive die rendered here produces the bulb shield illustrated at left and was the subject of Isatec's unique FEA efforts.

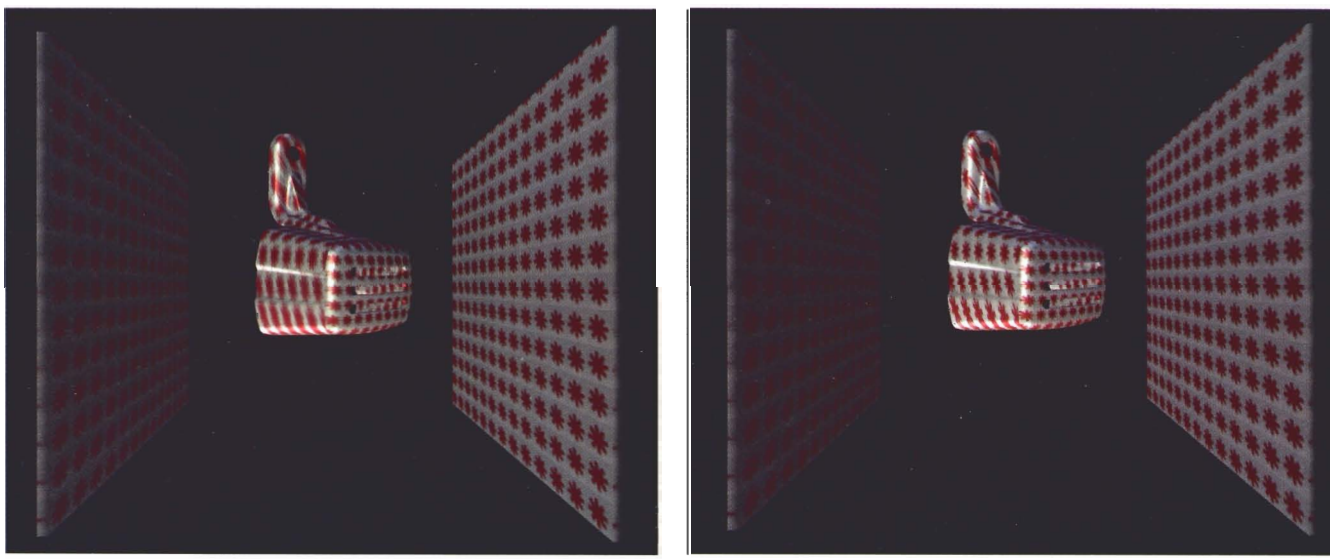
Corp., Troy MI, and purchased from Compass Technologies, a reseller of computer software for toolmakers located in North Olmsted, OH. They wondered if an application could be built to predict finish quality from this data. After all, for insurance reasons, the company already was performing die simulation in the design phase of every die it built to ensure proper tool performance.

"Dynaform presents a wealth of data," says Strazzanti, "such as material thinning, major and minor axis strain, and work hardening. We theorized that we could use this data to determine a material's surface roughness. We felt that if we could do that then we also could map the results in a surface simulation of the subsequent nickel-chrome plating process. Once completed, only one more puzzle piece remained: the generation of computer graphics showing surface smoothness so that our client could see its part in virtual reality."

Isatec underwent an 18-month R&D project to develop the new application with positive results. Now, in its quoting operation Isatec can show its clients graphic renderings of finished parts. Though Isatec's application for creating the graphics is patented and proprietary, the results are not, as shown in the graphics accompanying this article. Animated files (view some samples at www.isateceng.com/quotations) also communicate surface quality.

"Our new application has taken most of the guess work out of surface-quality specifications for bulb shields, and our customers are delighted," says Strazzanti. "And we're able to do a better job of negotiating the true costs of production into our contracts because part material and the amount of chrome plating are quantifiable in both their cost and effect."

Predicting surface quality with the new FEA application did require some changes at Isatec, reports Strazzanti. Primarily, it stressed the importance of maintaining a closed-loop system between design and manufacturing. Specifically, the company installed new procedures to ensure that computer modeling and analysis data reflect exactly what is happening on the production floor, meaning that every engineering change brings a possible rerun of the surface-finish-quality simulation. It also means that diemakers no longer can alter a die on their own—no more



This rendering depicts a computer simulation at Isatec where reflection plates are used to test the reflectance of a bulb shield. Note the sharper reflections on the rendering on the right, signifying higher surface-finish quality of the shield.

tweaks without the approval of the engineering department. Violation of these rules now means the loss of control over the process and the possible delivery of bad parts.

Isatec Finds Other Uses for FEA

Besides simulating surface-finish quality, Isatec employs FEA in another incremental application: analyses of customer parts in their applications. Though such a service is provided by many tool suppliers, Isatec goes further by including manufacturing-process factors such as thinning and work hardening.

An analysis performed with typical CAD data where sheetmetal thickness remains constant throughout the part may show no problem with a part design. But including manufacturing data from an incremental analysis, data derived from the drawing and stretching of the sheetmetal through cup sequences and form stations, provides clues to part-design flaws.

Isatec uses ETA's Virtual Proving Ground (VPG), a sister application to Dynaform, to perform FEA on customer parts in their applications. These types of analyses can include statics, dynamics, vibration, fatigue and thermal. Prompting Isatec to adopt VPG was a job involving a bulb shield, suspended on the end of a long mounting arm. Analysis showed that it would begin vibrating at a harmonic frequency of road noise. This prompted further fatigue analysis that showed the arms would fail in time. This would have resulted in replacement—under warranty—of the entire headlight assembly. Catching such problems before a product hits the market is imperative.

"Certain VPG system modules were built specifically for the auto industry," says Arthur Tang, ETA managing partner. "For example, one includes a complete FEA model of a typical automobile where almost all of the components are represented by 'sticks.' A user simply replaces the stick that represents his part. Then he can rerun as much of the entire vehicle analysis model as he chooses."

Leverage the Data You Already Have

Incremental analysis as part of FEA should be a goal of every die-design business, according to Strazzanti.

"Including incremental analysis data in our FEA analysis is not particularly new in the industry," he says. "But what is surprising to me is how few companies actually do it. I believe that the real competitive edge of a company is in its ability to run faster than its competitors, to capture the data it already has and owns, and to leverage it forward into incremental value (via incremental analysis) for its customer." MF