



Peter Ulintz is Advanced Product Engineering Manager for Anchor Manufacturing Group, Inc., Cleveland, OH. Having worked in the metalforming industry since 1978, his background includes tool and die making, tool engineering, engineering management, advanced process planning and product development. Ulintz has been speaking at PMA seminars, symposiums and roundtables since 1996, focusing on tool and die technology, deep-draw stamping, metalforming simulation and metalforming problem solving. His published technical works include a computer-assisted deep-drawing method and metalforming-simulation case studies.

**Peter Ulintz**  
[pete.ulintz@toolingbydesign.com](mailto:pete.ulintz@toolingbydesign.com)  
[www.toolingbydesign.com](http://www.toolingbydesign.com)

## TOOLING BY DESIGN | PETER ULINTZ

### Process Design: One Step at a Time

In many die shops, the number of metal-stamping dies designed and developed using process-modeling techniques continues to increase, often times exponentially each year. A common process-modeling technique used in the stamping industry is computerized metalforming simulation.

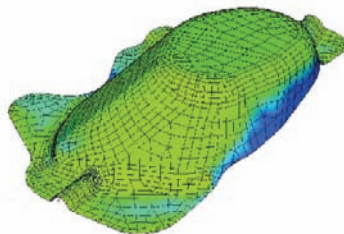
Metalforming simulations employ numerical analysis based on the finite-element method. This method consists of three components: preprocessing, numerical analysis and data output. Data compiled during the preprocessing phase, discussed in last month's column, is submitted to a solver for numerical analysis. Solvers, often referred to as code, carry out the computations and provide data output in the form of a virtual die tryout.

Two types of code find use in metalforming simulations with each having its own advantages and disadvantages. One-step codes are used during product development and process planning stages to assess manufacturing feasibility. Incremental codes are used as final validation for completely defined product and process designs. This month's column will focus on the one-step code.

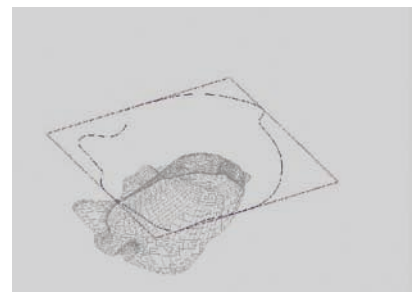
One-step codes are very fast and easy to use. All they require from the user are

final product geometry, usually in 3D CAD format, and minimal material properties. The software takes the final product geometry and forces it into a flat blank, providing reasonably accurate blank shape predictions. Resulting strain and stress distributions are calculated based on how much the material has moved (displacements). Since press shops are not in the business of making blanks out of final part geometry, the inverse result is more useful—that is, forming a blank into a finished part. Because steel has the same strength in compression and tension, strains from flattening the blank can be mapped back to the original product geometry with the same magnitudes but opposite (inverse) sense. In other words, negative compressive strains in the blank are mapped back as positive tensile strains to the product geometry. For this reason, one-step codes also are referred to as the inverse-method.

Due to simplifying assumptions, one-step codes compromise accuracy for the sake of time. These compromises are offset by the fact numerous what-if scenarios can be evaluated in a matter of minutes to help identify important process parameters. Because of its speed and minimal input data,



Formability Plot



Blank profile

Fig. 1—One-step simulation results



**Fig. 2—Blank output with trim material and part carriers added**

one-step codes routinely find use during product design to help establish feasible processing methods. One-step codes can provide visualized data output as wrinkle and splitting tendencies and/or approximate strain and thickness distributions induced by the forming process. The chief disadvantage of one-step codes is they are restricted to a single, one-step forming operation.

Wondering how this technology can possibly be beneficial, let alone cost justified, in your organization? Place yourself in this real world example:

Your customer sends an RFQ for a progressive die. Included with the request is a 3D CAD model of a relatively difficult stamping. The 3D product geometry is transferred, usually in IGES format, from your CAD software to a one-step software. Initial material properties are selected by the user and in a matter of minutes, results similar to those shown in Fig. 1 become available.

The initial formability results from the software indicate no splitting issues, which usually show up red on the formability plot. The dark blue area indicates a tendency to form wrinkles in this area. You must consider this in your overall process plan or make your customer aware of the potential for surface imperfections in this area.

Being satisfied with the initial results, a few more minutes will be spent altering material parameters to determine if the process is sensitive to property changes. This might involve setting the n-value and/or material thickness at low limits and reiterating the simulation. If the solution fails (splits begin to form), the process is too close to the so-called “deformation cliff” to form the part safely in one hit. At this point, the customer might be approached with a

design change recommendation to allow the part to be formed in one hit in the press. Or you may choose to quote the process with two draw operations.

Conversely, if the above solution indicates that your proposed process is not sensitive to material property changes, then friction coefficients and/or restraining forces might be altered to assess process sensitivity to lubrication or draw pad pressure changes. If the results still seem acceptable—maybe the wrinkle tendency was even eliminated with one of the changes—a process with only one draw station could be proposed.

Accurate blank-shape predictions present another advantage provided by one-step codes. These solvers can capture material stretching and compression that normally occurs during the forming operation; something that cannot be accounted for using classical length-of-line measurements or unfolding software. Once the blank profile has been determined and stock carriers attached, as shown in Fig. 2, coil width and progression can be determined.

Now, a quality progressive-die quotation can be prepared for your customer. There are no extra “just-in-case-we-need-them” forming stations in this proposal; it is based on part-specific data, not past experience or fear of the unknown. Material utilization is accurate because material stretching, compression and displacements were considered in the one-step code when it generated the blank profile. Potential surface imperfections (wrinkles), which may require design changes or quality concessions, are identified and can be addressed in the product-design phase when design changes are relatively easy to make, rather than at die tryout when it is nearly impossible to get concessions.

It took less than 30 min. to generate all of this data. This is “one-step” you can’t afford to miss when quoting. **MF**