

4D layouts for sheet metal

The September/October 2001 issue of ISMR featured an article about a new software for rapid die face design and tooling optimisation from AutoForm Engineering. An update in the May/June 2002 issue reported on the software's 100th customer, and the benefits and cost savings realized at BMW and DaimlerChrysler Germany. The software is now in use with the twenty largest automobile producers and at over 200 tooling and stamping suppliers.

This article previews two important technical innovations in the latest version of the software – 3D-Die-Layout and 4D-Process-Layout – which are of particular interest to process planners and tool designers.

Getting the right data

To plan the entire stamping process and associated tooling, and to generate the process layout for all required forming operations, accurate and reliable information is needed. Typical questions that process planners and tool designers need to answer include: What is the best drawing direction? Will splits occur after restrike? What press forces are required? Are there any critical trim angles? Will all of the stamped parts be produced within tolerance, all of the time?

The conventional approach to generate a process layout – converting a flat blank into a 3D part geometry via several operations (e.g. first draw, second draw, trim, restrike, flange) – is typically CAD-based, involving 2D sectional design. This procedure is relatively unstructured, with the results of the process layout depending upon the experience of the tool designer. Furthermore, to generate 3D surfaces manually is not only time-consuming, but relevant practical experience may not even exist for new materials such as high-strength steels, which are increasingly being used to reduce vehicle weight.

The resulting 3D active surfaces are then used for tryout simulations of the forming process, and based on the simulations, the surfaces must be modified for additional tryouts until a satisfactory process is achieved.

AutoForm's software for 4D-Process-Layout is 'the first commercially available solution to generate, validate and optimise the entire sheet metal forming process'

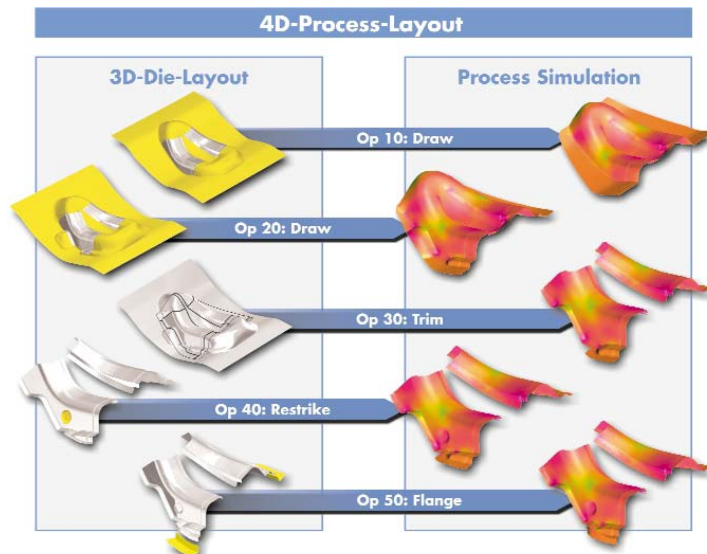
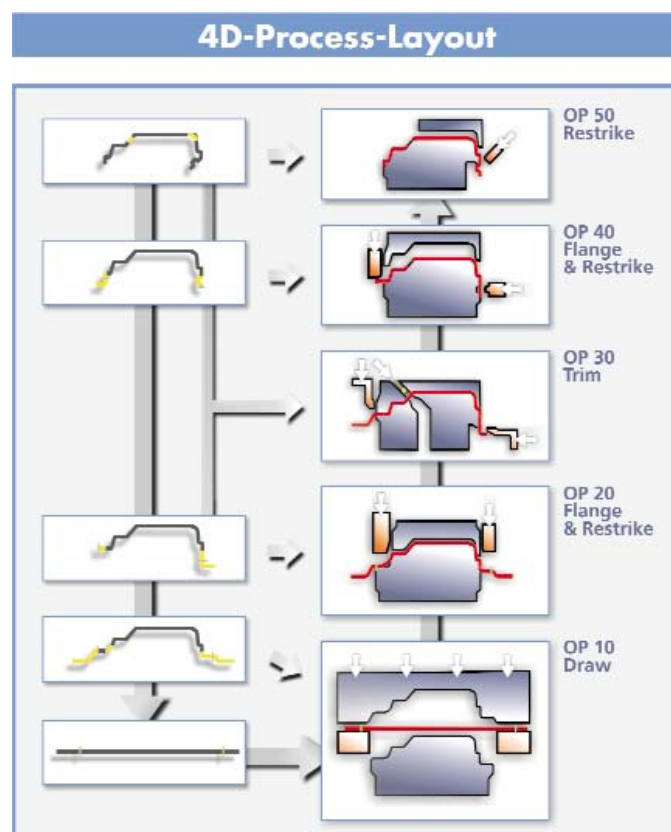


Figure 1 (above): The combination of the 3D-Die-Layout and the process simulation leads to the new concept of the 4D-Process-Layout

Figure 2 (below): Reverse part development (left column) and corresponding die layout (right column)



However, planners and designers typically do not have the time to make many surface modifications, to evaluate alternate process layouts or to optimise them. Therefore, the surface data used for the tryout simulations – and for subsequent milling of the tools – are not the best, and quality and reliability problems occur during production.

Technological innovations

AutoForm's new software addresses these problems by enabling early validation of the entire sheet metal forming process, combined with simulation of all the forming operations (pre-form, draw, trim, re-strike, flange) and springback. Specifically, the software's innovative concepts allow process planners and designers to directly generate 3D-Die-Layouts for all the stamping operations (including secondary operations) and directly validate the 3D-Die-Layouts through process simulation.

The 3D-Die-Layout integrated with the process simulation, which describes the movement of the tools and their effect on the formed sheet over time, is called 4D-Process-Layout. The 4D-Process-Layout provides much more informative feedback and is more reliable than conventional 2D-Process-Layouts, yet it requires less time. With its focus on the entire process including springback, the quality of the stamped parts and the robustness of the stamping process are increased and overall development time is reduced.

3D-Die-Layout

Several new ideas form the basis of the 3D-Die-Layout. First, the definition of 3D active surfaces for all operations is essentially based on the 3D part geometry. Secondly, an inverse approach is used to generate the surfaces. Finally, the 3D-Die-Layout is directly linked to process simulation, which is in fact the principle behind the 4D-Process-Layout concept.

parts

The 3D-Die-Layout starts with the complete 3D part geometry, and proceeds backwards to the flat blank, operation by operation, as shown in the left column of Figure 2. An important advantage of this approach is that all operations in the entire process layout are 'associatively linked'. This means that the effects of modifications to intermediate forming operations and even to the final part geometry are automatically reflected in the tooling surface data of all preceding operations. As a result, the software is well suited to the tasks of process planners and tool designers. Quickly and easily, they can define the entire stamping process and make process modifications, and also consider and evaluate different process layouts in order to find the best ones.

4D-Process-Layout

The 4D-Process-Layout includes the tryout simulation of the 3D-Die-Layout. It follows the production workflow, as shown in the right column of Figure 2. Each modification from one geometry stage to the next (see left column) corresponds to a forming operation. The required tools and the corresponding process are automatically created by duplicating and trimming the 3D active surfaces as well as by moving the tools in their working direction (right column). After the tool geometries have been determined, the initial blank outline is defined in the last modification - developing the 3D active surfaces to a flat blank.

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Many alternative process layouts can be evaluated in less than one day. Process planners and tool designers thus have all the information they need to define a robust production process for sheet metal parts - and process planning can reach a new level of efficiency and reliability. **ISMR**

EDITOR'S NOTE

Autoform will hold its first North American user meeting in Frankenmuth, Michigan, USA on 14-15 June 2004. Email naum@autoform.com for details.