Springback Compensation Process for High Strength Steel Automotive Parts

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Abstract. This paper is about an advanced stamping simulation methodology used in automotive industry to shorten total die manufacturing times in a new vehicle project by means of benefiting leading edge virtual try-out technology.

1. Introduction

We are talking about a springback compensation process in the automotive tool&die industry.Usually one part can only be produced through four operations to its final shape.To perform four operations,you need four dies and four presses which are building together a pressline.

Neither springback prediction nor its compensation is given considering only one forming operation.All existing operations of the part should be taken into account to reach desired results.For that reason we developed a methodology which we call as stamping simulation system.Accurate springback prediction is the key point of that system.All other following processes are depending on the success of prediction.The main goal of virtual try-out engineering in the industry is always to decrease die manufacturing costs and delivery times.If your prediction is not enough accurate than you can not decrease the costs and times because you would have to recut the dies at the try-out.

2. Components of Stamping Simulation System

Stamping simulation system is a die process work flow including all aspects of stamping an automotive part within satisfying tolerances. The basic goal of that system is to solve all issues of the part during the die process phase and will have not any need to touch the dies at the try-out.

In the figure 1 you can see the general phases of a die manufacturing project and the above mentioned die process phase during which we implement the stamping simulation system.It begins with formability studies and ends with a virtual try-out step.One of the interesting things of that system is that we are also reporting and reviewing the die process output with the management with help of a virtual inspection report which is corresponding to the ISIR (Initial Sample Inspection Report).ISIR is the name of try-out measurement reports of the stamped parts used for part buy-off.In the figure 2 steps of stamping simulation system are showed in detail.

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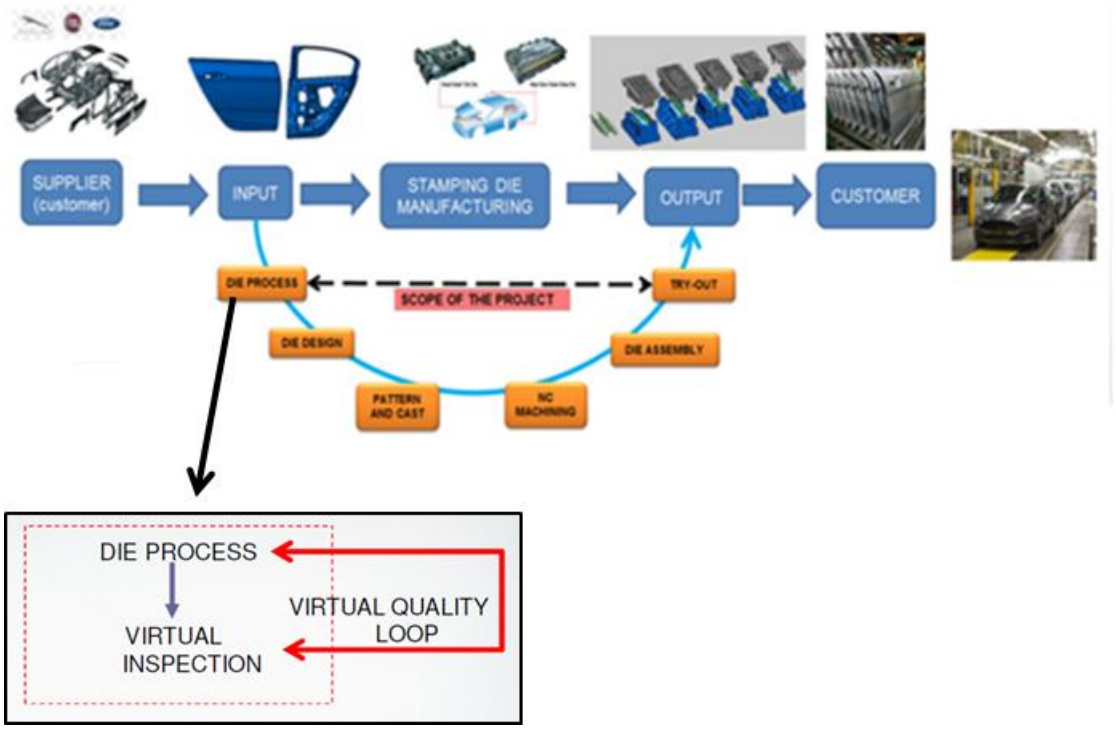

Figure 1. Die manufacturing phases and virtual try-out concept

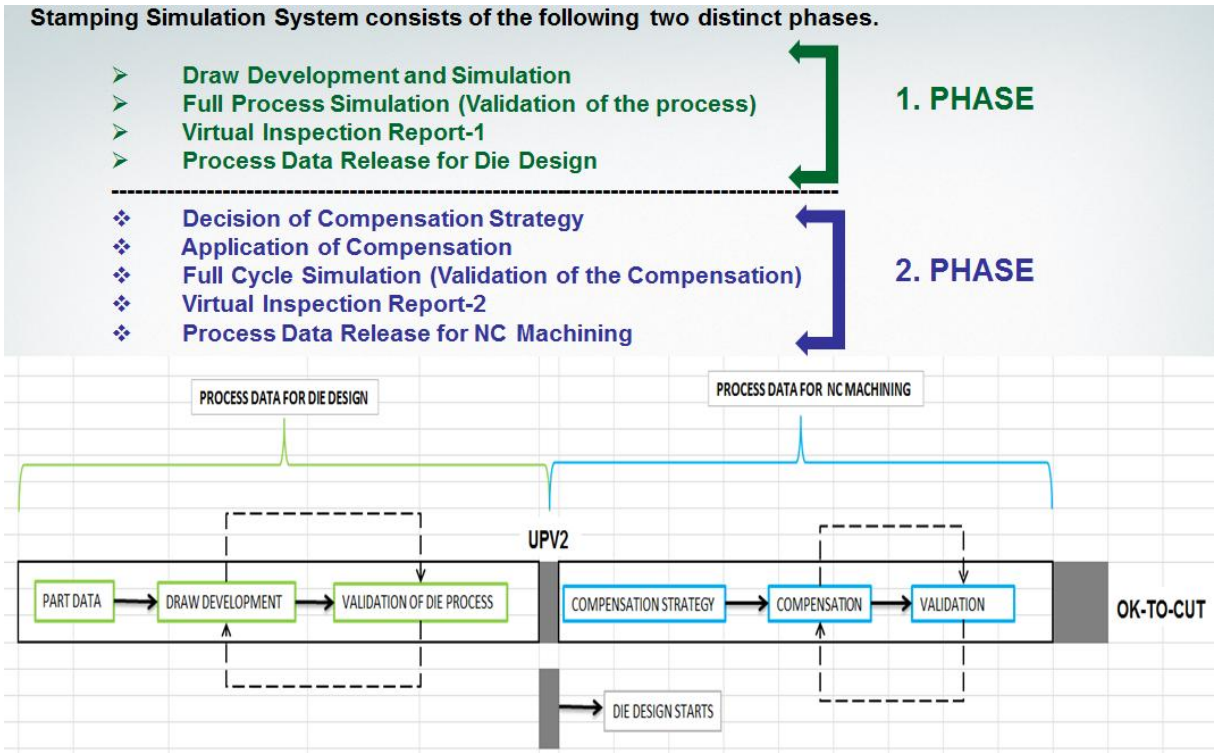

Figure 2. Components and phases of the stamping simulation system

2.1. Draw Development

Draw development is the most important phase where binder and addenda surfaces are developed for a part forming the draw die surface together.

In the figure 3 some of the main post-processing parameters are listed which must be checked during draw development.Before any springback compensation, minimizing opportunities of it should be carefully studied.Minimizing springback is the best compensation method.We are using only Autoform as FEA software for all kind of simulations.

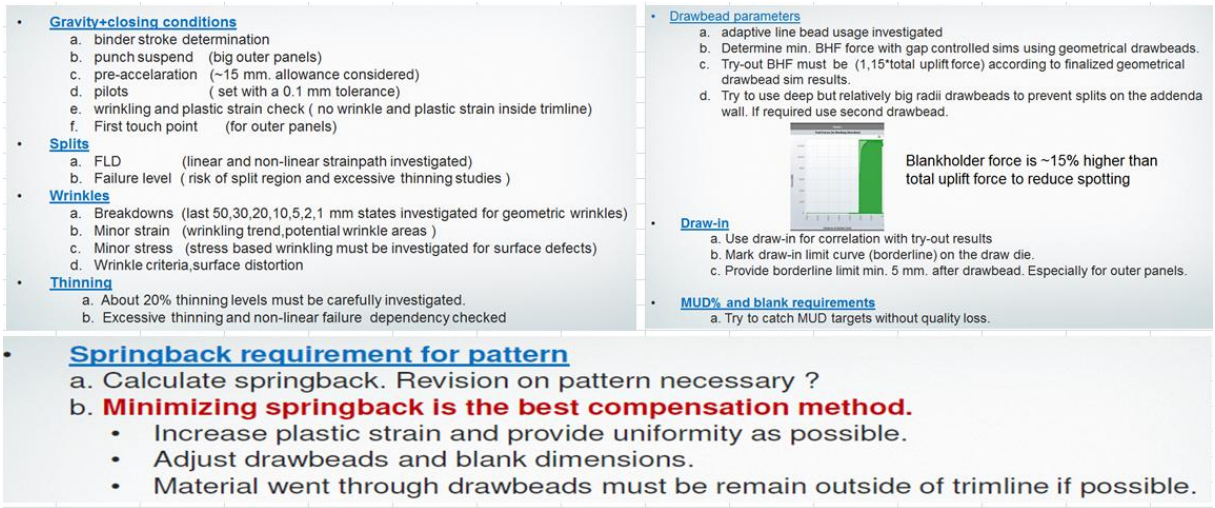

Figure 3. Details of Draw development

2.2. Springback Compensation

For a satisfying springback compensation there should be some strategies you can follow.Compensation is seen as a process because all operations of the part must be considered and will be affected because springback differs after each operation.What we want is that stamped part would be within %90 inside the satisfying tolerance limit.In the figure 4 several compensation strategies are showed which we apply according to the springback behavior of the part.

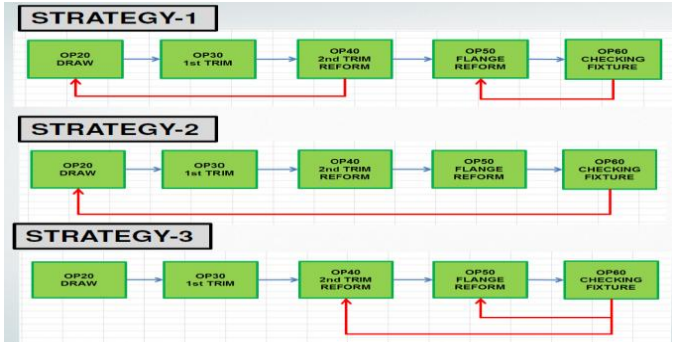

Figure 4. Compensation strategy samples

2.3. Virtual Try-Out

Virtual try-out is a final validation purpose advanced level simulation.If something not satisfying with the results more than one iteration (virtual quality loops) can be done until you achieve expected results.In the figure 5 parameters of a such simulation is listed.

- Simulation with morphed surfaces and all operations.
- Springback calculation after each operation.
- Fitting of blank checked and studied for all operations. (gravity+locating)
- First trim tool developed according to springback after draw.
- Used tool structures are taken from die design (pad relief taken into account)
- Forces similar with die design (gas springs, pad force, air cushions etc.)
- Trim operations are performed with pad as the reality.
- Geometric drawbeads are used. (Mesh size must be small accordingly)

Figure 5. Items of the virtual try-out simulation

3. A High Strength Steel Case Study

One part from our projects is given as an example below.Its material is HSLA380 and it has a thickness of 1 mm. There is a special point on the springback prediction of HSS parts.You must consider kinematic hardening which has a big effect on the springback results.The below part is a good example for that.In the figure 6 comparison can be seen between the virtual part and real stamped part.All phases mentioned in the above sections are applied during compensation process.

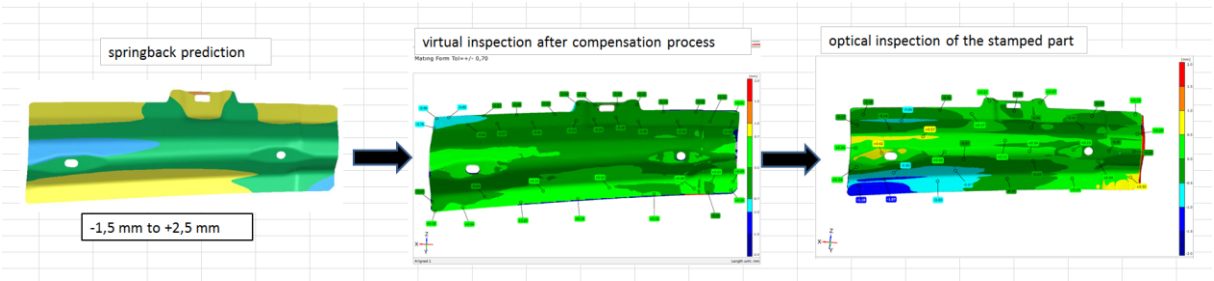

Figure 6. Results of a HSS part

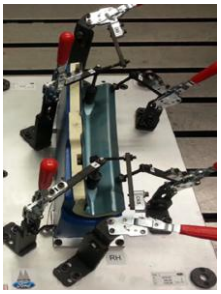

Figure 7. Stamped part on the checking fixture