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This issue contains two blog posts.

Bruning Tecnometal on the Benefits of Using Simulation

With 80 Successful Simulations Run in One Year

Sheet metal simulation has played a fundamental role in the growth and competitiveness of industry over the years. Now this resource has become vital to the permanence of companies both large and small.

However, there is room for growth through utilizing virtual engineering in the Brazilian market, because there is an assumption by some that these resources are only available to large companies. Others don't see the advantages to using virtual engineering, believing an equivalent profit can still be earned, with or without these tools. The truth is that while the initial investment is costly, the use of simulation offers great returns in the medium and long term, including reduction of costs and project time, agreeing to what was planned, among other interconnections. In this article, we see how the successful implementation of simulation technology for sheet metal forming has benefited AutoForm customer Bruning Tecnometal Company, bringing them improved results.

Bruning was founded on April 1st, 1947 by Mr. Ernesto Rehn. Most of the company's business comes from the maintenance of agricultural equipment. For the last 41 years, they have been working in the agricultural and wood sectors, producing machines and parts. 1988 presented a new challenge, the production of structural components for trucks. Starting in the 1990s, production became modernized, sparking the demand for high-tech imported machinery. In 1995, Bruning Tecnometal boomed in the automotive sector, in addition to operations in other fields. (Figure 1)

Like all companies working in mechanical transformation, Bruning Tecnometal was executing tool designs based on the experience of their professionals. According to Ibson Härter, Die Developer and long-time employee at Bruning: "It was until the middle of 2008, all developments were carried out based on the experience of designers and toolmakers. The steps were empirically planned based only on the geometry of the product."

Over the years, the sheet metal forming process became more complex, as companies ordered products with bolder designs. As if the added geometry complexity was not enough, professionals now had to take into account the raw material factor; the range of available materials was increasing, containing different mechanical characteristics and affecting the behavior of materials in this process.

"At that time, the geometries that Bruning manufactured were not so complex and we had a smaller range of materials," added Ibson. "In this period, tools had no compensation, there were tool losses (surplus or missing operations), many try-out loops, there were dimensional problems, high development costs, and long try-out times. Tool results were always unknown, cutting and blank tools were only designed after the draw die was ready (during the tests, the blanks and cuts were made with lasers)".

With these advances, it was necessary to use technological resources to support professionals in understanding the behavior of these new materials for the sheet metal forming process. Cue the initiation of computational simulation.

"Nowadays, it is no longer possible to evaluate the complexity of a part by evaluating geometry alone. A geometry that is apparently simple can become complex, depending on the material used," added Ibson. This consequently inhibits the prediction of the behavior of materials used in the forming process.

It was then that Bruning started to incorporate simulation services into their business. As reported by Ibson, "From 2008 until 2011, we outsourced simulation services, but only for more complex parts."

In 2011, to meet the necessity and demand of the market, Bruning started to invest in simulation resources internally, motivated by the following aspects, according to Ibson:

- Complexity levels were increasing;
- Range of materials had increased;
- Need to reduce development time and costs;
- Reduction of the amount of try-out (time and cost);
- Increasing demands on dimensional attendance and increasingly restricted tolerances;
- Using the simulation, the result of the try-out is already known, even before die design begins;
- Reduction of raw material used for try-out;
- All operations needed to be manufactured simultaneously, including blank operations and cuts, thus requiring accurate results of draw-in and flange development.

It was then that they implemented the AutoForm technology.

According to Ibson, we chose AutoForm because it is:

- An interactive software;
- Relatively easy to train new users;
- Fast processing;
- Quality in results;
- Easy to exchange simulation files with clients;
- Quality of technical support and speed in responses.

He added, "The simulation stage is part of our development flow, so all parts that have some forming process are simulated, from the simplest geometries (springback compensation) to the most complex ones." (Figure 2).

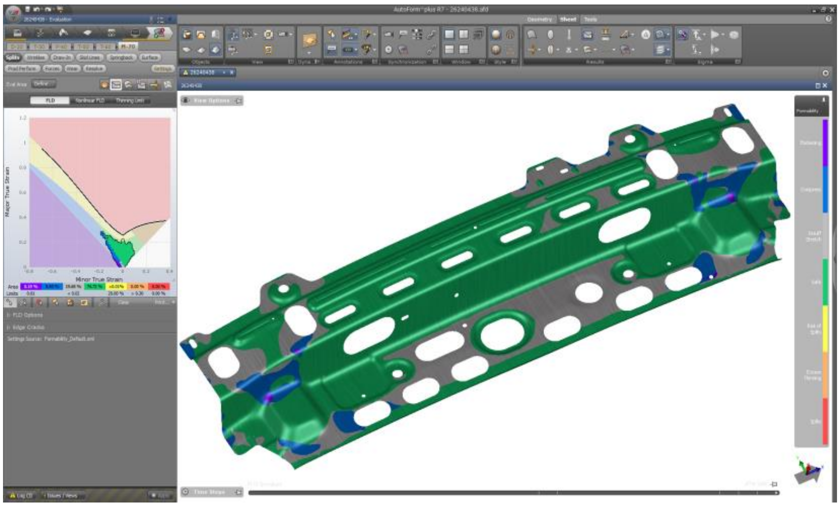

*Figure 2 –Formability analyze made in AutoForm software (Bruning Tecnometal)***.**

As we can see today, simulation has become a powerful tool, not only for aerospace applications or other specific analyses, but for a wide variety of industries. With advances in technology increasing rapidly, it is necessary to take advantage of burgeoning resources of industry, including in sheet metal forming. Nowadays, there are technologies that cover the entire course of the development of a stamped product, from the feasibility analysis, to the support, to the try-out and production. It is already possible to analyze and forecast noise variables, guaranteeing a robust process even with the performance of these variables being 20% variation in mechanical characteristics and 10% variations of sheet thickness, according to the standards applied from lot to lot; this compromises the production as to when they exchange.

Yet Bruning says, "Even with all the variables in a forming process, we have achieved satisfactory results. In these developments, we have reached an average rate above 80% in the first try-out."

In order to achieve good correlation results referring to these resources and to faithfully represent the simulations, the involvement, dedication, and effective communication of all professionals involved in the development cycle is paramount. This is one of the points that Ibson emphasizes, representing all of Bruning's success in developments: "It is important to highlight that they are the results of an entire development chain that began in the stages of bidding and commercial negotiation, process study, simulation, tool design, machining phases, tool assembly / adjustment, to try-out and delivery, and finally to production ".

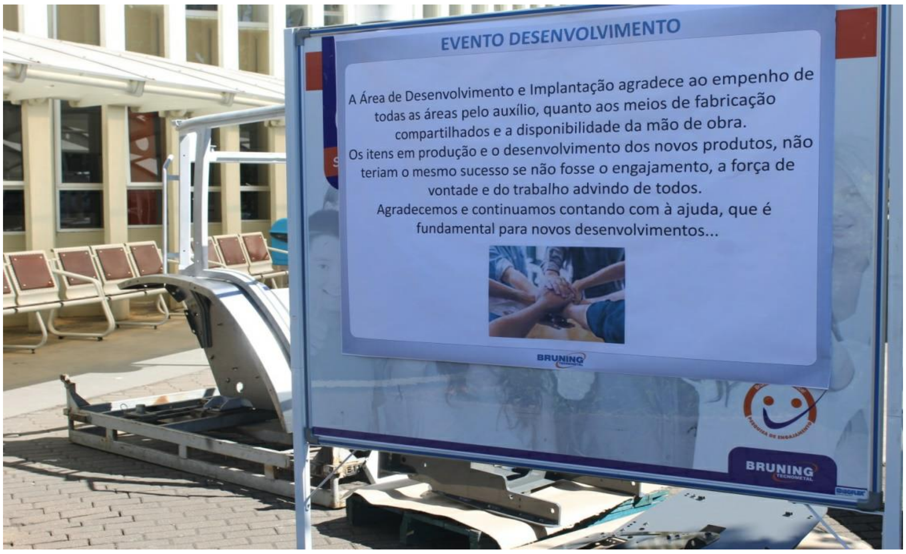

Figure 3 – Development Event (Bruning Tecnometal).

In the year 2018, Bruning achieved approximately 80 simulations, arriving at an average rate above 80% for forming segments. Based on this information, the company has started an initiative to promote the success of its projects internally, by holding an event to display the importance of both the simulation process and the work of every professional from all departments involved in the projects. (Figes 3 & 4).

Figure 4 – Development Event (Bruning Tecnometal).

Figure 5 – Structural parts stamped Bruning Technometal.

Figure 6 – Simulation results made in AutoForm software (Bruning Tecnometal).

Figure 7 – Correlation between simulation versus reality (Bruning Tecnometal).

Written by Edson Rodrigues dos Santos Jr in Collaboration with Ibson I. Harter.

Ford Nails 99% Accuracy Springback Prediction for a Cargo Truck Door Opening: Case Study Revealed!

Ford Otosan Talks Customer Satisfaction for Keeping Within Tolerance

In this blog post Stamping Process Engineer Fatih Onhon from the Tool & Die Department at Ford Otosan in Turkey reveals a case study for the springback compensation of a door opening panel (DOP) for a cargo truck. He reveals some of Ford's operating norms for springback minimization and publishes some astounding results!

Springback is one of the most important issues in my work as a Stamping Process Engineer. As the one and only cause of form deviations for a stamped part it is precisely where cost is incurred in terms of lost money and time. Most will agree any other issue is slightly easier to solve. With increasing use of materials such HSS and AHSS, which produce more elastic return, virtual engineering has become increasingly crucial for its management.

"It's a must if you want to reduce time to delivery of a die line while keeping the costs under control and achieving high final quality" said Fatih.

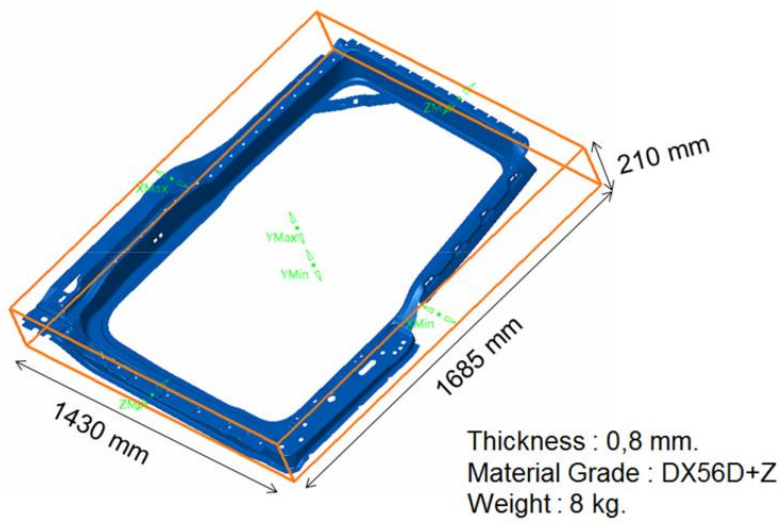

Fig. 1: *Dimensions of Door Opening Panel (DOP)*

We spend a lot of time reading research outcomes to find cutting edge methods that will give us an advantage. But, once you depart the academic world and enter the industrial then things change as there are other demands. The main goal is customer satisfaction. For the customer buying the part the main factor is the Percentage of Inspection points Satisfaction Tolerances - PIST. The minimum PIST value required for mating surfaces, which tolerance is ±0.5mm (but sometimes even ±0.25mm) is usually 90%. Yet this value is about to change to reach 95% quite soon! Dimensional accuracy is becoming more and more stringent.

With this in mind, the expectation is for engineering to master springback and leave little room for expensive mistakes!

Compensation cannot be viewed as the only way to address dimensional issues (it is not always that simple) but other countermeasures have to be put in place before actually getting to step of tool compensation. Springback minimization is an important aspect of the entire process: to reduce the magnitude of the deviation of the sheet from the nominal geometry is important as well as the stability (robustness) of the behavior of the sheet (consistency of the springback direction when process parameters may slightly differ from nominal).

Expedients to reduce the magnitude and ensure compensatibility can either come from tool geometry (gainers, radii reductions) as well as from process parameters (tool time entry – tool impact). When getting to compensation, the way we measure springback is fundamental and therefore the clamping concept becomes really important.

There is no need to remark on the importance of having a FEA simulation software to evaluate different options and select the most effective countermeasure to achieve the PIST"

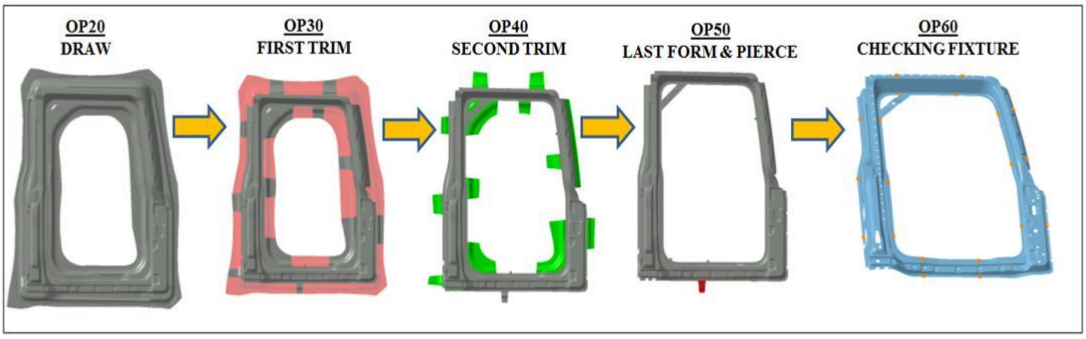

Fig. 2: *Production operations of DOP (4 operations + 1 measurement fixture)*

As shown above, the production of a DOP requires four stamping operations in the press line. In the simulation software the, measurement of the final part on a checking fixture is also set as an operation. The DOP part is a double unattached type which means we stamp right and left door on the same die line starting from two different blanks. Because of the dimensions of the parts we can definitely say that the die is one of the biggest in size you may come across within the sheet metal stamping industry.

We had prerequisites to be compliant with for the validity of springback results, as well as formability which of course must not show risk of splits, wrinkles etc. and the thinning distribution had to be within a given tolerance limit. In order to ensure that there will not be geometrical wrinkling on the part surface, wrinkling behavior had to be checked at 10 mm, 5 mm and 1 mm before reaching the bottom of the stroke.

Fig. 3*: Left, formability output of draw and final part form. Right, die-set design.*

The formability results of the process simulation reached a "green result" meaning the part would be free of splits and heavy wrinkling conditions ensuring at the same time the desired stretch amount of the material. Below are the input parameters of the full process simulation.

Material Grade	DX56D+Z
Hardening Curve Type	Swift
Kinematic Hardening Model	Autoform (Krasovsky)
Yield Criteria	BBC 2008
FLC	Arcelor
n-value	0,2
r_0 ; r_{90} ; r_{45} (anisotropy coefficients)	1,96 ; 2,1 ; 1,45
thickness	0,8 mm.
initial mesh size	12 mm.
layers	11
max.side length (tool)	10 mm.
radius penetration	0,16 mm.
refinement level	6

Fig: 4. *Input parameters of full process simulation of DOP*

Since slight changes in input parameters can make big difference, and because of unavoidable variation occurring in serial production, we ran the robustness analysis.

At Ford this process is becoming more important from a springback point of view. The figure below shows the result of noise variation level and the Cpk value as indicators. According to our standard, if Cpk >= 1,33 then the process is accepted because the level of stability (robustness) is reached.

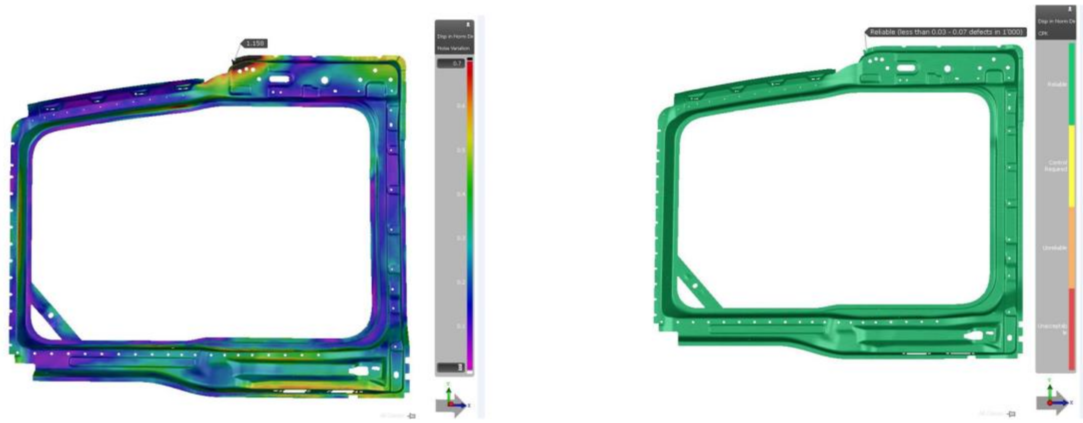

Fig: 5. *Left, noise variation of DOP. Right, Cpk of DOP*

Getting to springback, since the compensation of the outer panel puts its quality (style) at risk, only the compensation on the inner panel is preferred. Like the outer part, stretching is also effective, but the PDPD (Process Driven Product Design) is a more useful countermeasure used to decrease springback here. By adding extra geometries, such as ribs, swages etc. to the part CAD data you can "easily" keep the springback under control.

For compensating the DOP our method was to compare the springback measured in OP60 (checking fixture) and the one in OP40 to fix the effect of secondary forming on the springback as seen in the below figure. If there is no major effect of secondary forming than we can compensate D20 tool according to the OP60 result. The draw die surface will be morphed as shown below (1st step). Any springback in OP50 can be compensated in the OP50 die. Of course, compensation strategy must be validated through a full cycle simulation where also the fitting of sheet on the trimming dies (pad-post) is also checked (avoid panel restrike and apply unwanted plastic modifications). But if secondary forming has a major effect on the overall springback than compensation gets complex.

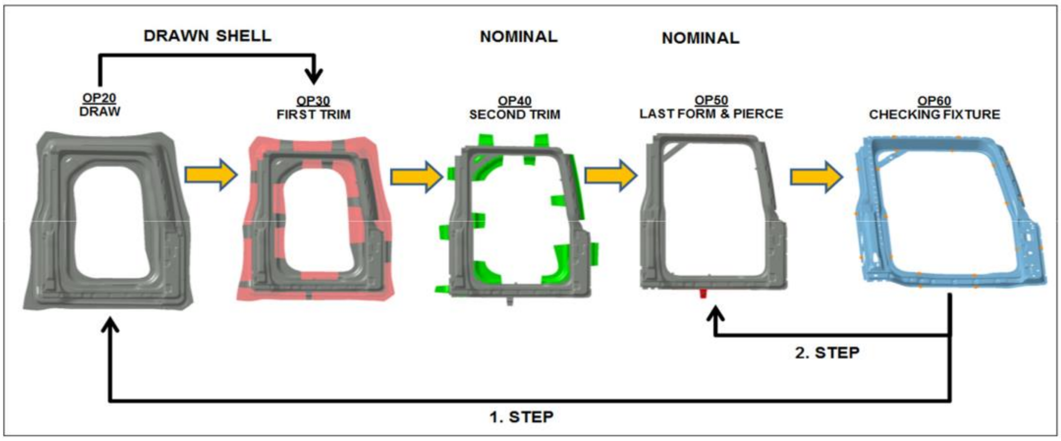

Fig: 6. *Compensation steps of DOP*

Conclusion

As result of the project, the figure below shows three PIST values. The figure on the left shows the simulated springback value when no tool compensation is performed. As you can see the PIST value is 63% and it is not acceptable (minimum requirement is PIST=90%).

Once the tool compensation is performed we obtain a 99% of PIST value: the minimum required value is reached (see figure in the middle). Virtual PIST values are the values obtained from AutoForm's FEA software.

On the right side of the figure below, you see the actual PIST value obtained of the real stamped part. For mating surfaces it reached 92% and for non-mating surfaces 100%. A really impressive result has been reached!

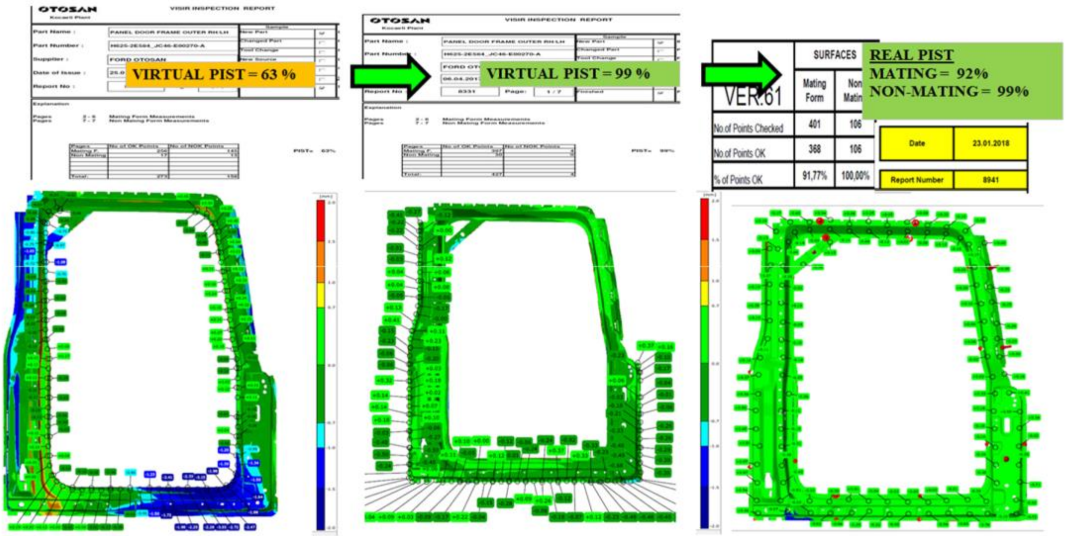

Fig: 7. *Comparison of virtual and real PIST values of DOP*

Note: source paper – "Evaluation of all Springback Aspects through a Success Story on Ford Cargo Truck Door Opening Part: MS-10-14" IDDRG. With Permission from Fatih Onhon

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