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The Printed Edition for AutoForm Customers

Dear AutoForm Customers,

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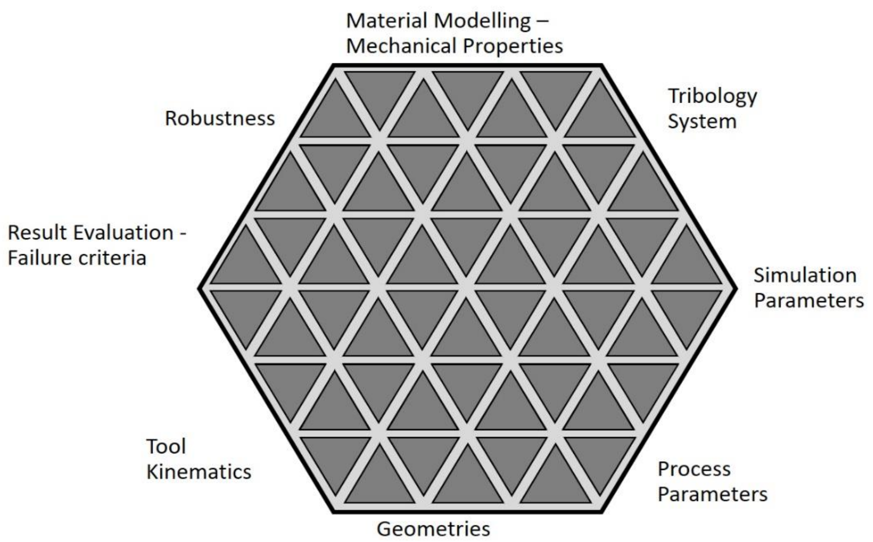
This issue contains two blog posts*.*

How Can You Prove Accuracy in Sheet Metal Simulation? The Principle of the Accuracy Footprint Unveiled

Looking Under the Hood of the Accuracy Argument

An accurate simulation is one that predicts the result of an experiment correctly. The accuracy footprint is a concept taught by AutoForm, which can be applied to any sheet metal forming software to determine how accurate your simulation is. What it does is provide you with a systematic process to check the quality of all the inputs. You can then find any differences to reality and reconnect an "inaccurate" result to the stamping process.

In practice you hear, "Ok, here is the simulation result. There is the result from tryout (or production)." If the resulting part does not match the simulation result then you can be sure something is different in tryout. In our experience 4 out of 5 cases in tool tryout did not fully reflect the engineering intent and one or more important process details in tryout did not match the simulation set-up. As a troubleshooting process our accuracy footprint model proves this time and again.



Accuracy Footprint Diagram.

Troubleshooting with the Accuracy Footprint

The basic principle is that if the experimental set up and the simulation set up are identical then the result will be identical as well. This is the foundation of the footprint. Within the accuracy footprint itself we then look into the actual quality of the footprint. In doing so this allows us to examine how well the simulation and experimental input correlate. Therefore, the footprint diagram becomes a symbolic representation of the quality of the input. As an organic process the footprint itself grows in size when a larger number of parameters match.

Let's consider the different aspects for the entire stamping simulation to understand the diagram. As we examine it we'll move around clockwise.

It starts with material and mechanical properties. These consist of elements such as the R-values, yield strength, tensile strength, material model, blank thickness, etc. These are represented by the individual triangles in that section, which as a whole comprise "Material Modelling - Mechanical Properties."

The same occurs for the Tribology System. That block in the footprint consists of different aspects which, in their totality, should represent the complete tribology system seen in reality.

Going around the diagram you expand the accuracy footprint to include your Simulation Parameters, Process Parameters and Geometries. The last of these looks into the geometries of the level of the punch, the binder and the die. But you can also examine it at the level of the addendum, the radii and wall angles, etc. The diagram shows that within each block you end up with different aspects and levels of what should be taken into account.

The next part is the Tool Kinematics, then the Result Evaluation and Failure Criteria. Lastly, the diagram features the Robustness part of the footprint.

All of these are aspects of simulation but represent a complete stamping process in all its detail. One must understand, all these aspects need to be defined during the experimental set up, just as they were set up for simulation.

Realistically, you'll also work with your Material, to see if you have the proper blank size and thickness, for example. You'll want to make sure the Mechanical Properties are the ones we want to have.

In reality, you'll work around the accuracy footprint to the tribology system like before. Do we have the right amount of lubricant? Is the surface roughness of the blank and tools as expected? This should all be done in the experimental set up in tryout. Troubleshooting is too late.

Tryout has all these details to observe during their own set up. They work through the accuracy footprint. They'll look at the Process Parameters, such as the positioning, the tool movement, the forces, etc. Continuing to work the diagram clockwise they'll get to check their Geometries, do they have the correct radius, or correct wall angles, etc.?

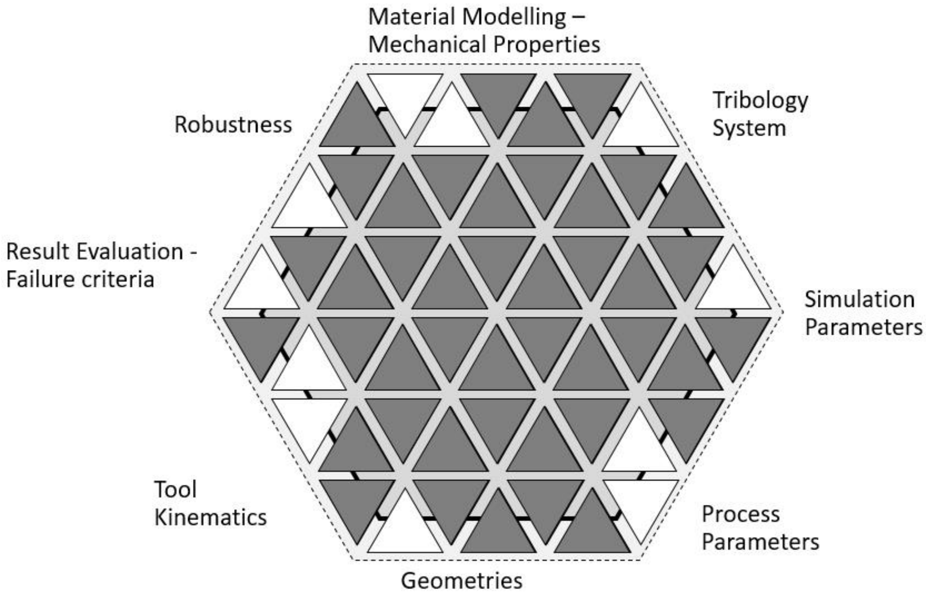
Now they get to the Tool kinematics part of the footprint. They'll set up the tool movements, and verify the cam angles etc.

Arriving to the Results Evaluation and Failure Criteria splits and wrinkles are easily detected, but going deeper, we must look for things like skid lines or springback.

Lastly, at the Robustness part of the footprint you will have to look for repeatable results. It's not one lucky shot, rather the reliable serial production of the part a production process set-up aims for.

The Problem of the Reduced Accuracy Footprint

If one or several parameters do not match then you have a reduced footprint (below diagram). Consequently, you can expect deviations between simulation results and experimental results. Differences in input on either side is why the results don't match.



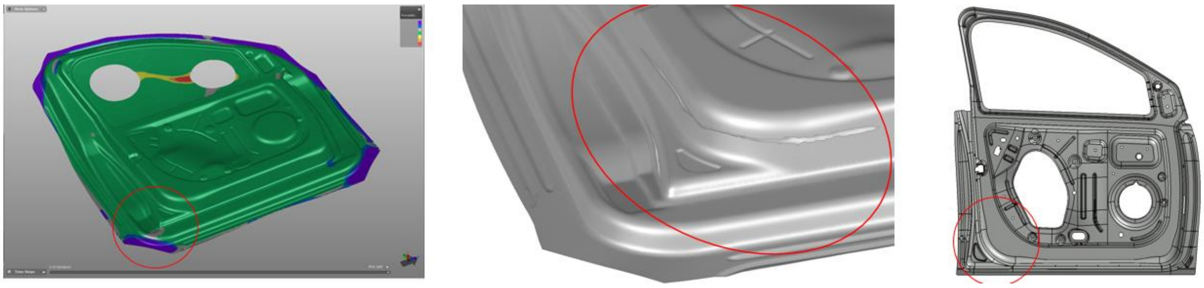
Reduced accuracy footprint diagram.

"Right and wrong" becomes a none-issue. The method allows us to question "Is it really identical, yes or no?" If results are different, then you will always find there is a difference in the tryout setup. The role of the tryout process at this stage is to create a perfect match with the digitally engineered model. The footprint represents a methodology to systematically go through every parameter defined on both the simulation setup and the tryout setup, side by side, so you can troubleshoot by verifying that one coincides with the other. This process is illustrated in the practical examples described below.

AutoForm has a guideline we strongly recommend you to use, which systematically defines your simulation settings. It's naturally easier to modify the simulation than to modify anything in tryout.

Case Example Door Inner OP Drawing

A "Door Inner OP Drawing" saw a split occurring in tryout in the lower corner. This was not observed in simulation so we returned to the accuracy footprint and recognized the blank thickness settings did not match. In simulation the thickness was 0.98mm but in tryout they had used a 0.80mm. Because a different blank was used in tryout, it created the mismatch between digital set up and experimental set up.

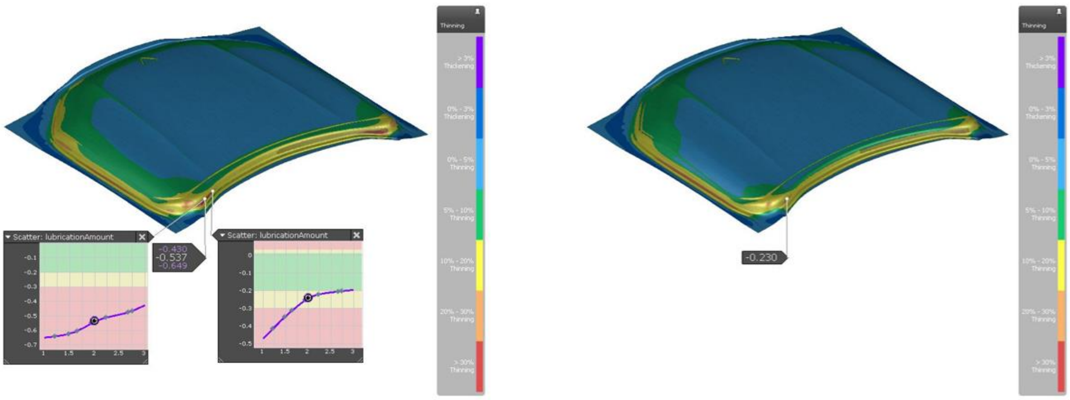


Now, in order to verify the result the simulation was re-run with the blank thickness actually used. The resulting simulation predicted splits in that area. Simply put, having a matching input between simulation and experimental set up provides results which match. And this simulation set-up may be used to find a solution for the actual forming problem – namely the split in the lower left corner.

Case Example Hood Outer

Another good simulation was mismatched in tryout by a split in the corner.

Yes, there was some thinning in simulation but nothing major. Upon investigating it through the accuracy footprint we found that the die was barely polished which created excessive thinning and splits. They compensated by adding oil. In simulation they had used a polished tool surface when the roughness in reality was higher. The default amount of lubricant was 1 gram per square meter but they used three grams in reality to decrease the amount of friction. Even when the sheet was practically floating in lubricant it didn't help resolve the splits.



As an exercise the digital set up was changed to incorporate this high die roughness and high lubrication amount – and the splits were correctly predicted. While the study showed you could influence the thickness in that corner by increasing the amount of lubricant unfortunately this effect was insufficient to compensate such a high surface roughness. The solution to the problem was that tryout needed to polish the die and work according to engineering's initial plan.

Changing the digital set up to match tryout just digitally predicts splits in the same area. But the exercise of matching an unsuccessful tryout set up through simulation should be considered an "academic study." Good input on both ends, or bad setup on both, once the digital and experimental set up match - the simulation and tryout result perfectly match each other as well.

The goal is not to match your simulation to a bad tryout setup, but to match your tryout to a green simulation that predicted safe parameters. This accuracy footprint therefore is not just a symbolic representation. It's a thought process for successful engineering.

We also must bear in mind, comparing ONE experimental measurement and ONE simulation result does not allow a valid conclusion regarding accuracy. And even if you have just one real panel measurement – all AutoForm users (!!) have the chance to easily generate a point cloud for simulation results. So every AutoForm user has the chance to upgrade to a “real” accuracy assessment! We’ll go into this more in our upcoming accuracy series.

In its totality AutoForm’s Accuracy Footprint concept provides a proven framework to systematically analyze the root cause of most discrepancies between measurement and simulation. This is not only helpful for quickly identifying the cause of a mismatch, but also offers a tool kit to speed up tryout AND for future improvement of simulation set-ups.

By Dr. Bart Carleer, Technical Director AutoForm

SDM Korea Sees 200% Increased Work Speed with Compensation Modeling!

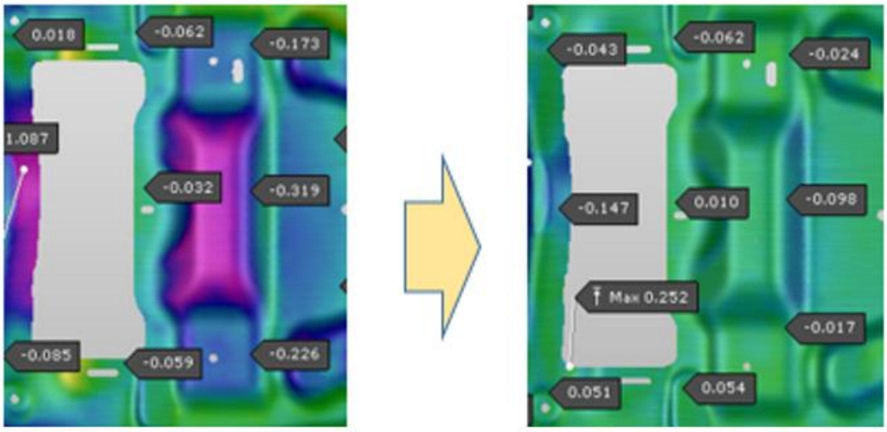
Forming Analysis Team Enhances Work Efficiency by Adopting AutoForm

By Taejun Kang, AutoForm Korea

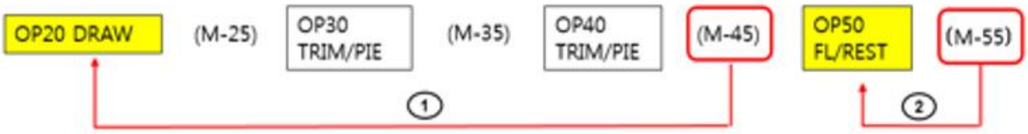
The Forming Analysis Team at SDM Co. Ltd. (hereafter SDM) has been using AutoForm since 2009 and has veteran master level users who have worked together to reduce compensation modelling working hours by 200%. In this blog post, we will learn how this competitive company utilizes simulation tools to enhance their tool making accuracy, thereby shortening tryout times.

SDM is a company renowned for consistently winning bids in competition with domestic metal forming companies. They are highly familiar with AutoForm, as evidenced in their recent robustness analysis presentation in Korea. In continuation of our flourishing relationship, we at AutoForm visited SDM to observe their usage of AutoForm-ProcessDesigner^{forCATIA}, which was newly adopted last year.

SDM Forming Analysis Team leader Dongjin KONG states that, “In the past, we could do just 10 parts a week with CATIA. But now we are doing 20 parts, using ProcessDesigner^{forCATIA}. Our work speed has literally doubled! Currently, simulations for the entire forming process are being performed for all tool types, including progressive dies, tandems, and transfer dies, all of which require modeling for process analysis. Where CATIA took too long, our new efficiency saves half the time and labor. Another satisfaction point (unlike the early days when only free springback was considered) is that springback compensation accuracy is very high due to analysis run for each operation and draw shell application.”



Springback Result Before Compensation **Springback Result After Compensation**



As the entire process becomes CAD-based and enters its 3D layout, the related modeling is linked with CATIA, thus becoming much easier. KONG says, "Although the software was initially purchased for the process engineering (flowchart) review, SDM has found a big advantage in that compensation modeling and initial simulation can also be done easily. In addition, the feature of the "roughness check" during surface modelling also makes machining much smoother."

"It must be said, the compensator functionalities greatly improved the springback compensation quality so that in the CMM, the initial score is over 80 PIST (points in tolerance) on average, going up to 90-100 points. We apply the compensation results to the forming process, including the draw shell, springback analysis and compensation, so that with these three processes finished, machining data can be completed."

Regarding materials to which they have applied compensation include aluminum of over 2.5mm for overseas lightweight, high-end sports car models. Another is 3.6mm aluminum, used to make the rear plate of a side member for pickup truck models. KONG stated that springback compensation is applied to almost all of their products, depending on customer requirements.

As a result of using AutoForm, Mr. KONG says "Fewer and fewer people are required in tryout as the emphasis is more on digital engineering. In the past, the company expected a lot from the shop floor workers. Now we rely heavily on software. If any problem arises in the field, then we depend upon the analysis team for problem solving, and tryout work is based on the simulation results we get. We engineer according to good simulation results." He continues, "Looking back, our team first standardized a lot of manual tryout processes. Nowadays, we train on-site workers based on AutoForm."

Mr. KONG also mentions that many factories in Korea still largely depend on old-fashioned know-how and manual labor for parts production. However, as the parts and tools become more sophisticated and the processability becomes more complex, the need for forming analysis is becoming more important. For this reason, he expects an increase in the use of formability analysis across the Korean industry.

SDM Co. Ltd. (www.toolmaker.co.kr) was established in Gwangju, Korea in 2001 and currently retains over 100 employees. As a tool maker, the company supplies a variety of products, including Transfer, Line and Progressive dies (for both casting & steel) to customers such as Hyundai Motors, KIA, GM, Ford, Magna, Volkswagen, Proton, Toyota, SGM, JAC, Uchida, etc. Contact SMD Co. Ltd. to find out more.

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