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This issue contains two blog posts.

Nissan Optimizes Surface Defects with TriboForm! Accuracy Up by 20% - Detection Errors Cut by 10%

Case Study Opens Sustainable Growth and Business Evolution

In this article Ms. Natsumi Goda from the Stamping Engineering Department at Nissan Motor Company (hereafter Nissan), reveals a never before seen evaluation project performed for a hood-outer part. This was one of the first ever testing of the TriboForm Software in Japan! Nissan is an AutoForm customer and wanted to examine how the TriboForm Software might highlight surface defects that had not previously been detected in their sheet metal stamping simulations. See the results below.

The emergence of new technologies, such as electric vehicles and autonomous driving, means the global automotive market has become increasingly competitive, with companies continuously looking to gain an innovative edge in this fast-changing environment. To adapt to this environment, Nissan is actively engaged in a revolutionary transformation process across all areas of its business, from car design and development through to production, sales and service.

Ms. N. Goda, Stamping Engineering and Development Department, Nissan Motor Co., Ltd

Nissan has formulated a six-year midterm plan, named "Nissan M.O.V.E. to 2022," covering the years 2017 to 2022, as it looks to accelerate its efforts for long-term sustainable growth and development of the business

At the same time, Nissan offers new technologies and products through its vision of "Nissan intelligent mobility" leveraging technological advances such as electric vehicles, autonomous driving, connected cars, and accelerating the development of new mobility services through new technologies and businesses.

Detecting surface defects by integrating TriboForm into stamping simulations

The core objective of the company's business plans is to produce attractive products for its customers. Worldwide, Nissan offers a range of highly original and innovative products, including models such as DAYZ, SERENA, NOTE, LEAF, X-TRAIL, and JUKE. In recent years, customers have particularly been looking for cars that incorporate a full range of design features as well as reduced weight. As design technology evolves, the increased complexity of stamping tools and parts introduce a new challenge. At the same time, manufacturers need to shorten their development lead-times in order to respond promptly to the demands of the market. Ms. Natsumi Goda from the Stamping Engineering Department in the Vehicle Production Engineering and Development Division explains, “To speed up development, it’s essential to shorten the required time due to more challenging tool designs and also simulation processes.”

To respond quickly to such market demands, Nissan uses the AutoForm software which has a significantly shorter analysis and simulation time compared to competitor products.

However, Nissan had found that some surface defect issues were not being detected by the company’s previous simulation process and inspection methods and only came to light after stamping. To solve this problem, Nissan used AutoForm to evaluate the panel’s surface quality during and after the forming process. When surface defects occur, this often means that the design or forming process has to be adjusted which can have a major impact on the lead time. As a result Nissan decided to become the first Japanese OEM to test the TriboForm software, a tool for simulating friction and lubrication conditions in stamping simulations. The company decided to carry out an evaluation project with the intention to integrate TriboForm into the simulation process if the project was successful.

Sheet metals used in car body parts have specific surface properties. The material type used and the surface roughness affects tribology and friction in the forming process. The TriboForm software allows users to quickly simulate the effects of tool surface coatings, lubrication type, material surface characteristics or new tool and sheet materials on friction and ultimately on product quality; it is also easy to use. The user simply defines the material type and surface roughness of the tool and sheet material and specifies the type and amount of lubricant that is used in the forming process. After integration of the more realistic friction and lubrication conditions in the stamping simulations, the software can more accurately predict panel surface defects that will occur during forming.

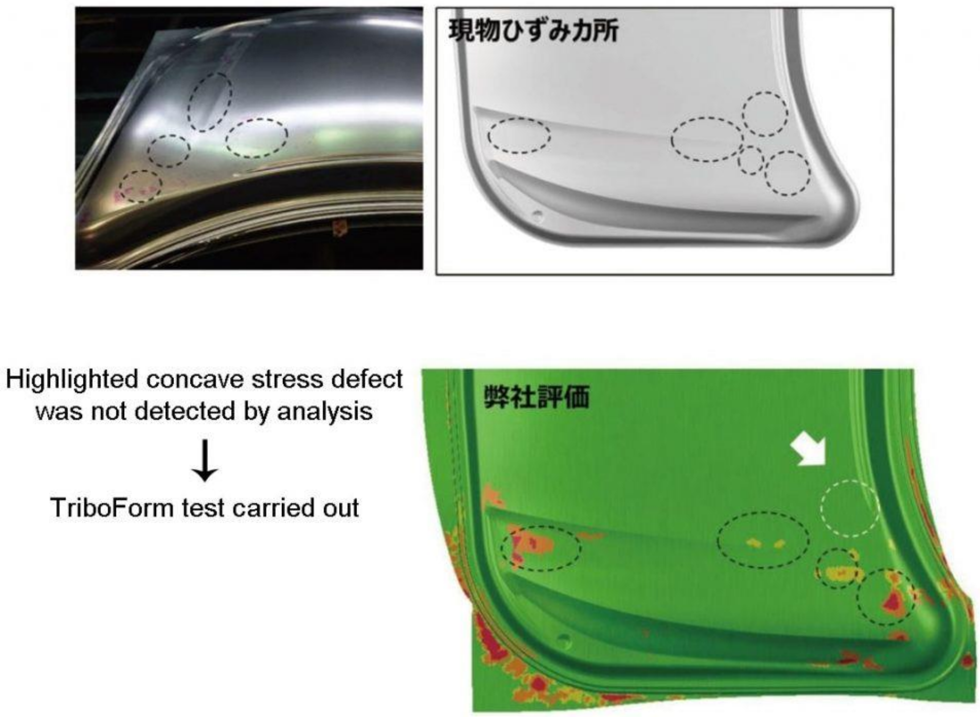

Figure 1. Comparing the surface defects in the real panel (top image) with the simulation results (bottom image) shows that some surface defects were not detected when using a constant coefficient of friction in the stamping simulations (white arrow showing the missing surface defect in the simulation, while present in the real panel).

According to Ms. Goda, "AutoForm simulations can usually be run with a constant coefficient of friction. However, we found that some panel surfaces were defective because of surface defects in production. With TriboForm you can use a variable friction coefficient in the stamping simulations which varies by location and in time, rather than a constant value. So, we decided to assess whether a more accurate friction description would result in the detection of surface defects."

Accuracy rate up 20% using TriboForm; Detection errors cut by 10%; Lead time reduction

The assessment was carried out by Nissan in 2017 over a period of six months. The evaluation project focused on an aluminum hood-outer part. This time the stamping simulation was run on a stamping tool where surface defects had occurred on the part (as shown in Figure 1) to see whether the software could predict all the defects.

In fact, the AutoForm simulation including the TriboForm friction model detected a panel defect which had not been picked up by the conventional simulation method using a constant coefficient of friction, as shown in Figure 2. Successful detection of defects that would have been overlooked previously has increased the Nissan's simulation accuracy by 20% and also reduced the lead time of such panels. "Furthermore, some false surface defects were detected using the conventional simulation method which has declined by 10% using AutoForm with TriboForm." says Ms. Goda.

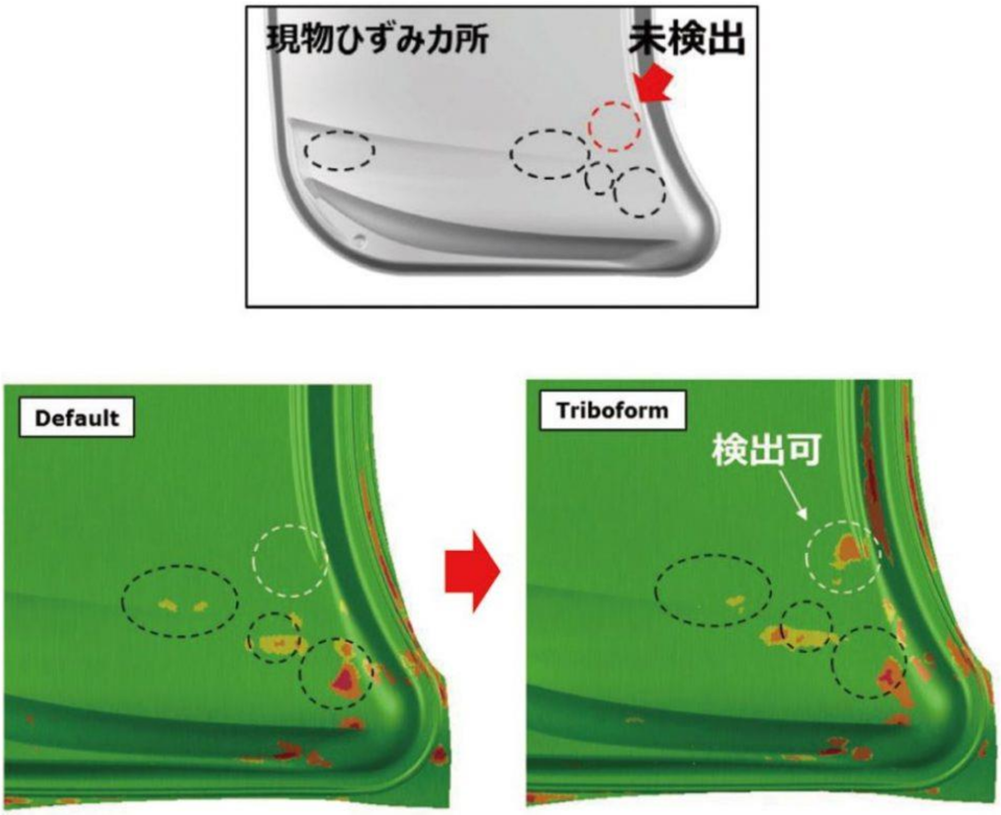

Figure 2. The surface defects found in the real panel (top image) were detected in stamping simulations when using TriboForm friction models (see the right images, indicating TriboForm). Some defects could not be detected when using a constant friction coefficient (see the left images, indicating the conventional simulation method).

Using the TriboForm friction models in AutoForm, Nissan was able to predict surface defects that were not found using a constant friction coefficient, as shown in Figure 2. "You have to make sure that the input parameters of any simulation are consistent with the real stamping process, and we found that the combination of AutoForm and TriboForm showed excellent results" adds Ms. Goda. "In the future, we would like to investigate how the tribology-related input parameters can be obtained efficiently corresponded to the end process when using AutoForm."

Currently Nissan uses the default TriboForm friction models which is provided with the TriboForm software. However, the default TriboForm library deviated to some extent from the exact material grades and lubrication types of Nissan's parts. Currently, customized libraries based on Nissan's specification are being generated to continue and increase the use of the TriboForm software at Nissan. Ms. Goda goes on, "we expect to further improve the simulation accuracy using Nissan's customized libraries." Evaluating surface quality for different analysis ranges and material types with accumulated test data.

After completing the evaluation project, Nissan officially started to use TriboForm. TriboForm is now integrated in the stamping simulations by the Stamping Engineering Department. In the future, in addition to simulating the hood-outer part described in this study, Nissan plans to expand the scope of its analysis to doors and fenders and to build a database of test results by running simulations of different material types such as aluminum and mild steel grades.

"Our impression of TriboForm is that it's really easy to use and to understand. All you need to do is to specify the material and lubricant that you're using. In fact, we encourage our engineers to find new applications and ways of using it."

TriboForm simulates friction conditions to help users shorten the lead time required for development and to aid cost reduction. Using it has enabled Nissan to improve accuracy levels in its simulations.

Sensitivity Matters: How Minor Changes to Input Can Massively Influence Your Part Simulation Results

Addressing the Question of Simulation Accuracy from Another Angle

In this post AutoForm Technical Director Bart Carleer revisits the question of AutoForm's accuracy and challenges readers to not merely go by judging what is before their eyes in tryout, but to reexamine input parameters. He also demonstrates how small changes of input can result in massive consequences in forming simulation results. Even more interesting: he questions if benchmark studies demonstrate accuracy well or whether they are influenced by unaddressed factors?

One of the things that I am often asked is "How accurate are you?" They often ask for a ballpark figure: "80%, 90%? Give us an idea." For me this is an impossible question to answer and I'll explain why. But also, I'd like to illustrate the issue of sensitivity.

Throughout my career I have rarely come across any unified agreement for a definition of what accuracy is. Everyone seems to have their own take on it. Therefore, first, we need to define that and why our definition is valuable. At the risk of sounding like a "Mr. I told you so," some flaws in contrary ideas should be pointed out in developing this understanding.

Here is our definition of accuracy:

"Accuracy is viewed by comparing a simulation with the experimental result."

End of story? Not quite. It really means first we simulate the forming of the part in our software and then we compare it with the real part produced in tryout. One of the assumptions some people make is that you can compare one particular software with another. They'll try comparing AutoForm results with results from another brand like LS-Dyna or Pam-Stamp. Is this really of any value? Not at all! If talking about accuracy we have to only compare software, whatever its brand, with how well it matches reality.

But What About Benchmark Studies?

Everyone loves benchmark studies. They generally compare various simulation tools and reality, normally for a specific part or shape for the experiment. The parts or experiment under investigation are well defined and in these publications you see a side by side comparison or table of how well or badly the various software products performed. Naturally these attract readers.

But, do they accurately represent reality?

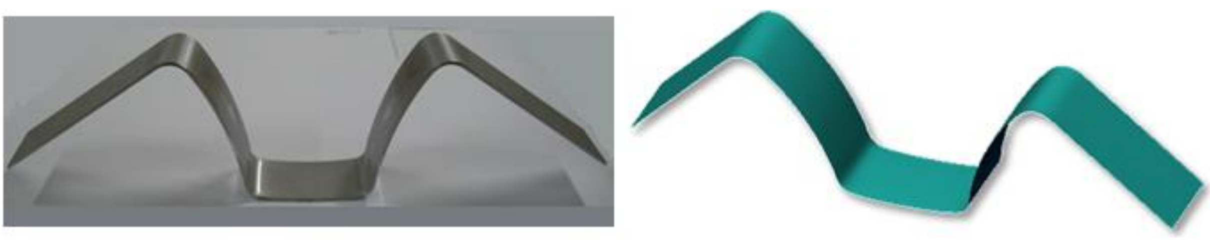

Fig. 1: Numisheet 2011 U-Bend Benchmark.

Yes, benchmarks represent reality - however only a limited scope of reality. Industrial stamping processes are much more complex. Now you're looking at the impact of accuracy over a range of operations, all for one part. Still, at the very basis of all such complexity one thing really determines accuracy. Regardless of your own definition, we must have similarity between the simulation set up and the reality set-up, and look at how they match. That means, as long as the input of the simulation and the input of the experiment are identical (as far as can be achieved) then the output of your simulation is going to be – or should be - quite identical with the real part and therefore accurate. But, now, you have to open Pandora's box.

There are a lot of factors that go into the input. All these combine for the whole of accuracy.

To name just a few: material properties, mechanical properties, tribology systems, failure criteria, also geometries, tool kinematics and process parameters such as forces etc.

When you compare an academic example, such as the "U-bend" above, with the engineering of a door, then you see that the academic case you are dealing with has far less complicated variables than in an industrial production environment. The door has a drawing operation, segmented trimming, some flanging etc. The boundary conditions are therefore far more complex for its engineering.

For the "U-Bend" study, I am not saying that it is "less accurate," but rather - it is far easier to ensure that your input for simulation matches the input you have for the experiment. Such benchmark studies are nice for comparing brands and their solutions at that level, but having greater in-house expertise is also a factor in the real world and having that additional support ensures greater accuracy for the more complex productive environment. Now you have to look deeper at those brands.

Of course, if you can't match your simulation to reality for such a basic part, you're in very big trouble. What then will happen with more complex parts? In either case, from one side of the difficulty spectrum to the other, the name of the game is matching input to tryout. Quality in, quality out.

Closing the Gap Between Engineering and Reality

Now, input parameters would be straightforward if we knew everything from the start. In reality lots of engineering tasks are being carried out simultaneously. When simulation-engineering starts so does method planning, die design and the making of the tool pattern can overlap with some of the engineering tasks. Casting and surface design might overlap with some of those as well. All of these accumulate changes that need to be considered as input parameters within your simulation set up. Otherwise it won't match reality any longer. Without trying to sound like a broken record, "You need to ensure that your real-world engineering adjustments are well-communicated and constantly updated!" This is a constant message from AutoForm and we have solutions that help with this.

There are other problems though. In reality digital engineering and tryout cannot be performed in direct sequence – they are separated by a time lag. This is the danger zone. Things happen in pattern design, casting, surface design and tool manufacturing. Sometimes it takes several months for all this to be done between the last simulation and the first stroke to turn out any part. The challenge is to ensure that digital engineering still matches your "experiment" (i.e. tryout) at the end.

Needless to say, if you've started out with a green simulation then it should work, so long as everyone worked accordingly and perfectly matched the last green simulation! However, when it comes to the final part and it suffers from thinning and splits does that mean the software was not accurate? Or does it mean something else? We want to compare apples to apples. You therefore have to secure an identical set up. But, what was first, the chicken or the egg? Are we simulating what we have on the floor or does simulation determine what must be used? Where simulation is applied to define the process setup during engineering it would be nice if we can entirely match reality to that green simulation. We know that certainly it would work. The software does not lie.

But, in reality a tryout team sees what they have before their own eyes, looking at what they've got in tryout. Now they'll scream "Hey, your software is not accurate!" But, as usual some references have been switched over time. They can't see this, or don't consider it, and it’s all too easy to blame the software. The issue lies in comparing those apples to oranges.

Therefore, in order to effectively apply simulation in an industrial environment we firstly need accuracy of input. Secondly we need process robustness and a generous process window. Thirdly we need reliability and numerical stability. This is the magic recipe.

Input Parameters are Sensitive Guys

It is astounding just how sensitive the results can be to simple mechanical criteria. Change a few things, even just a little bit, be it material properties or process parameters, and it can result in drastic consequences in production.

Let’s illustrate this using two real-life examples:

	Reference	Case
Yield Model	BBC2005	Barlat1989
r0	0.67	0.67
r45	0.65	0.67
r90	0.70	0.67
σ0 [MPA]	128	128
σ45 [MPA]	130	128
σ90 [MPA]	131	128
σb [MPA]	128	125

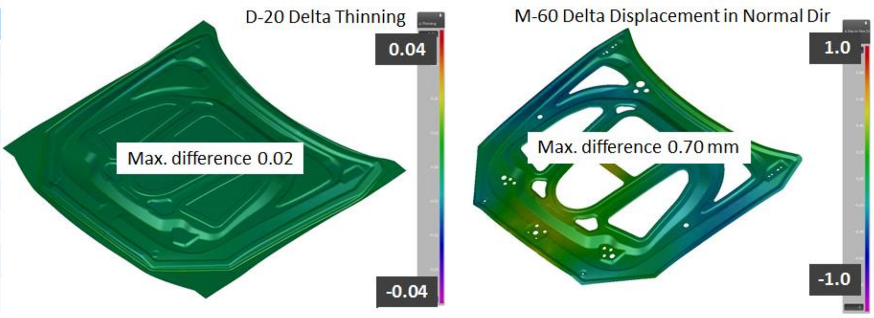

Fig. 2: Mechanical results sensitivity to input variables.

The input parameters for simulating mechanical properties include the hardening curve, yield model, thickness and rolling direction. Side by side you see the reference and the input differences for case study of the same part. The input changes result in a springback difference of 0.7 mm, which for any OEM is out of tolerance. Yet the input changes were very small.

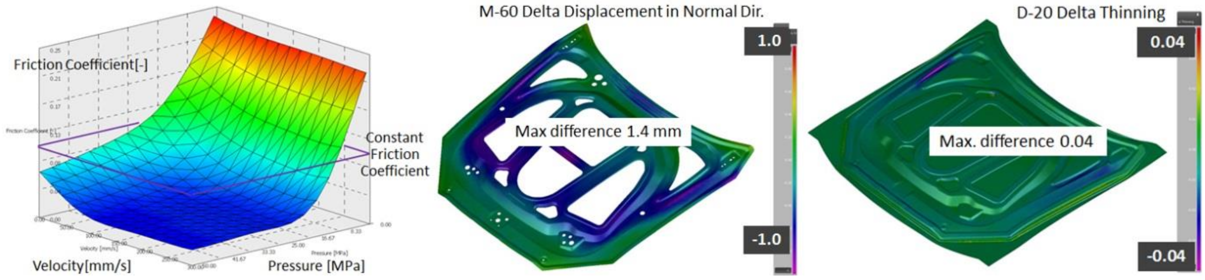

Fig. 3: Tribology results sensitive to friction models.

Tribology is also a sensitive issue. Its defining factors include the tool surface, lubricant and the sheet surface with its own roughness. When using an advanced friction coefficient model vs. a constant friction coefficient the results can be extremely different. In the case below you see up to 4% differences in thinning and for springback a difference of 1,4 mm. This is really significant and again the input changes were minor.

There are many more examples we have illustrated in recent presentations. But you get the idea.

In the end, accuracy is not about comparing different forming simulation brands on benchmark tables. AutoForm does extremely well on those, but we always advise that there is much more to the story. Accuracy can be achieved at a very high level. Ultimately, it’s all about making sure you have identical boundary conditions, no matter which phase you look at. If you make any physical changes, then make sure you recommunicate and re-simulate to ensure you're in the green. If you'd like to have support in capturing any of those adjustments being made by later departments and engineers, especially long after your first simulations, then you may be interested in taking a closer look at our tryout solution AutoForm-TryoutAssistant.

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