

A Real World Approach for using LS-DYNA to Achieve True Springback Compensation on AHSS Components During Forming

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Summary:

Springback is every tool designer's nightmare. A tool designer can make a die adjustable for some areas that need to be over-hit. Most parts are sprung throughout their entire surface. In these cases the entire part would need adjustment. Almost every time the die always requires a re-cut/re-work to put the part in spec. This re-work and re-cut is a time consuming, trial and error method that takes shop resources which typically are not available near the end of a build.

This presentation illustrated a method which uses DYNAFORM/LSDYNA as the analysis tool, associates with the measurement procedure, provides a complete process and a effective way for the springback compensation needs. This procedure saves hours of measurement and modelling time. In many cases, a single re-cut of the die is all that would be required to achieve the correct compensation in even the most difficult parts.



A REAL WORLD APPROACH TO SPRING BACK COMPENSATION

A Case Study By:
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Objective

- To use cost effective technology to quickly and accurately remove spring back.
- To reduce tryout, and re-work time in the press at the end of a die build.
- To aid in problem resolution of spring back anomalies that were not fully captured by spring back analysis.



The Problem

- All parts which are stamped in a die are prone to some form of spring back.
- Spring back prediction is possible with LS-Dyna, but the material testing data for an advanced material model (Yoshida model for example) is not always available.
- Spring back prediction is problematic when a twisting mode is encountered. This factor is present in most spring back scenarios, and as a result, the prediction can be problematic.
- Generally, it is extremely time consuming to analyze and create a corrected shape manually. In many cases, it can take days to generate a model that would completely remove spring back.

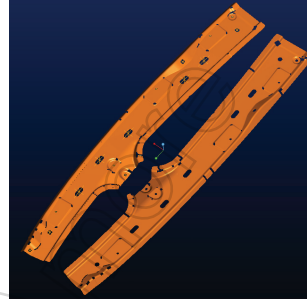


Difficulties Caused By Spring Back Issues

- Dies are not finished on schedule
- Poor Part Quality or inability to make a part in spec.
- Normally spring back is corrected over a minimum of two iterations, usually three. Each iteration for this example would cost approx \$5000.00 CDN
- A growing need to "make the part fit" instead of making a part that matches the nominal data.

The Case Study Specifications

- AHSS part of 590R material
- Two Channel shaped parts, with minimal form indentations to hold the shape.
- Customer will not pay for extra material to stretch the part into the plastic region, so a crash form is the only viable option.



First Impressions

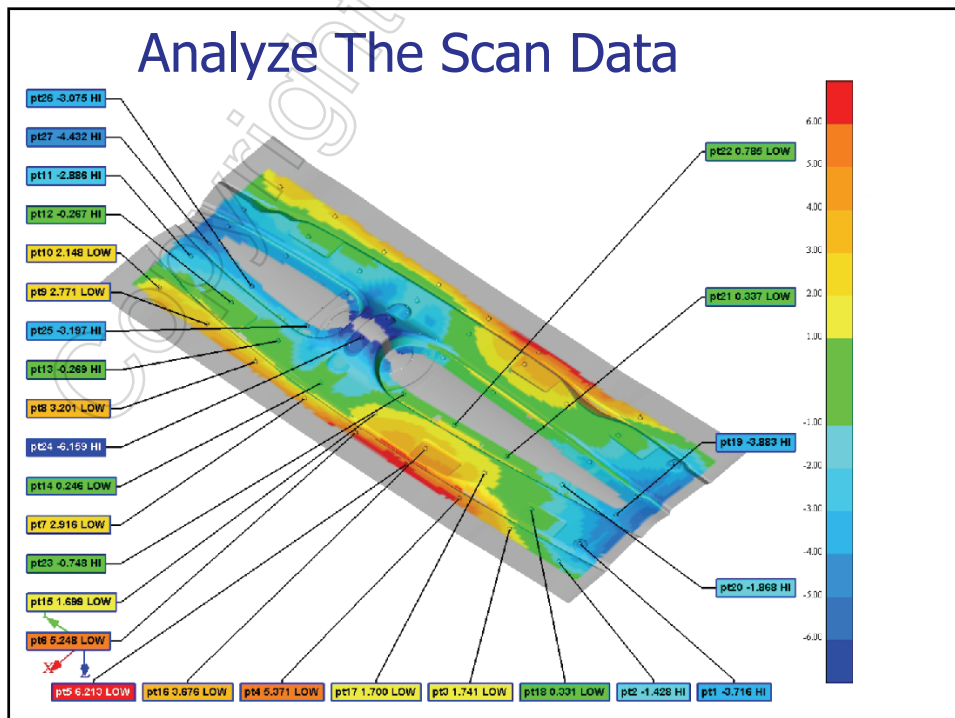
- After first tryout, the parts exhibited significant spring back issues.
- Part could not even be placed on the checking fixture without extreme hand-working.
- Part was bowed throughout the length of the channel, twisted, there were bulges adjacent to the deeper areas of form, form depth in the deeper areas was incorrect, and the stepped flanges were crowning.
- Part showed that it was under-bent just about everywhere.

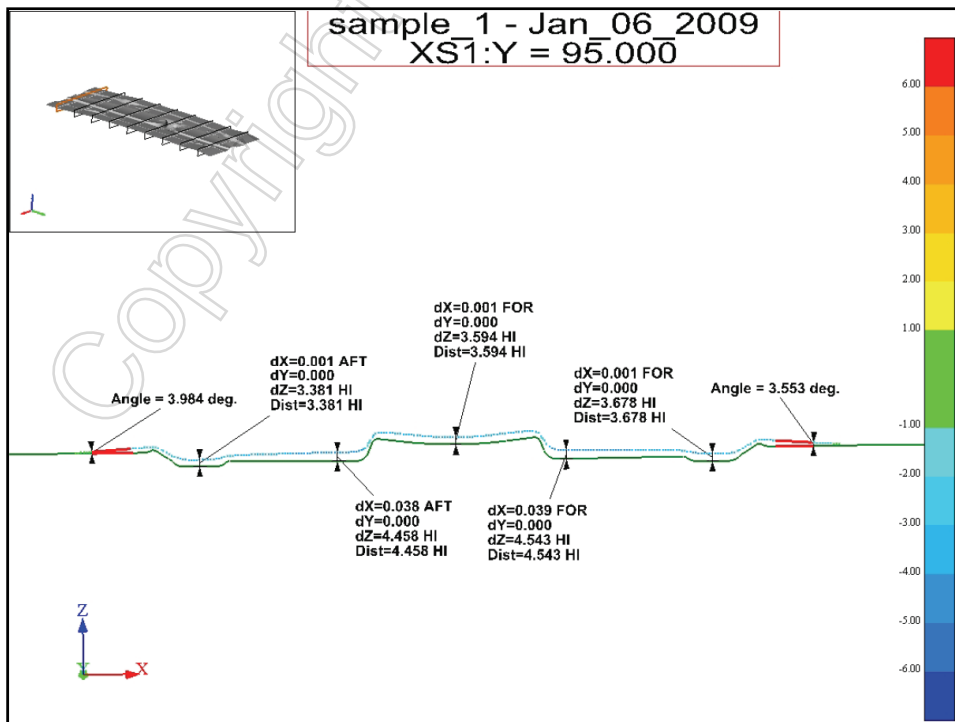
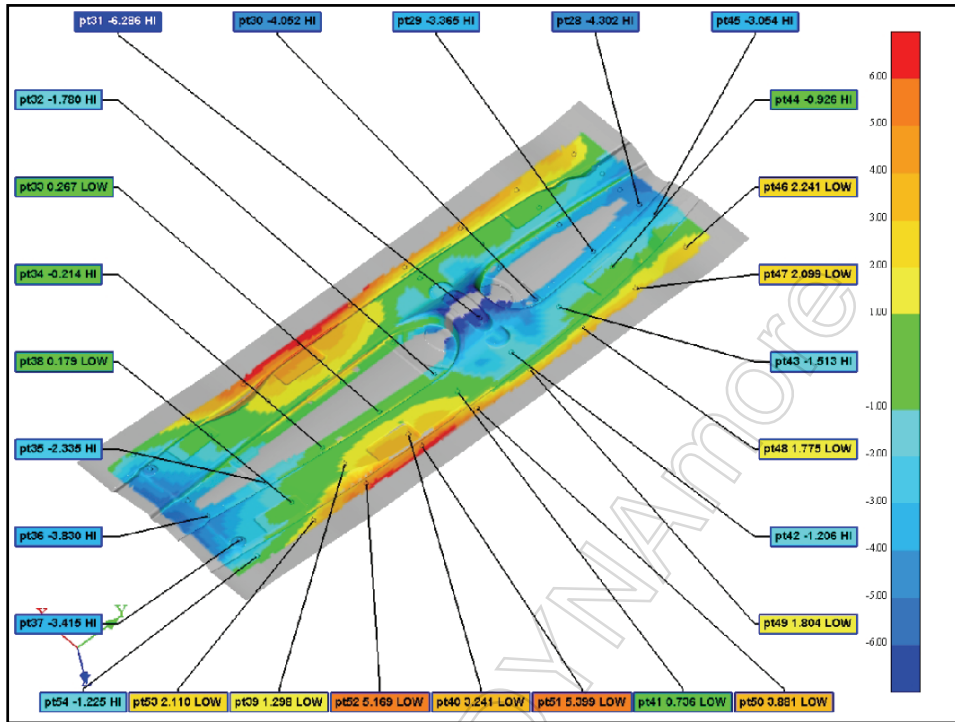


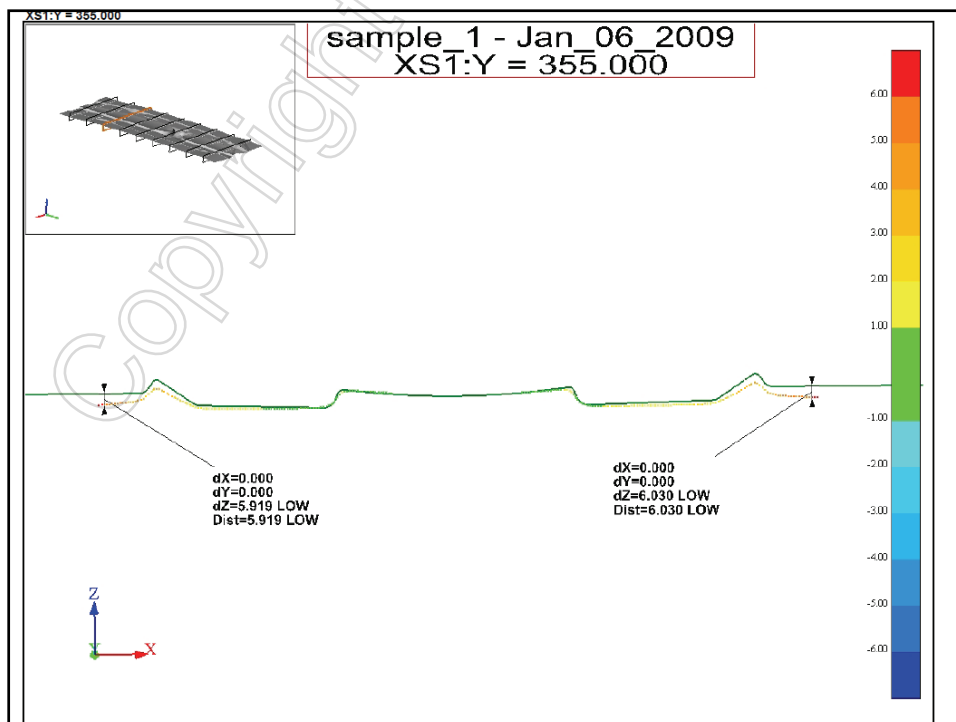
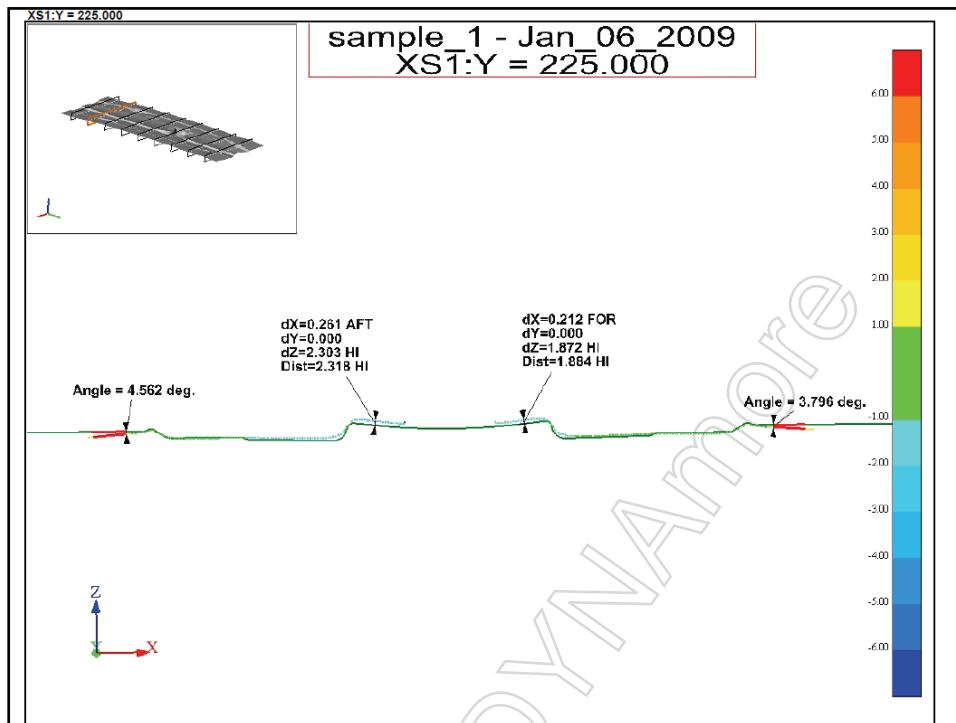
The Action Plan

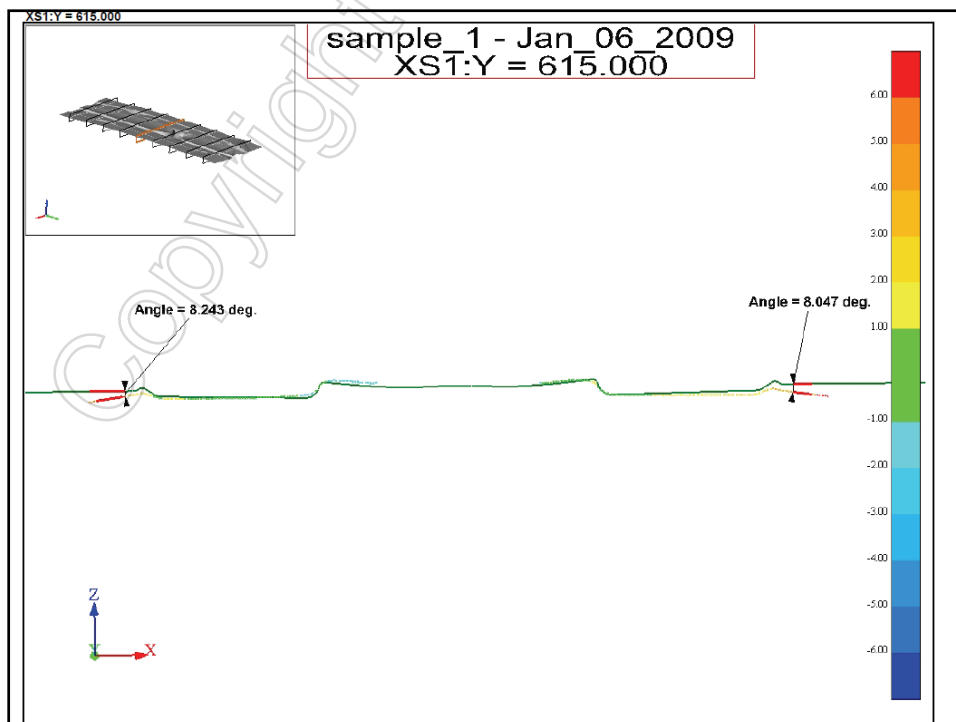
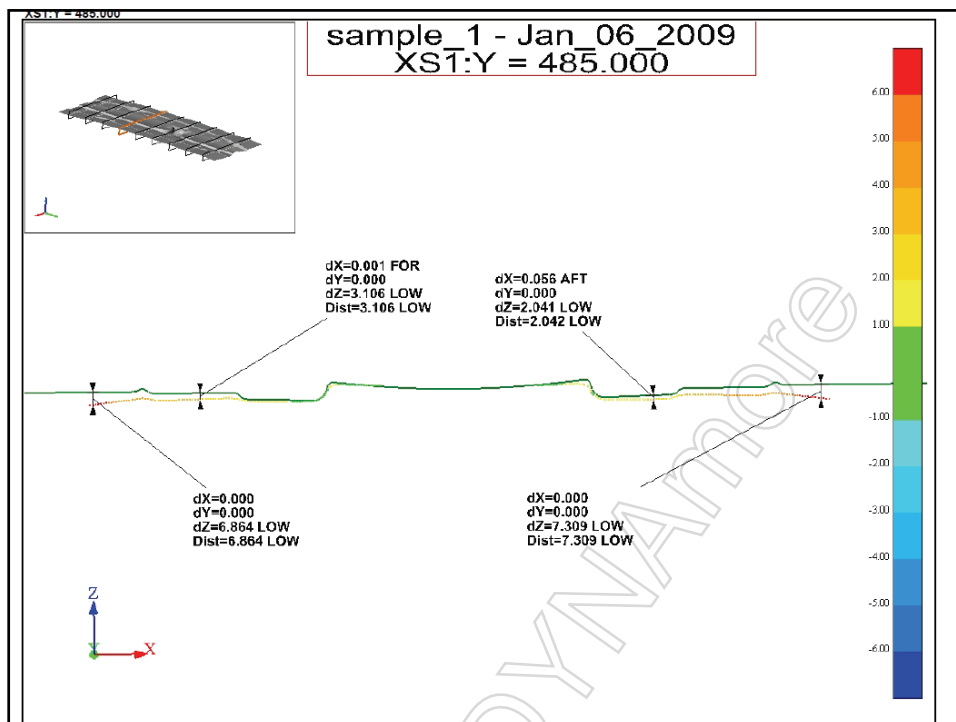
- We understand that the best stage to influence the shape of the part is in the first form stage.
- Lets send out a sample of the first form stage to a facility for white light or laser scanning so we can have our part checked.
- The cost to scan the formed part from the draw was \$250 CDN including a 17 page report, and STL output files.
- Canadian currency conversion,
 $\$1.00 \text{ CDN} = 0.79 \text{ USD} = 0.60 \text{ EU}$

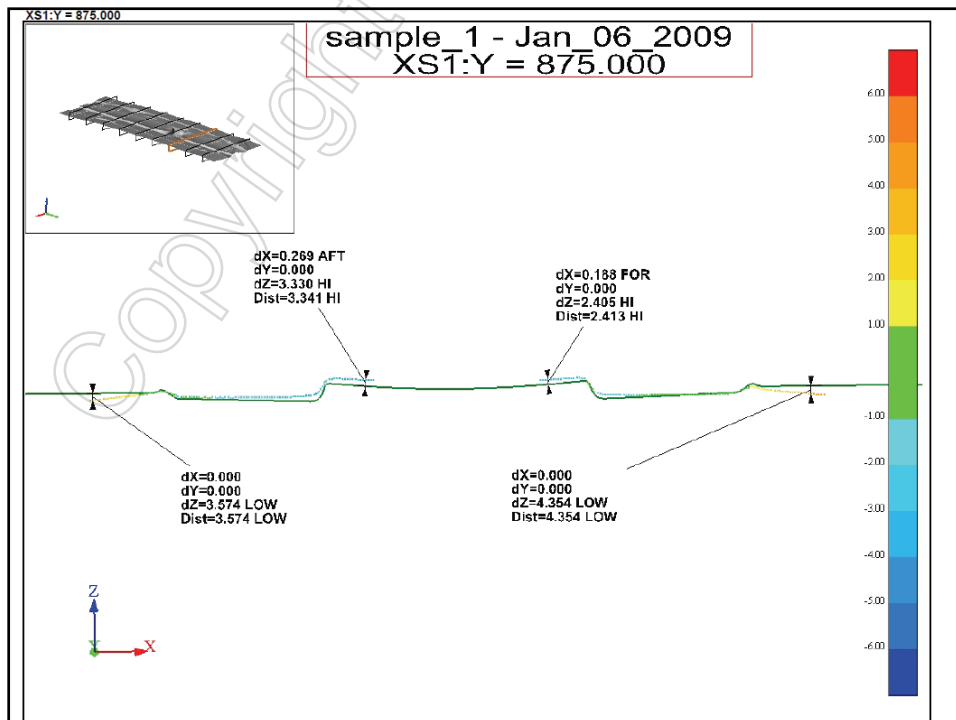
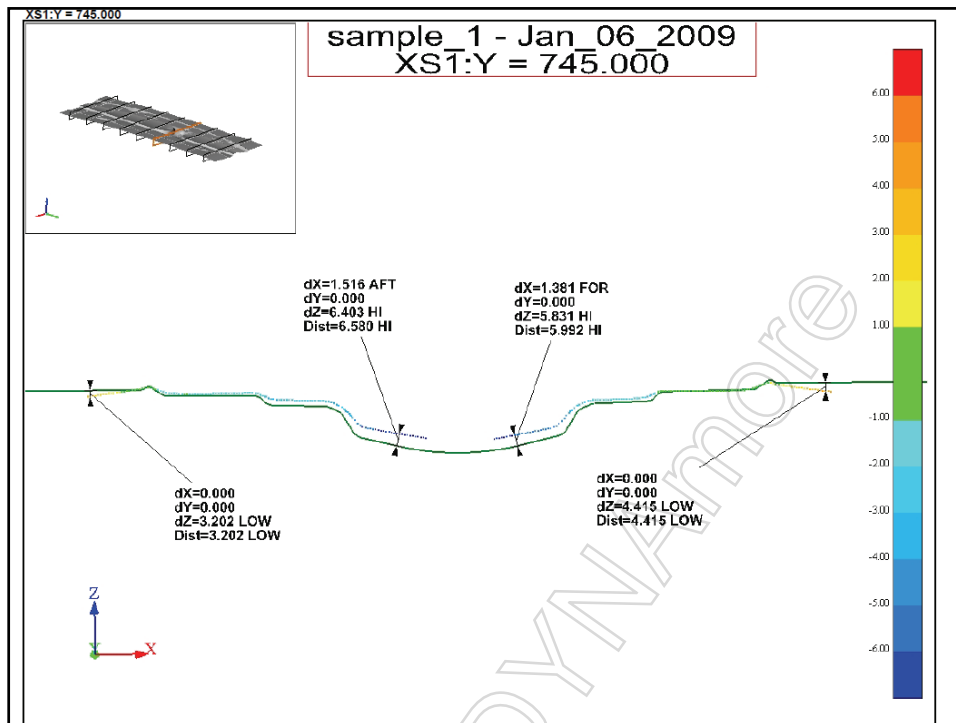
Analyze The Scan Data

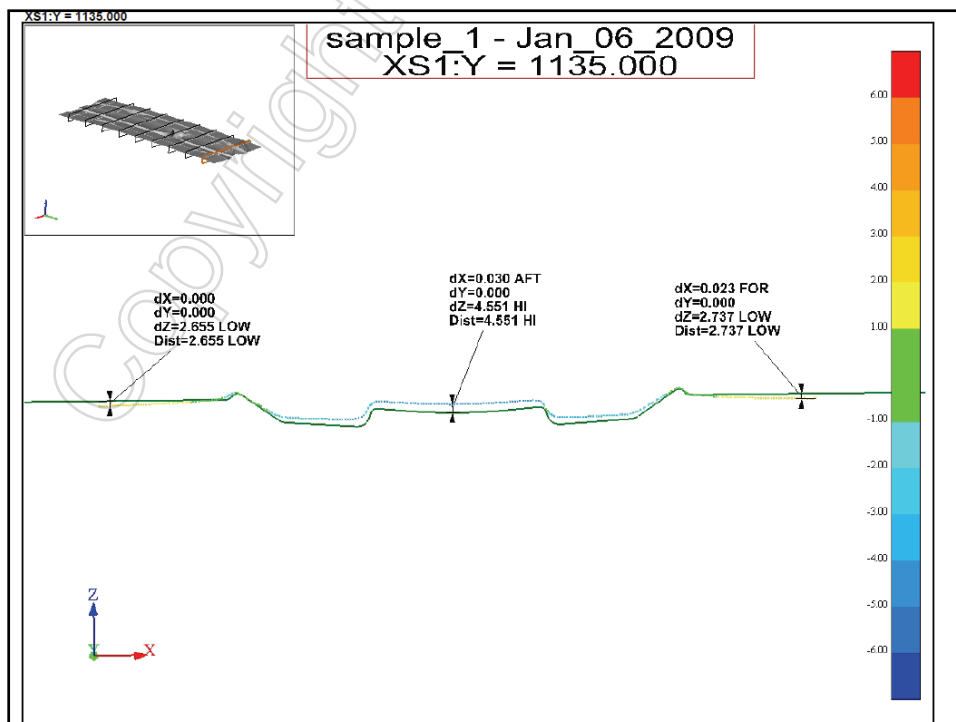
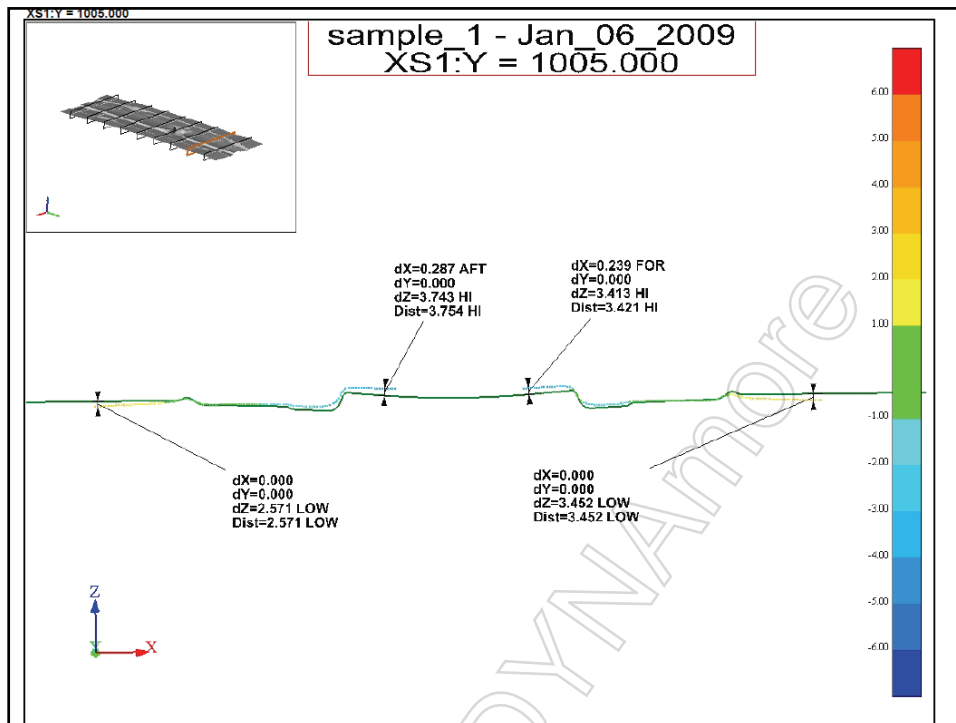






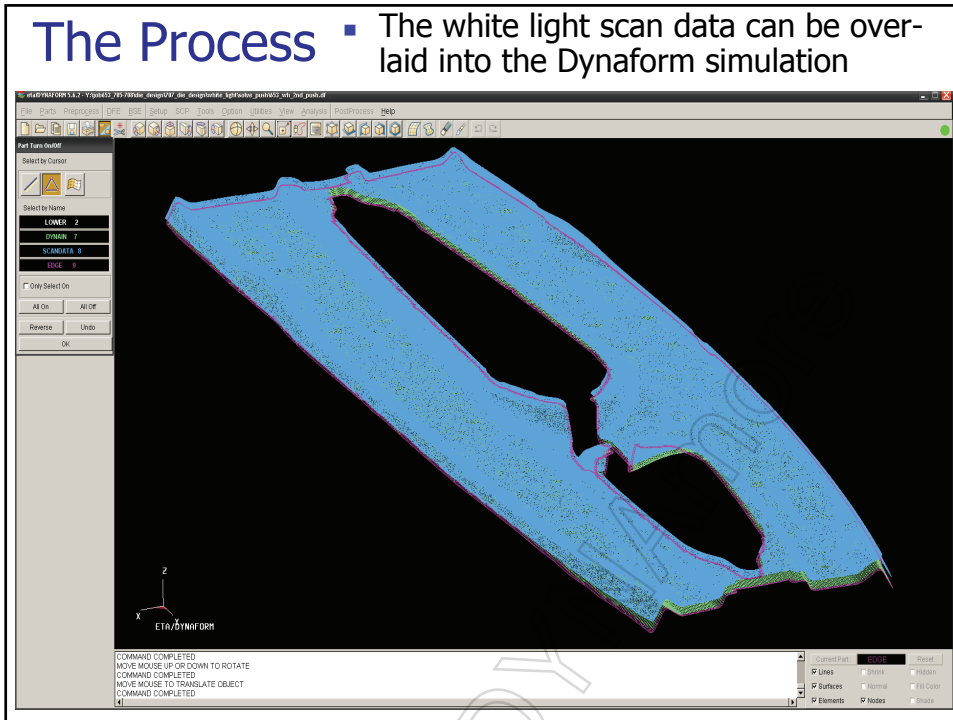






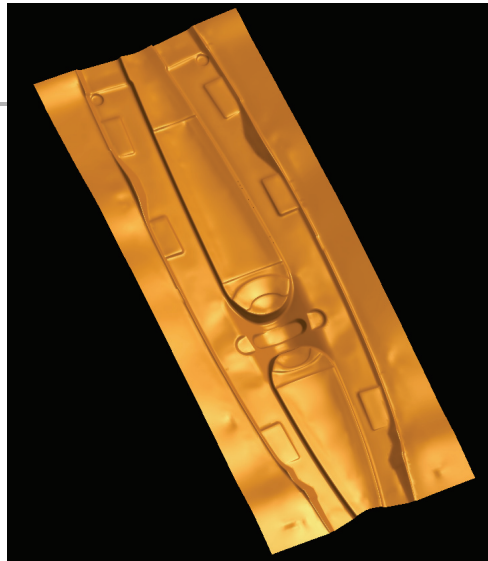
The Process

- The white light scan data can be overlaid into the Dynaform simulation



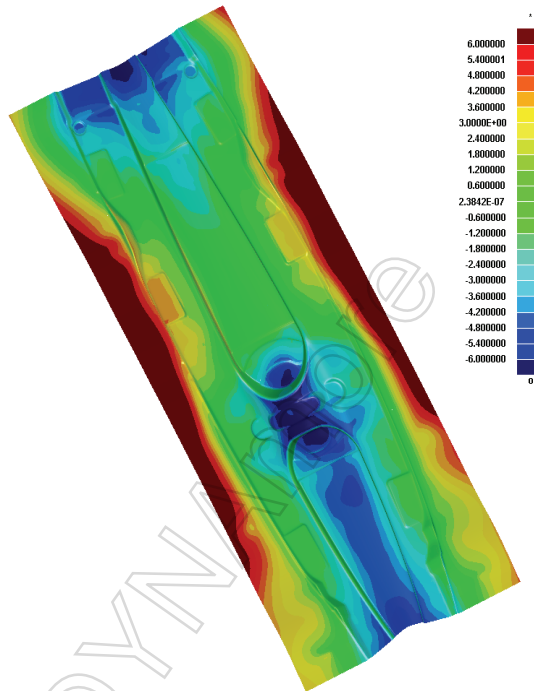
The Process Continued

- Utilizing the scan data as a spring back result, we used LS-DYNA and Dynaform interface to generate a new compensated tool shape.
- Part data is projected against the scan data, and then run through SCP compensation module.
- The actual amount of time required to generate this result is 1-3 hours depending on cpu capability.



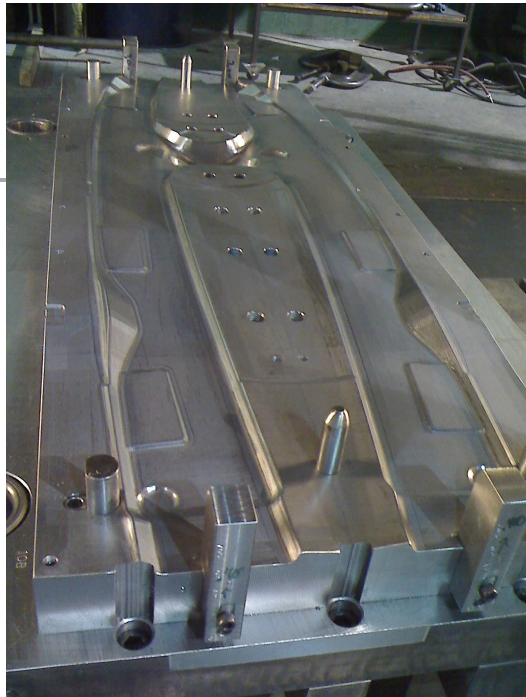
A Closer Look At The SCP Result Model

- This result file can be used to re-machine the die, and correct the spring back.
- Scale factors are case dependent. correction on this example is 1.0
- As you can see, the geometry of the entire model has been adjusted to reflect the deviations measured on the sprung part.
- This model is not created from the computed spring back result, but from actual scan data results which provide a 100% accurate baseline to build this model.
- This makes our model unique from conventional thinking, and provides a resolution that cannot be captured by conventional spring back analysis.



Real World Implementation Of The Result

- We machined the Die based on the modified mesh provided by the LS-DYNA analysis result, and hit a part in the press.
- Contrary to popular belief, the mesh generated in Dynaform can be machined.
- It is not necessary to generate surface data from the mesh, and risk losing resolution.



Tonnage

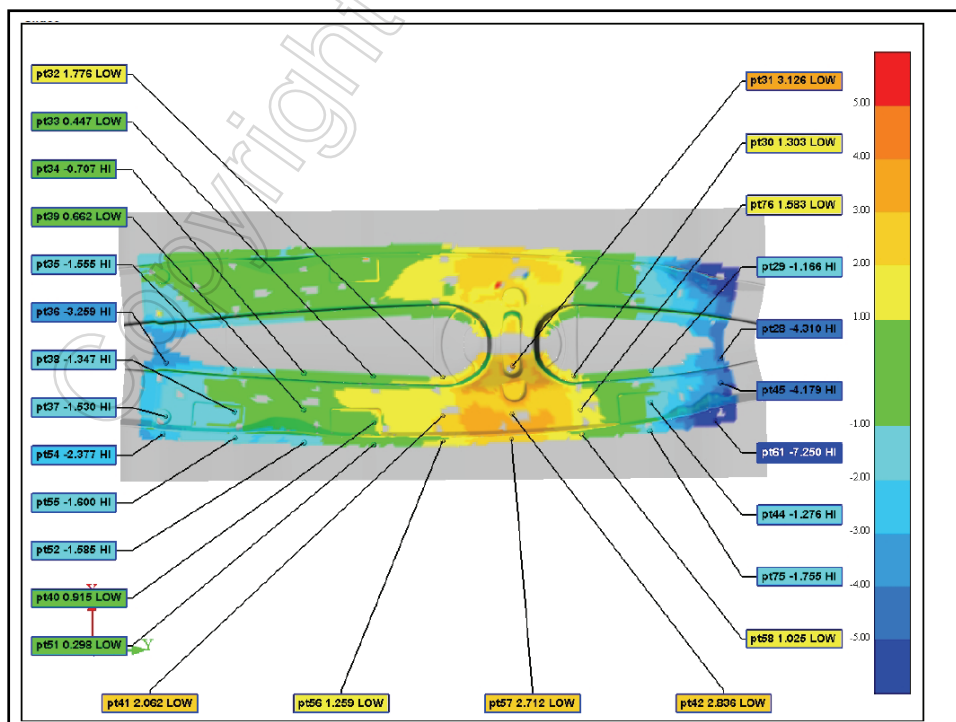
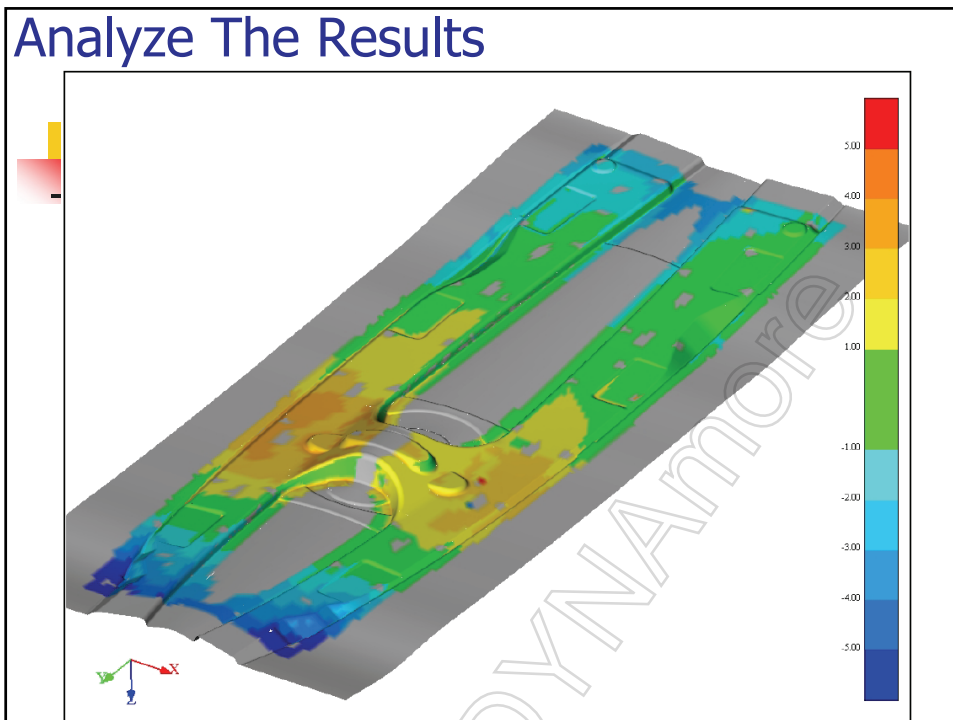
- Here is a view of the die in a 1500 tonne transfer press
- When We ran the form with nominal shape, the tonnage was 457
- After the SCP re-cut, the tonnage increased to 515

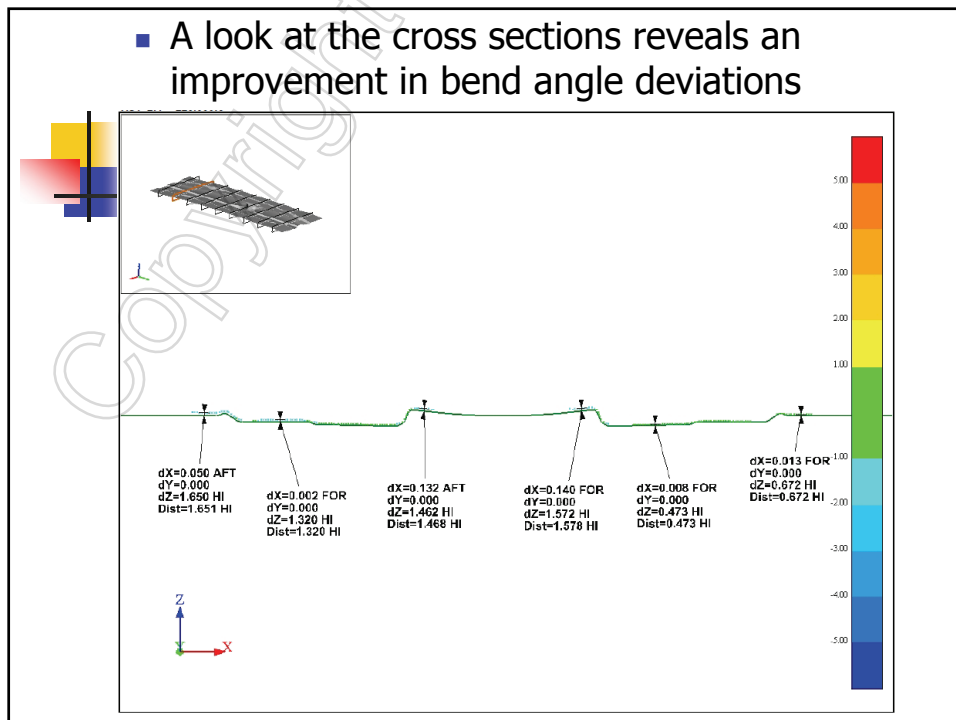
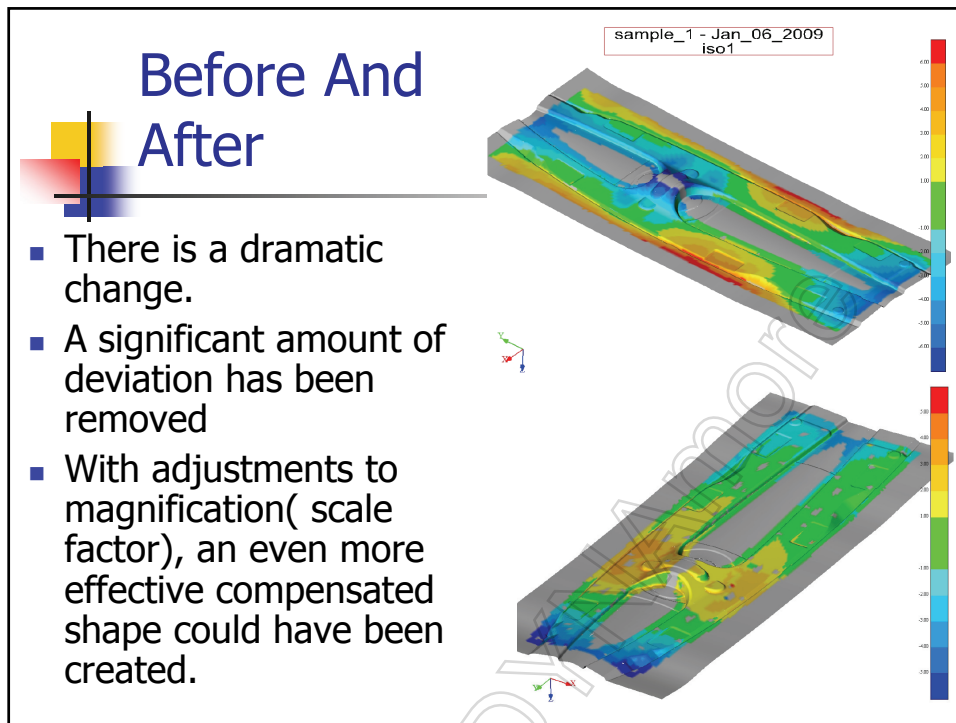


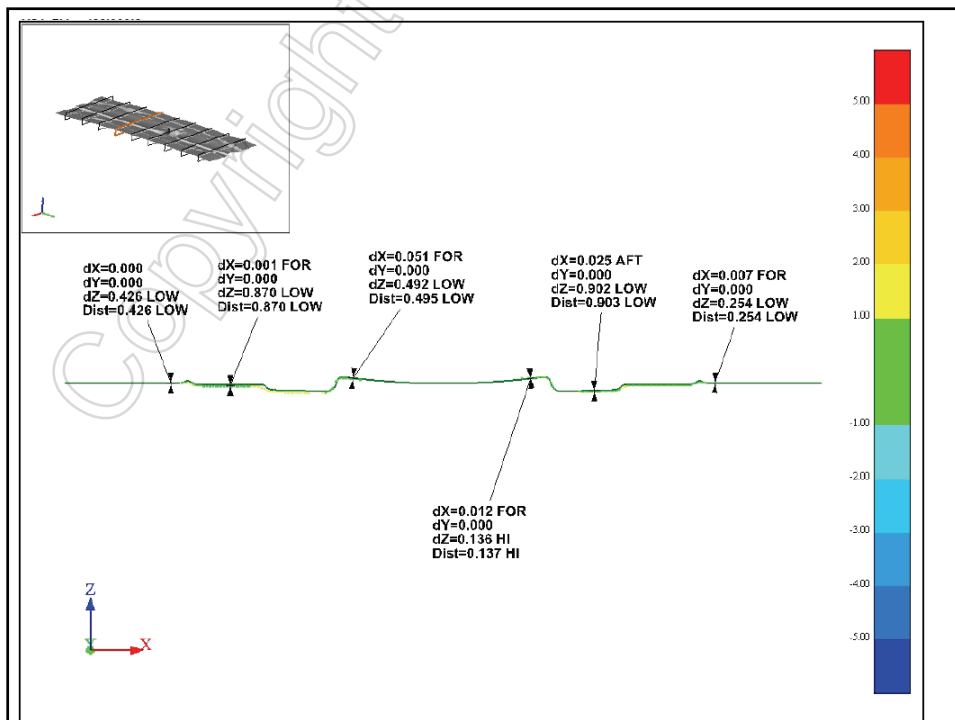
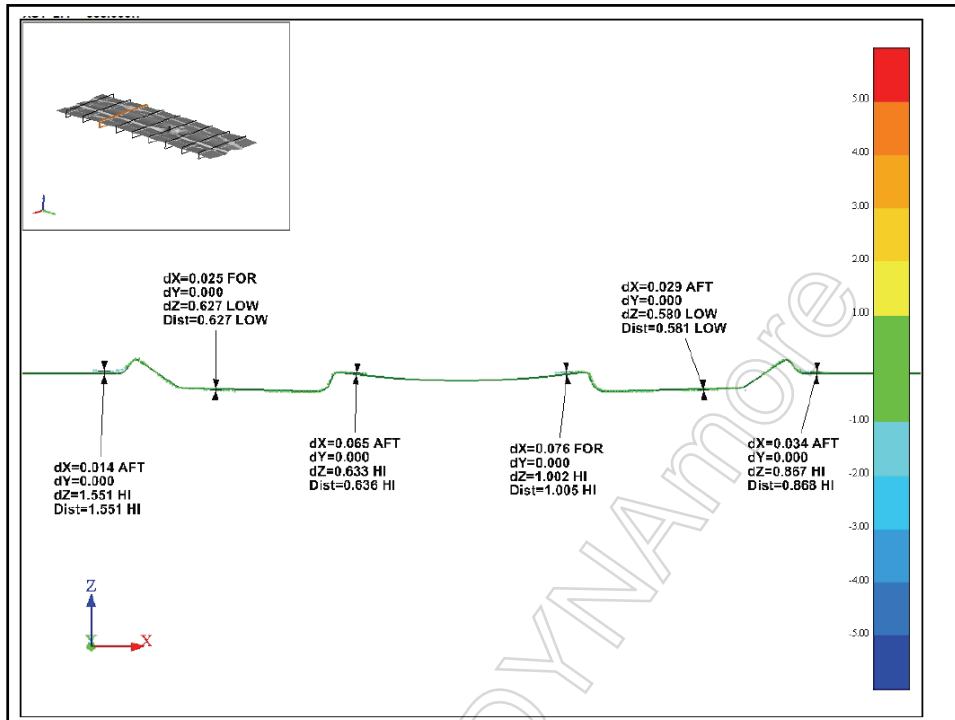
The Part After The Re-cut

- Twists, crowning, and deviation of form depth were all improved, the bow throughout the length of the part, and the bulging near the deeper form areas was reduced by a significant amount.

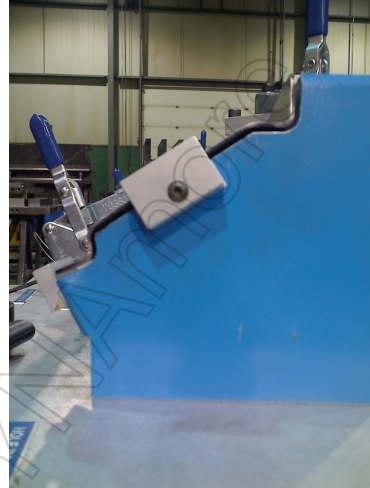
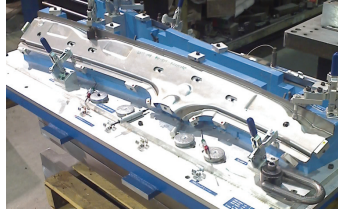






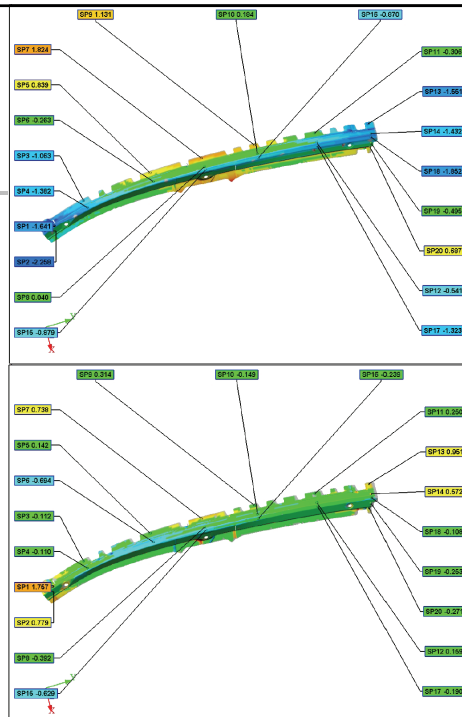


A Look at the part on the fixture after SCP Implementation



Another Example

- Channel shaped rail, curved profile with notches all along one edge.
- Part exhibits under-bend, and twisting.
- SCP with scan data was performed on crash form stage
- After 1st iteration, part is showing 90 percent removal of spring back





Cost Assessment to Resolve Springback Issues

- \$250.00 for outsourced scanning services.
- \$200.00 for approx 2 hours of Eng time to generate a compensated shape.
- \$1600.00 in cnc shop time to re-machine the form die.
- The total cost of \$2050.00 CDN and one day of total time spent (two shifts on CNC)



Conclusion

- We are still working to perfect the process, and identify correct magnification (scale) factors.
- We will continue to develop this process so that it can be an automated part of the SCP module in LS-DYNA/Dynaform.
- SCP with scan data model is an excellent option. Quite often, adequate information is unavailable to build a Yoshida Material Model for spring back prediction.
- SCP can prove to be superior option when dealing with parts that have multiple and large trim out stages that also affect spring back prediction.
- The cost savings on this project alone is thousands of dollars in re-work, and re-cutting.
- When the customer compared the part quality to similar parts produced by conventional methods. It was noted that our part showed a significant and noticeable improvement.