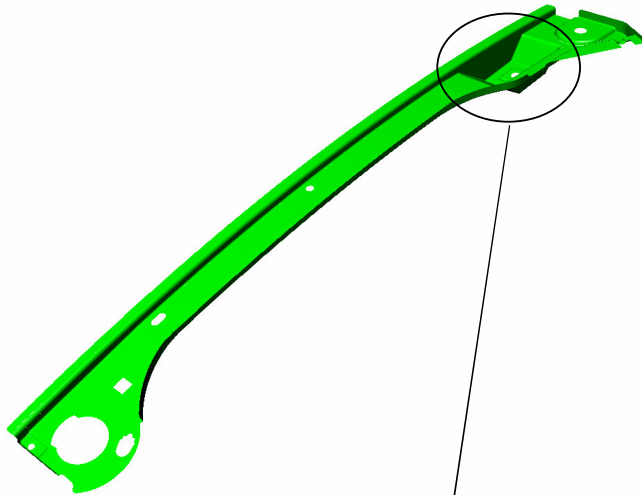


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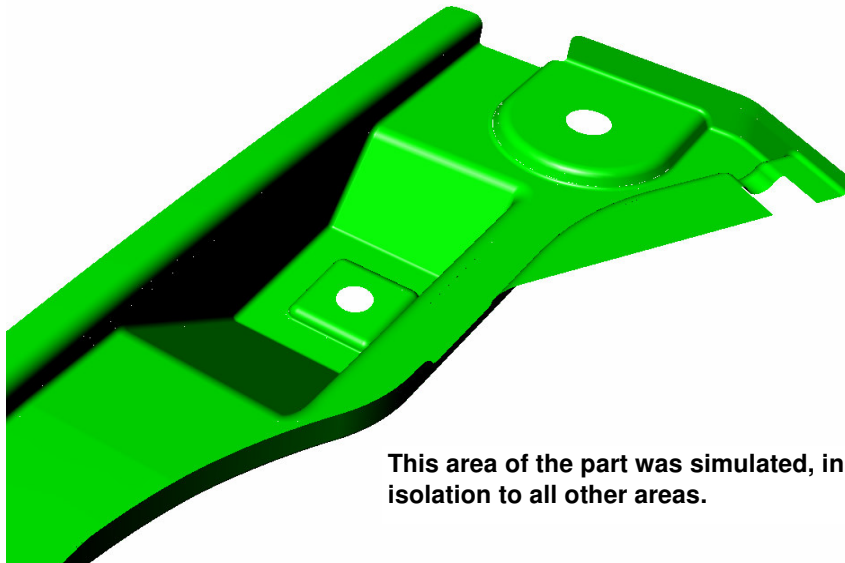
Client: Company Name Date: Report Date



Introduction

The client provided the CAD model of a final part and requested simulations to answer the following questions. However, only one section of the part was of concern hence simulations were focussed only in this area:

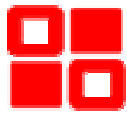
1. What's the minimum wall reduction we can expect on sides & at base of pocket?
2. The optimum Number of Draws?
3. Optimum Punch to Die clearance?
4. Enlargement of rad at top of die & Punch?
5. Predict material reduction at various locations within the draw pocket?
6. Will draw beads be required at corners to stop wrinkling?



This area of the part was simulated, in isolation to all other areas.

Material Information:

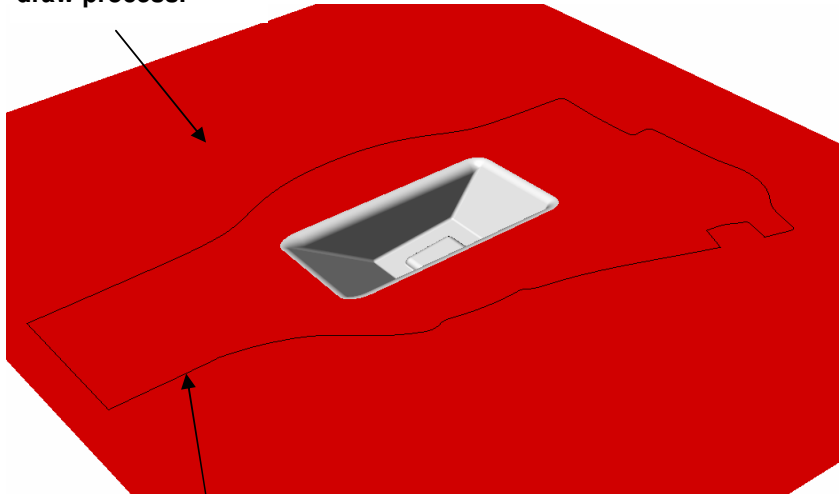
DX53D+Z , Tensile strength 140~280 mpa



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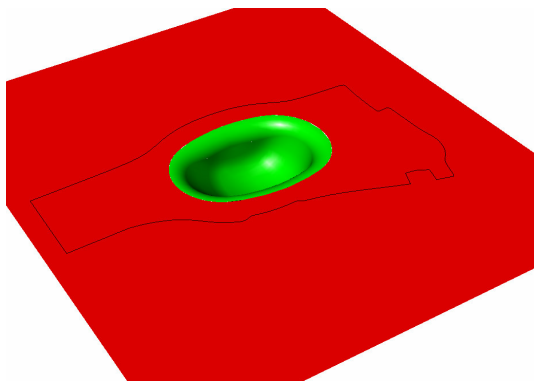
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Binder surface for
draw process.



Calculated blank shape used in
each simulation.

This data shows the setup for
the "crash form" and "single
stage draw" processes.



This data
shows the
setup for the
"pre-draw"
process.

Simulation Setup

Numerous different options were setup and simulated. The first step was to calculate and approximate the blank shape to use in the first draw process.

The next step was to choose a process and setup an appropriate simulation.

1st Attempt

The first attempt simulated a "crash form" process, whereby a male and female punch and die were closed together to try and form the shape.

2nd Attempt

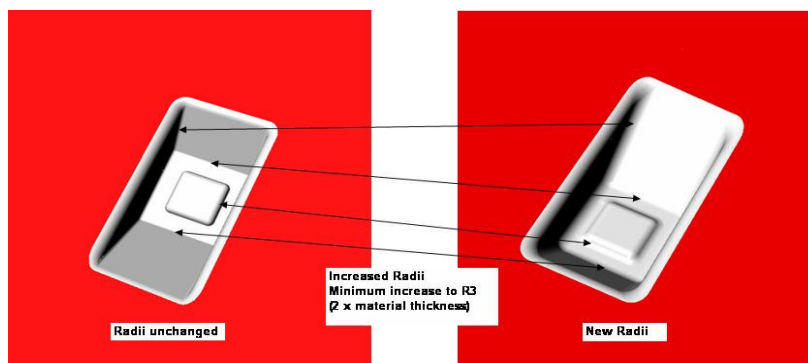
The second attempt used the same die face data, however, a draw process was used whereby the material was held in a binder and stretched over the male punch. This was a "single stage draw" process.

3rd Attempt

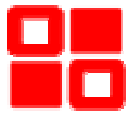
The third attempt used a pre-form shape followed by a final form process. However, the final form shape used increase radii to countermeasure predicted splits encountered in earlier simulation results.

4th Attempt

A fourth attempt used the two stage process but further increased the final form radii to 3x original values.



This image shows which radii were increased and by how much for the final form process in the third attempt.



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This data shows the CAD model that was provided by the client, with hugely increased radii in some areas.

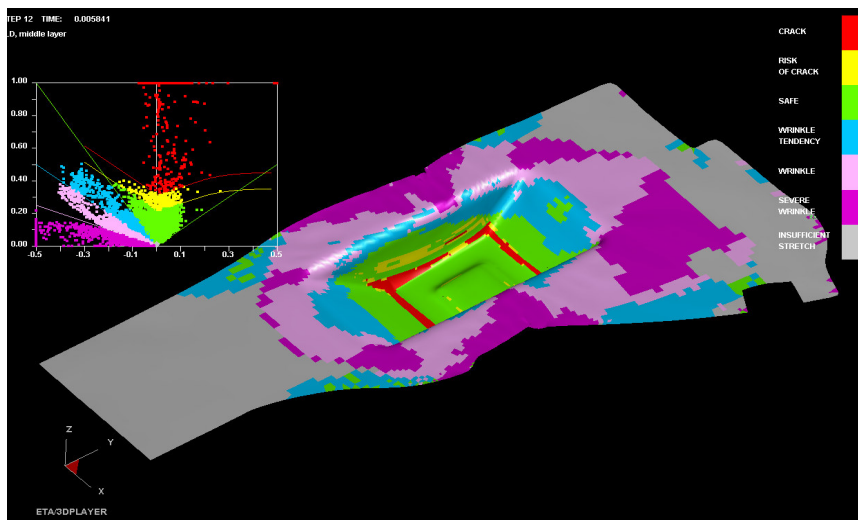
5th Attempt

In the fifth attempt, the client provided a modified CAD model with greatly increased radii. Some areas had radii increased to as much as 8x original values.

The two stage approach was used (ie: with a pre-form) but the final form shape used the provided CAD data.

6th Attempt

Finally, the provided CAD model was simulated again, however, as a single stage draw process.



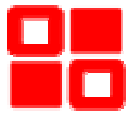
1st Attempt - Crash Form Process - Not Feasible

Results

For each attempt, a Forming Limit Diagram plot and a Thinning plot were provided. This allowed direct comparison of each attempt.

1st Attempt - Crash Form

The result showed severe wrinkles and splits. The conclusion was that this process was not feasible.



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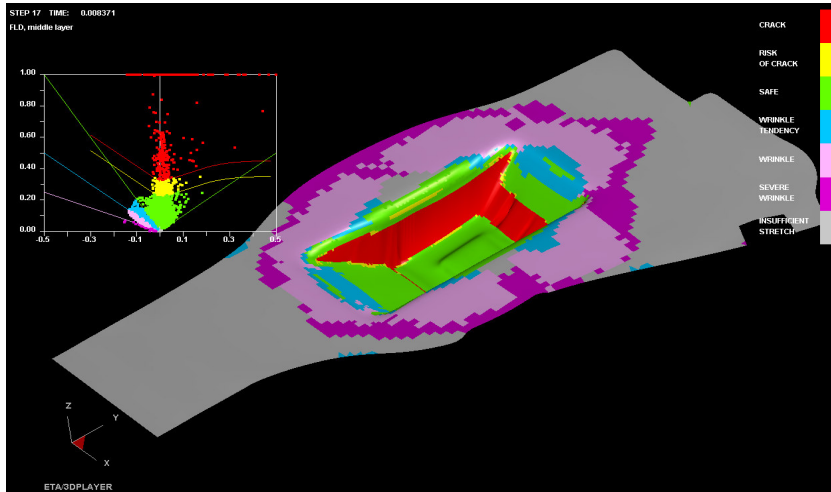
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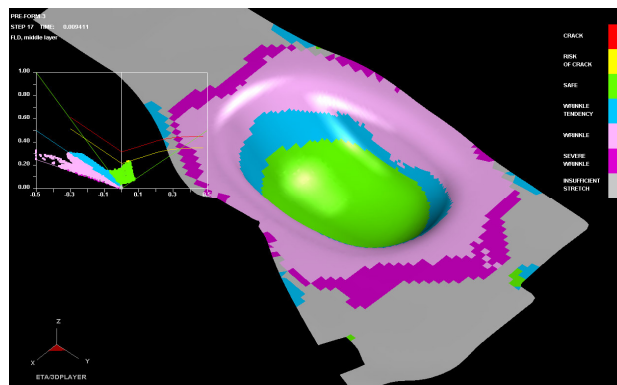


Results (continued)

2nd Attempt - Single Stage Draw Form

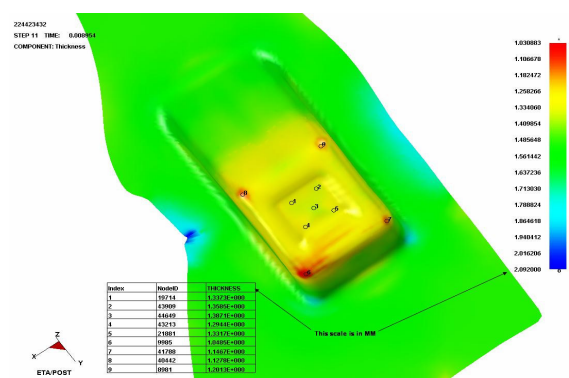
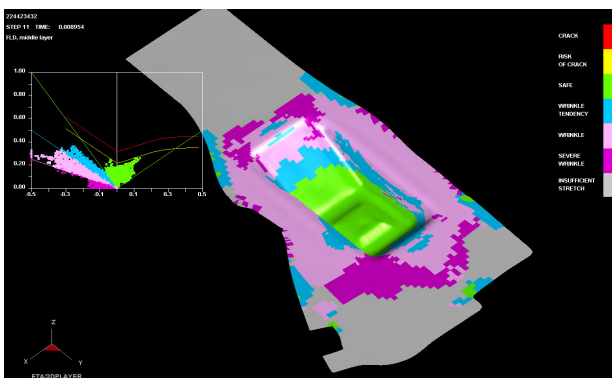
The result show severe material failure.

2nd Attempt - Single Stage Draw Form - Not Feasible

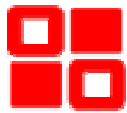


3rd Attempt - Two Stage Process with Increased Radii (2x)

This result showed a feasible process, however, the request was to further reduce thinning in the critical areas.



3rd Attempt - Two Stage Process with Increased Radii - Feasible



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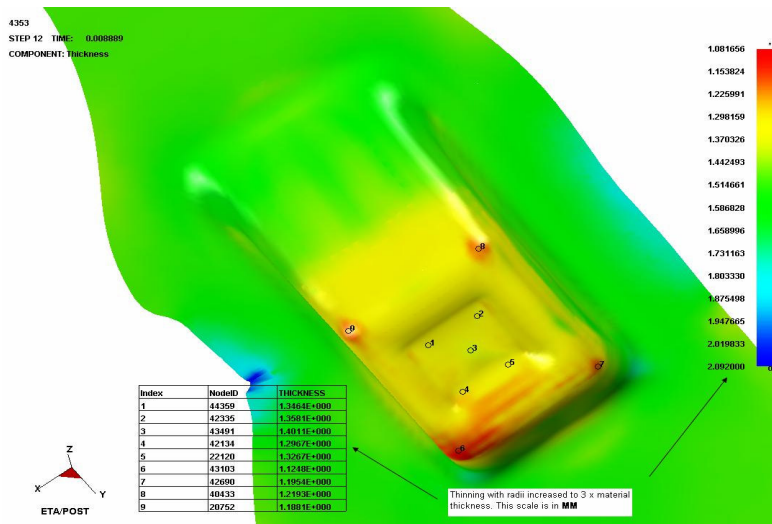
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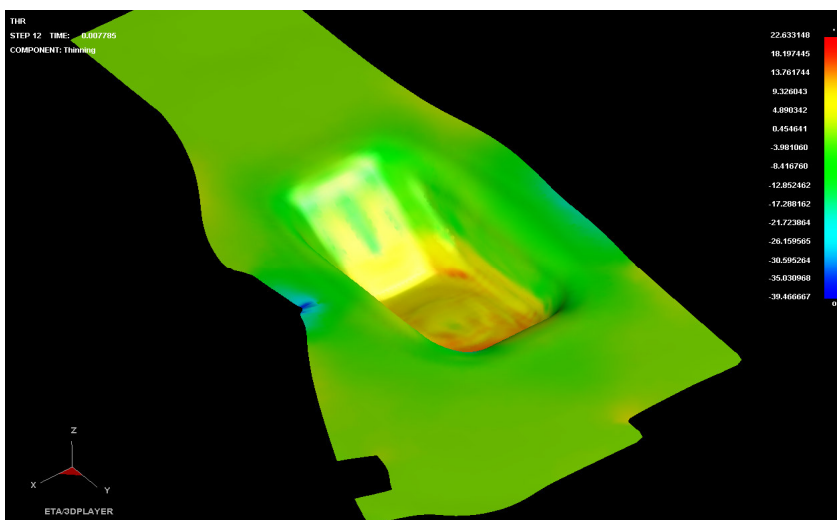


Results (continued)

4th Attempt - Two Stage Process with further Increased Radii (3x)

The result also showed a feasible process.

4th Attempt - Two Stage Process with further Increased Radii - Feasible

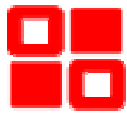


Results (continued)

5th Attempt - Two Stage Client's CAD Model

This result proved to be feasible and with hugely increased radii, final part thinning was further reduced. This was the best result produced.

5th Attempt - Two Stage Client's CAD Model - Feasible - BEST RESULT



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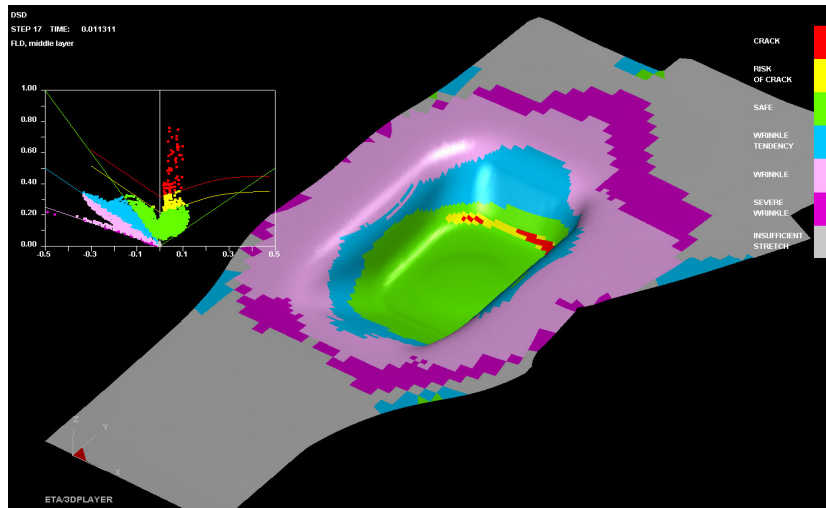
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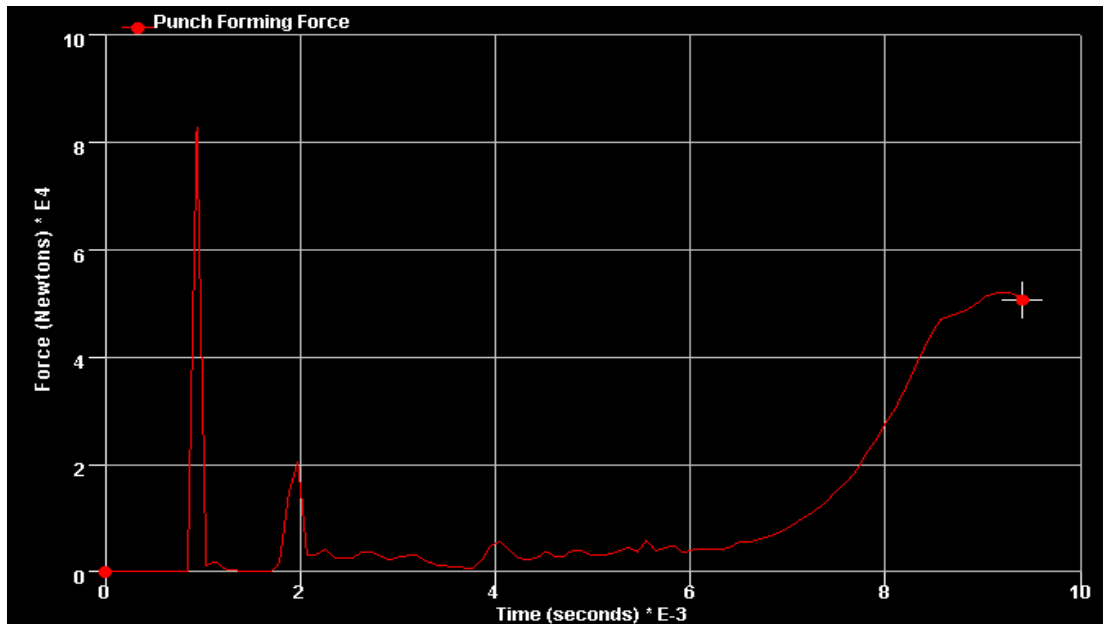


Results (continued)

6th Attempt - Single Stage Draw with Client's CAD Model

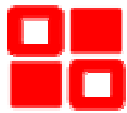
This result showed that even with hugely increased radii, failure was still predicted when drawn in a **single** process. If radii were increased in the failure location, it ****may**** be possible to make this process feasible. Another simulation would be required to investigate, however, no further simulations were requested.

6th Attempt - Single Stage Draw with Client's CAD Model - Not Feasible



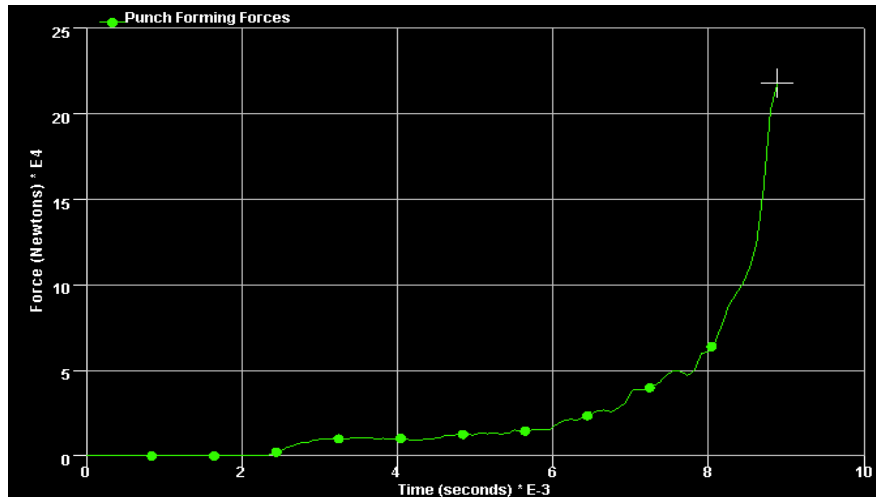
Forming Forces - Pre Form Stage

For each pre-form process attempted, the forming forces are approximately the same. Approximately **8.3 ton** of peak forming force is required in the pre-form stage.



Simulate CompleteSM | Process Feasibility Study

Client: Company Name Date: Report Date



Forming Forces - Final Form Stage

For each final form process attempted, the forming forces are approximately the same. Approximately **21.7 ton** of peak forming force is required in the final forming stage.

Final Comments and Conclusion

In response to the initial questions asked:

1. Wall (thinning) reduction plots for each attempt were provided. The best result was achieved in Attempt 5.
2. The optimum number of processes to form the deep area of the part (disregarding all other sections of the part) is two stages, that is, a pre-form followed by a final form.
3. The typical punch/die clearance for this material is 10% of material thickness. All simulations have used this value. However, to re-strike or "iron" some specified areas, clearance should be decreased in those local areas.
4. Various radii were increased through out each attempt. The best result was Attempt 5. This is logical because it had the largest change in radii.
5. A thinning plot for each attempt was provided, showing material thickness reduction in requested areas.
6. Draw beads will not assist this forming process (assuming the use of a pre-form process). The addition of draw beads would significantly increase the amount of material thinning and therefore counteract the improvements achieved by using increased radii.

Final Conclusion: A two stage (pre-form and final form) process is most feasible, using the CAD model provided by the client (with the hugely increased radii).