Design & Manufacturing a DP980 B-Pillar Inner for the GM Chevy Equinox / Pontiac Torrent

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OUTLINE

- **Design for Roof and Front Offset Crash**
  - **Design with AHSS Solutions**
  - **Design for Formability**
- **Production Experiences DP980 B-Pillar**
  - **Manufacturing Considerations**
  - **Process Selection & Tool Development**
  - **Lessons Learned**
  - **Summary**

Why have we changed the current design?

Increasing Government Regulation and Customer Demand for Safety

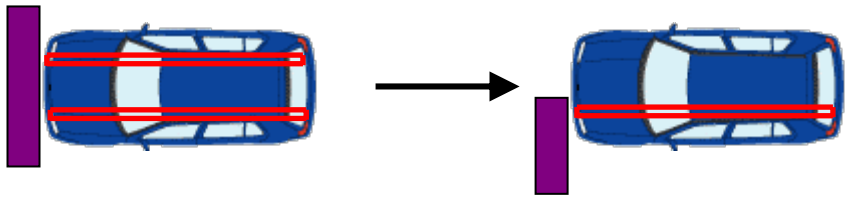
Roof crush requirements

Up to 2010	2010
1.5x	2.5x

X = vehicle curb mass

Front crush

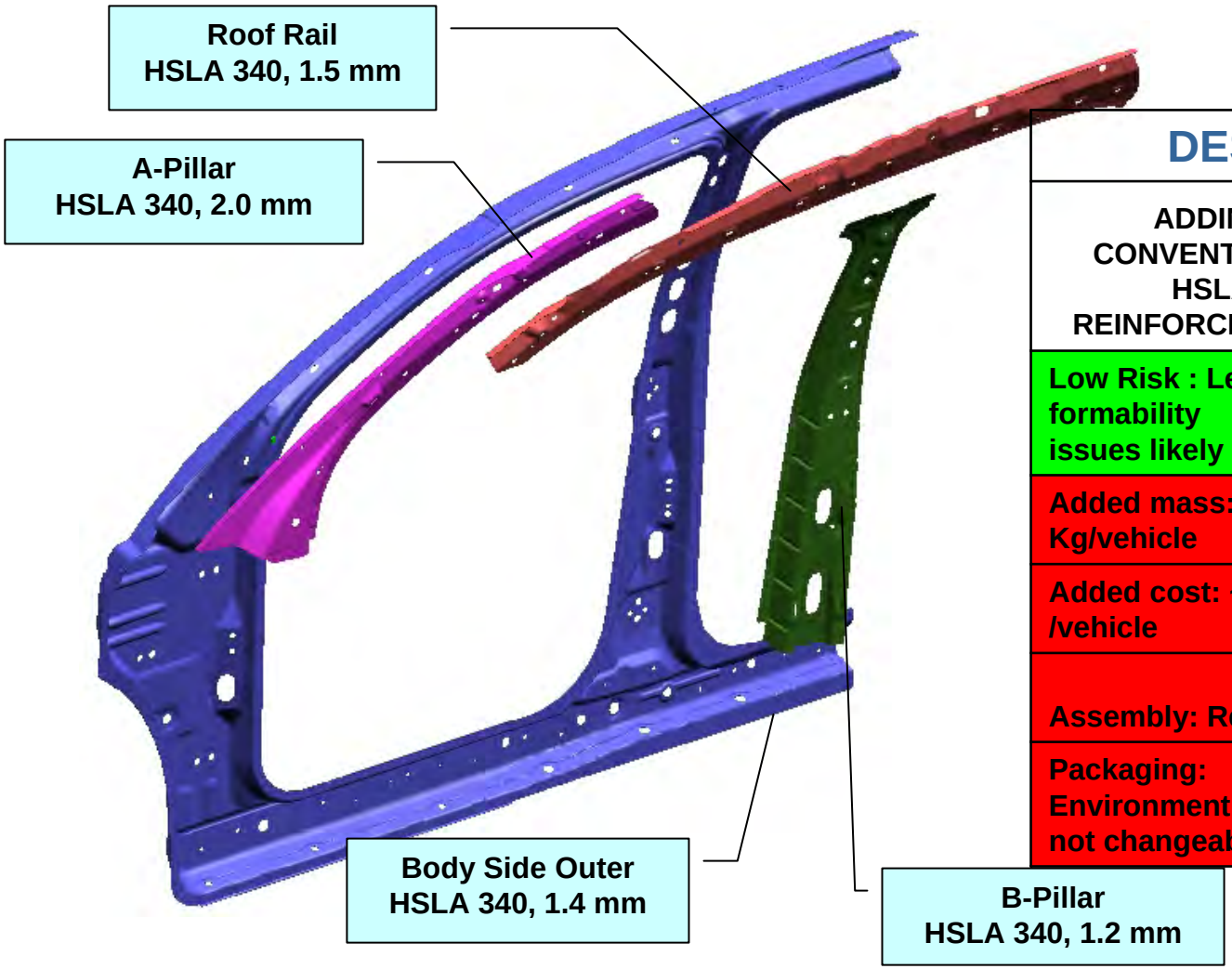
Front offset crush



NEW

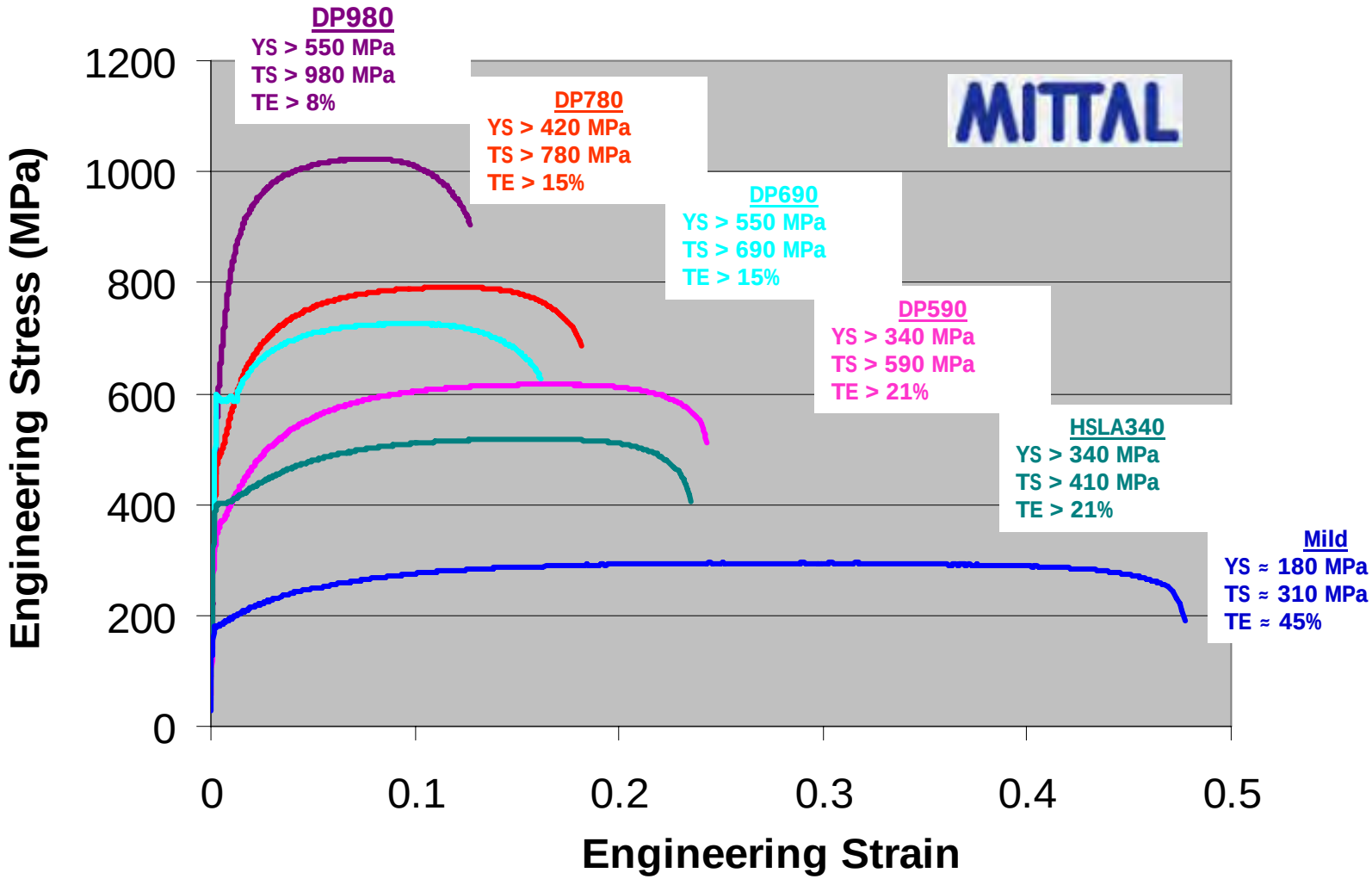
Past Model Materials and Design

Front Offset and Roof Crush Contributors



DESIGN DIRECTION	
ADDING CONVENTIONAL HSLA REINFORCEMENTS	USING AHSS / DUAL PHASE STEEL
Low Risk : Less formability issues likely	High Risk: More steel formability issues likely
Added mass: ~ 30 Kg/vehicle	Added mass: ~ 0.6 Kg/vehicle
Added cost: ~ $ 60/ /vehicle	Added cost: ~ $ 4/ /vehicle
Assembly: Restricted	Assembly: Not Affected
Packaging: Environment not changeable	Packaging: Not Affected

AHSS Material Alternatives



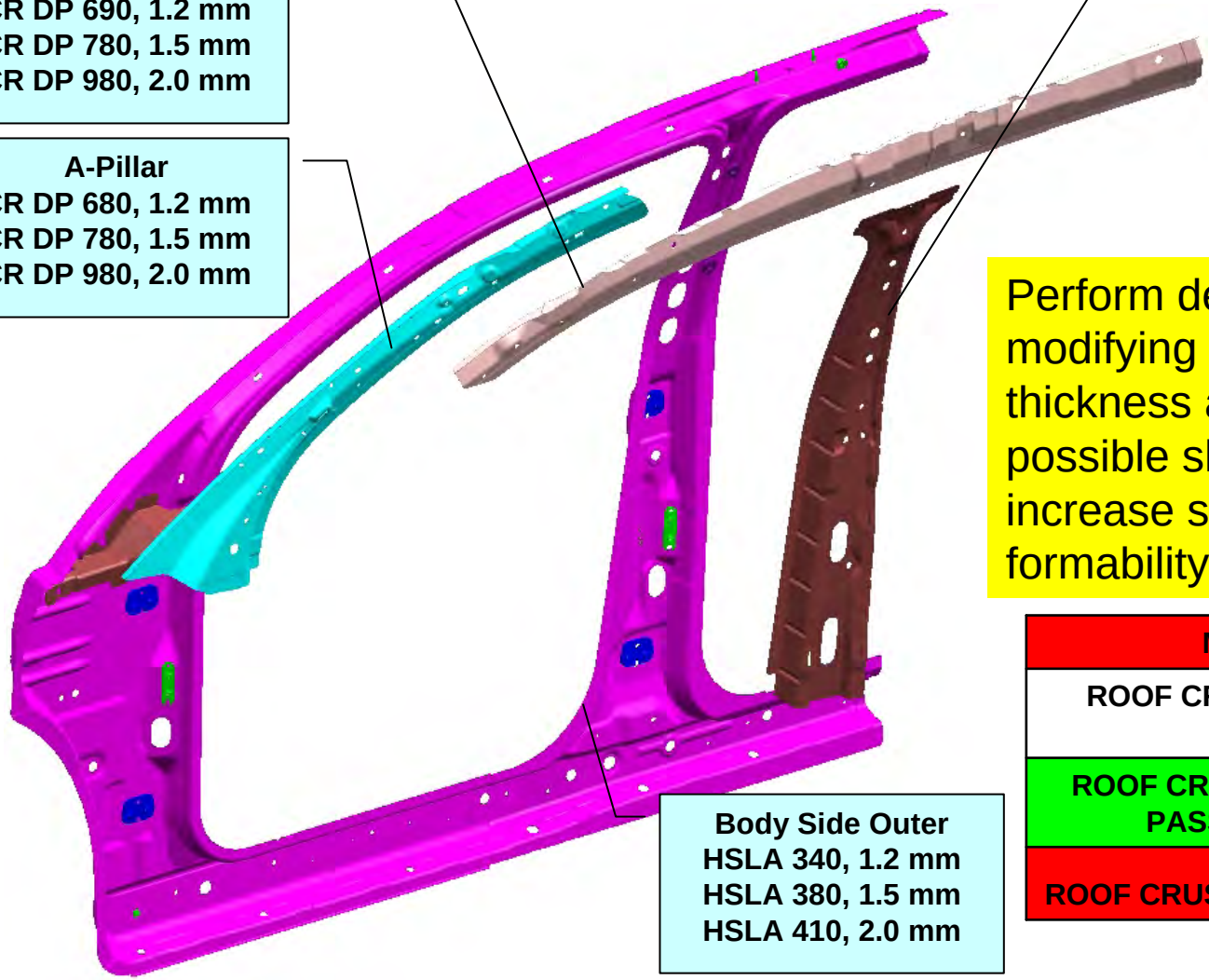
ROOF AND FRONTAL OFFSET CRUSH PACKAGE

Design Alternatives with AHSS

Roof Rail
CR DP 690, 1.2 mm
CR DP 780, 1.5 mm
CR DP 980, 2.0 mm

A-Pillar
CR DP 680, 1.2 mm
CR DP 780, 1.5 mm
CR DP 980, 2.0 mm

B-Pillar
CR DP 690, 1.2 mm
CR DP 780, 1.5 mm
CR DP 980, 2.0 mm



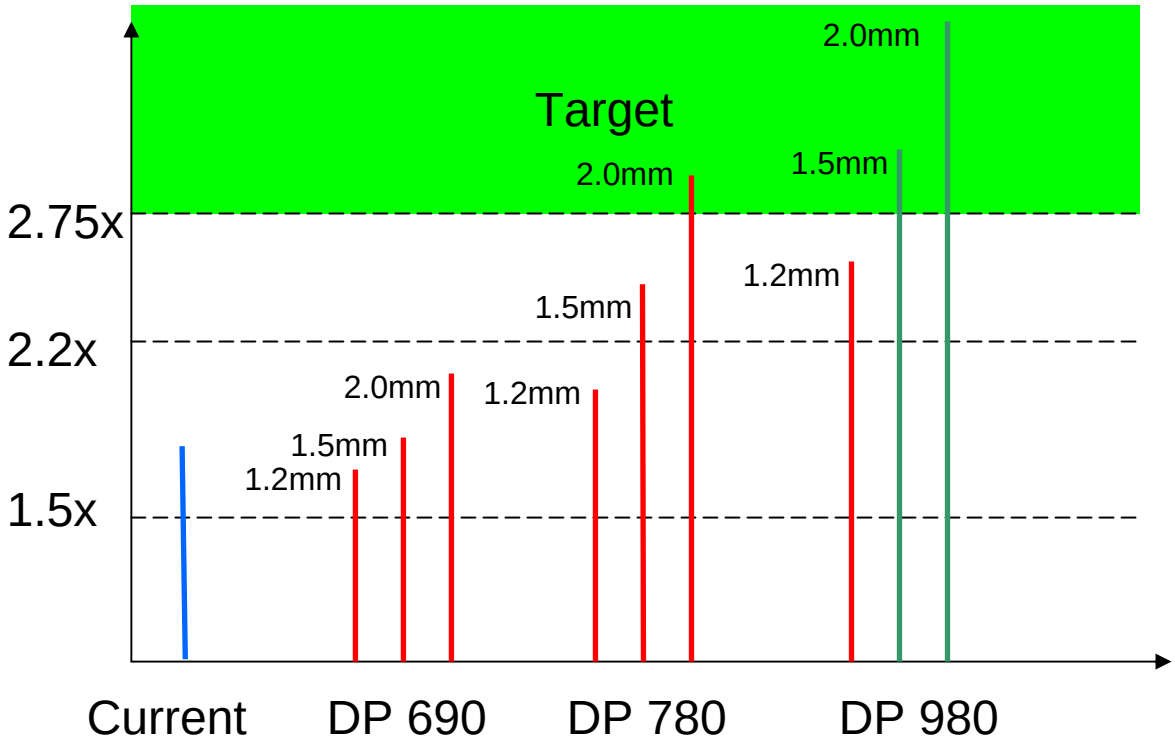
Body Side Outer
HSLA 340, 1.2 mm
HSLA 380, 1.5 mm
HSLA 410, 2.0 mm

Perform design iterations by modifying the material type and thickness as well as studying possible shape changes to increase structural strength and formability requirements.

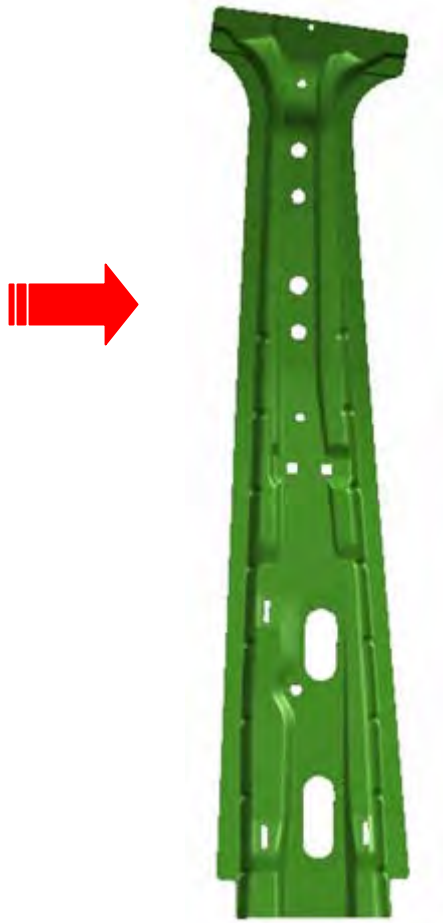
MAIN CONTRIBUTORS	
ROOF CRUSH	FRONT OFFSET CRUSH
ROOF CRUSH→ PASS	FODB FAIL
ROOF CRUSH FAIL	FODB PASS

Design Iterations using AHSS

Design iterations



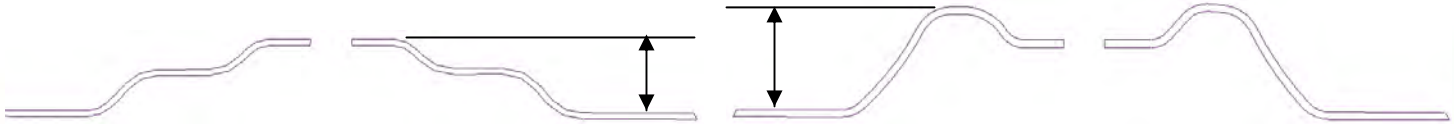
DP980, 1.5 mm thick

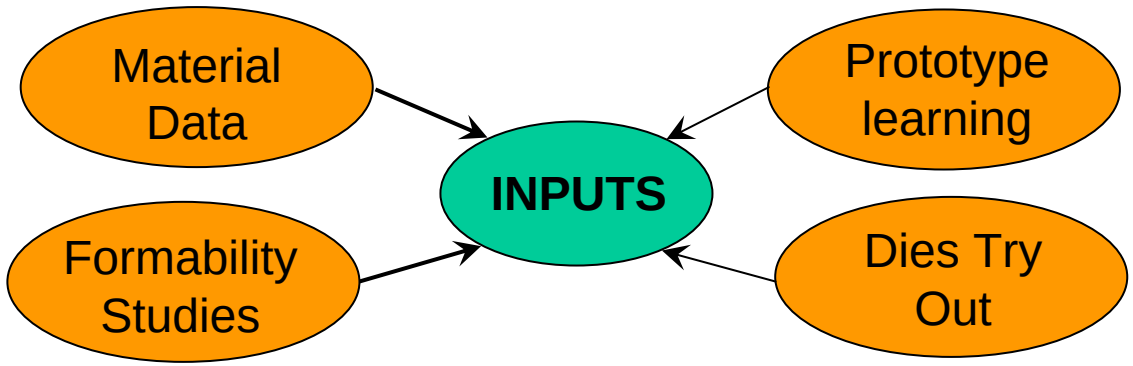


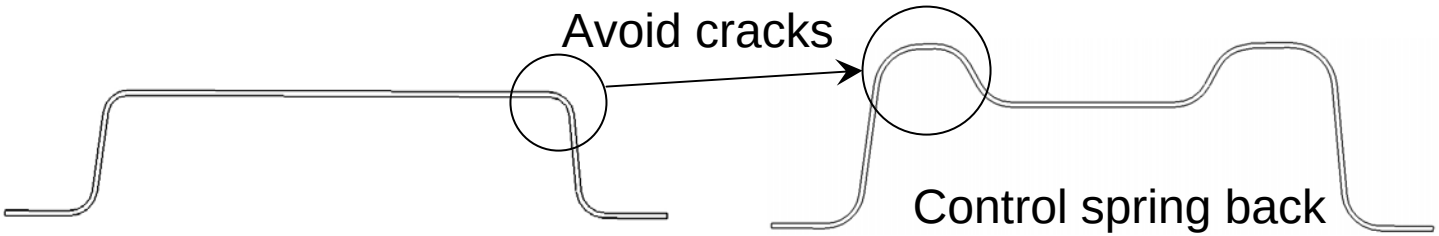
Design for Formability

From the current part … … to final product

Improve section stiffness







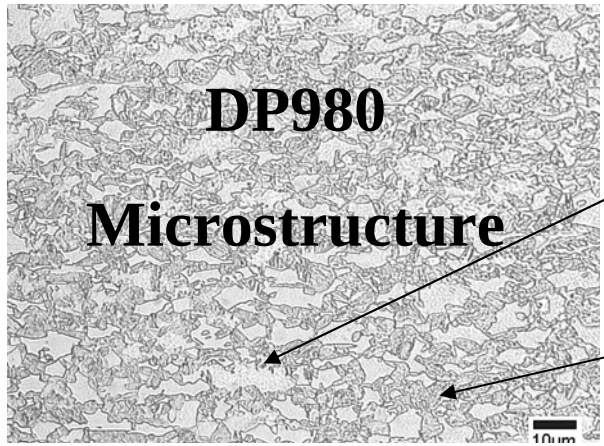
Early Manufacturing Feasibility Study

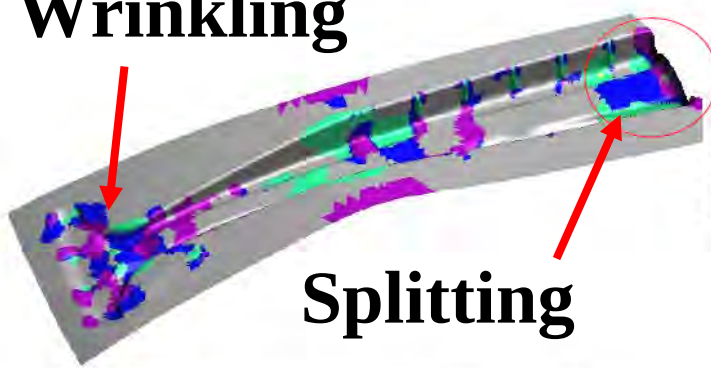
Typical Properties

YS, MPa : 650

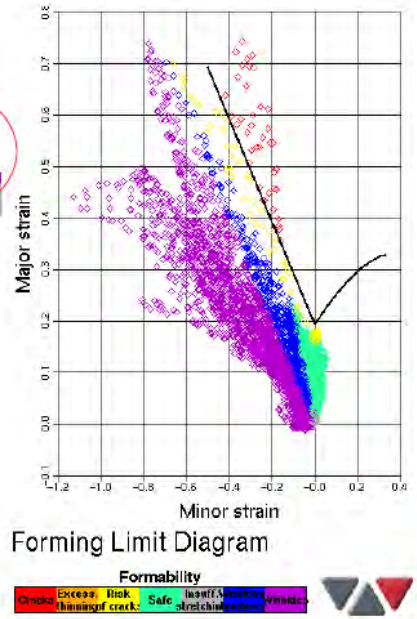
TS, MPa : 1025

TE, % : 13





Formed at reduced bead force. Splitting location is beyond trim line but there is increased risk of wrinkling compared to the result of DP690.



ROOF AND FRONTAL OFSET CRUSH PACKAGE

Design for Formability and Strength

Current part

Redesigned part

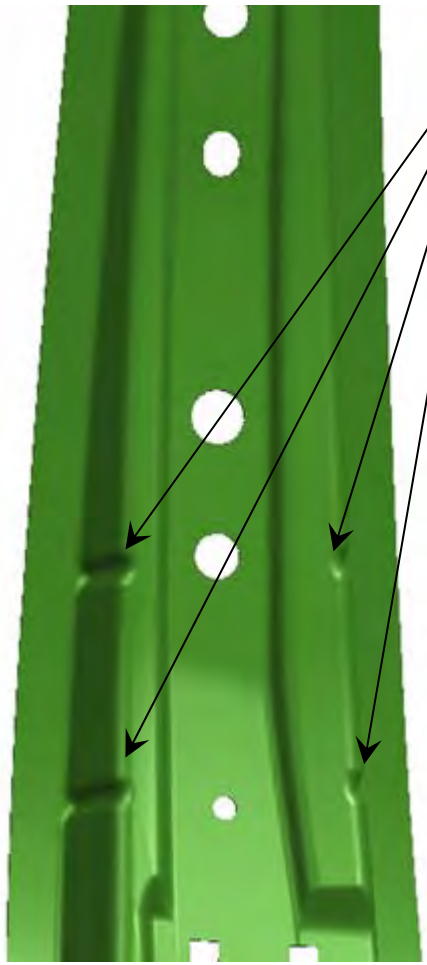
Geometry changed to:

1. Avoid splits along the vertical edges
2. Control the spring back of the ‘U’ channel
3. Strengthen the top portion where the failure happen

Design for Formability and Spring back Control

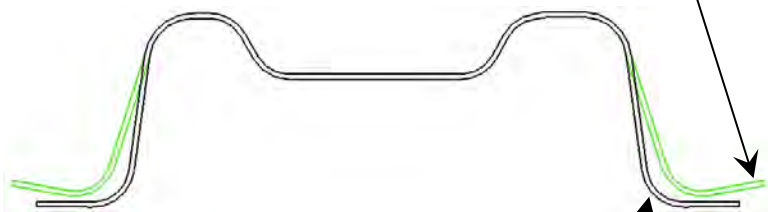
Past design

New design



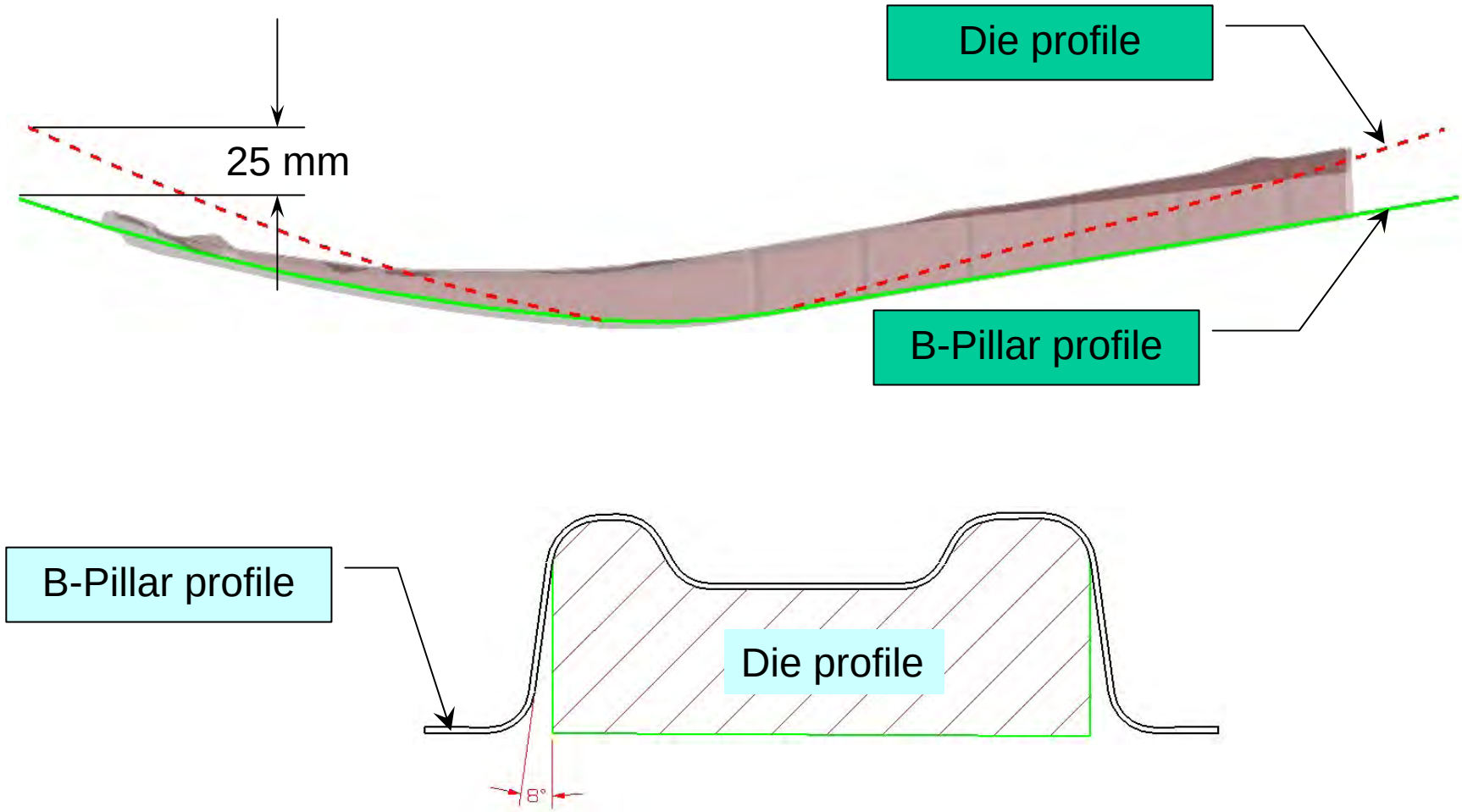
Added vertical beads to control the spring back of the ‘U’ channel and for dimensional control

Profile without beads



Profile with beads

Springback Control

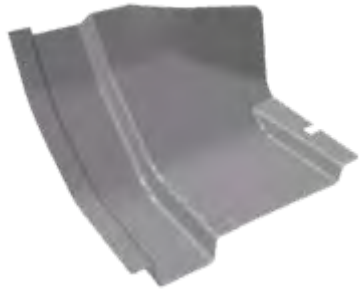


Production Experience
B-Pillar Inner DP980

Matt Rodzik, NARMCO

MANUFACTURING AHSS EXPERIENCE

- With over 60 years of stamping experience
- Specializing in Deep draw, HSLA and AHSS

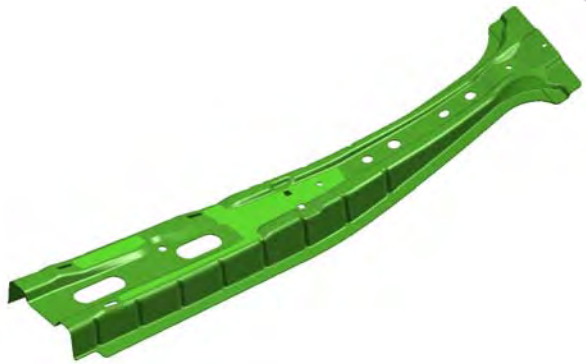


COMPRESSION PLATE (year 2000)
Material: (DP 600) t=1.4mm

ROCKER REINF. (year 2003)
Material : t=1.65mm (DP600)

SIGNIFICANT FIRST

Production of DP 980 B-Pillar Inner



B-PILLAR INNER (year 2006)
Material : DP 980T/550Y t=1.5mm

MANUFACTURING and TOOLING DESIGN CONSIDERATIONS

MANUFACTURING

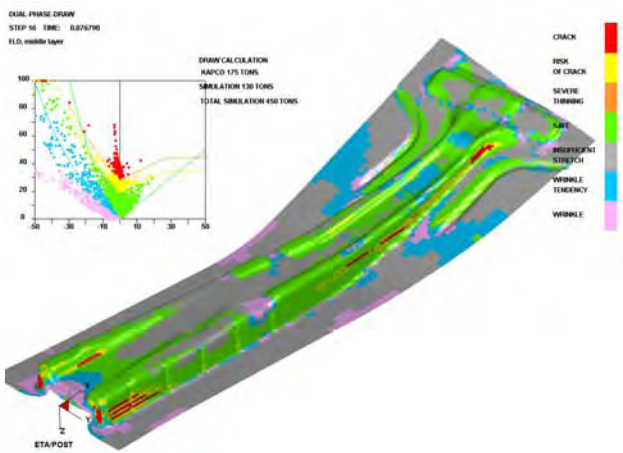
- PRESS FORCES
- DIMENSIONAL STABILITY
- TOOL ROBUSTNESS
- MATERIALVARIABLIITY
- MAINTENANCE

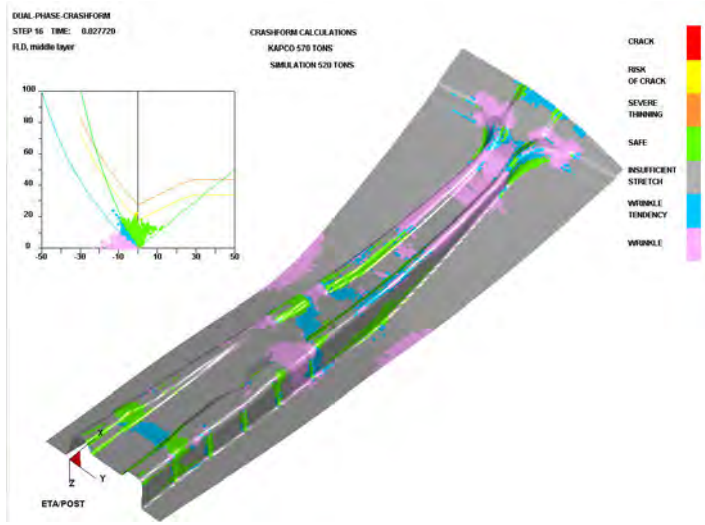
Final Selection Of The Process Is Dependent On Above Factors

TOOLING DESIGN

- SPRINGBACK AND DIMENSIONAL CONTROL
  - Sidewall Curl
  - Twist
  - Angular Springback
- TRIM EDGE
  - Trim Clearance
  - Trim Angle
  - Tool Geometry
- TOOL MATERIAL SELECTION
  - Impact
  - Wear

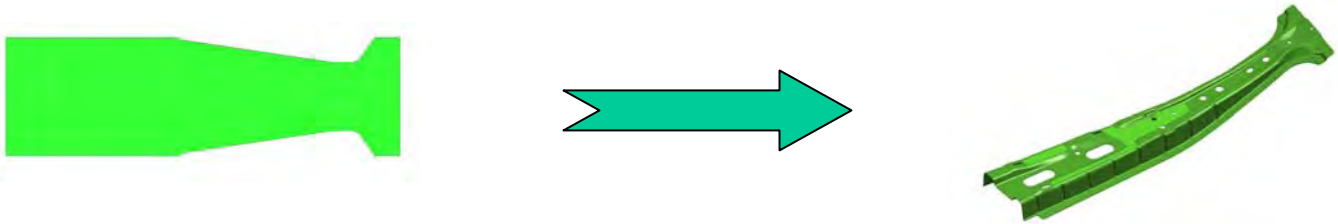
PROCESS SIMULATION



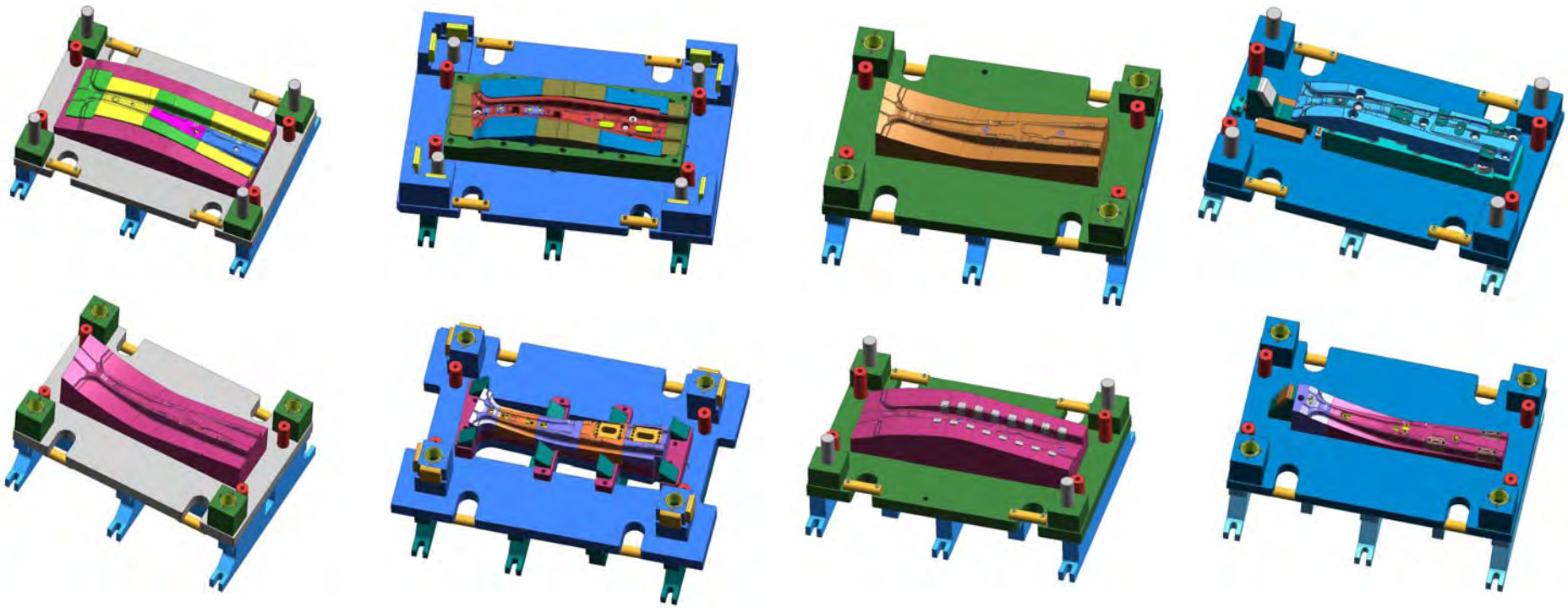


DRAW DIE		CRASH FORM DIE
•More Splitting & Thinning	→	•Eliminate Splitting
•More Side Wall Curl	→	•Less Side Wall Curl
•Less Wrinkling	→	•More Wrinkling
•More Work Hardening	→	•Less Work Hardening
•Material Wastage	→	•Less Material

MANUFACTURING PROCESS

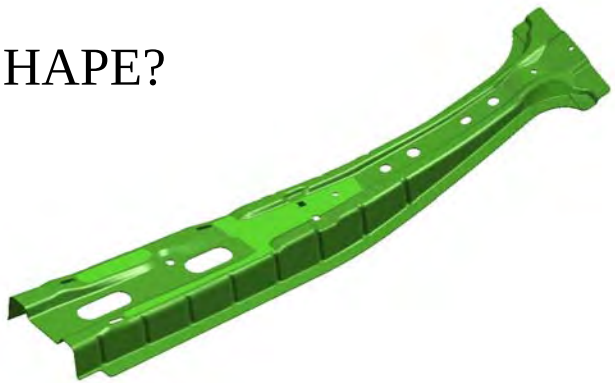


FORM DIE → TRIM DIE → RESTRIKE DIE → PIERCE DIE

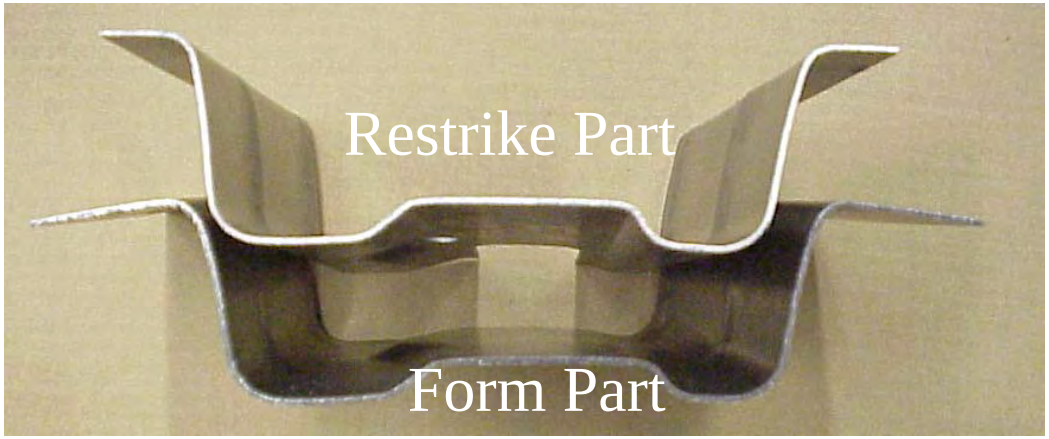


DESIGN INFLUENCES

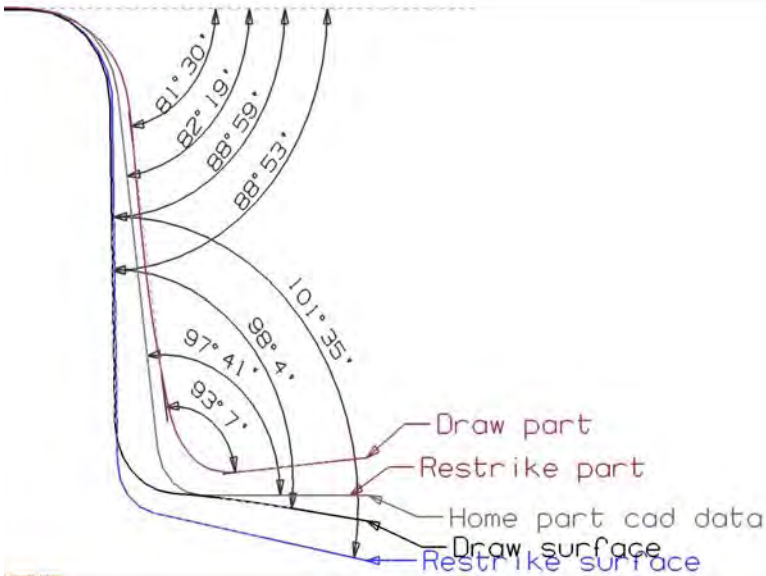
- OPTIMAL RADIUS?
  - R/t >2.5t
- HOW MANY SIDE WALL BEADS AND SHAPE?
  - Dimensional Stablity
  - Adjustability
- OPTIMAL WALL ANGLE?
  - > 8’ - 15’ for overbending
- OPTIMAL EDGE CONDITION?
  - Trim Angle & Clearance
- OPTIMAL SIDE WALL CLEARANCE?
  - 1xt (NO CLEARANCE)



All form to be completed in first operation



DESIGN DATA VS. ACTUAL DATA



OVERBEND

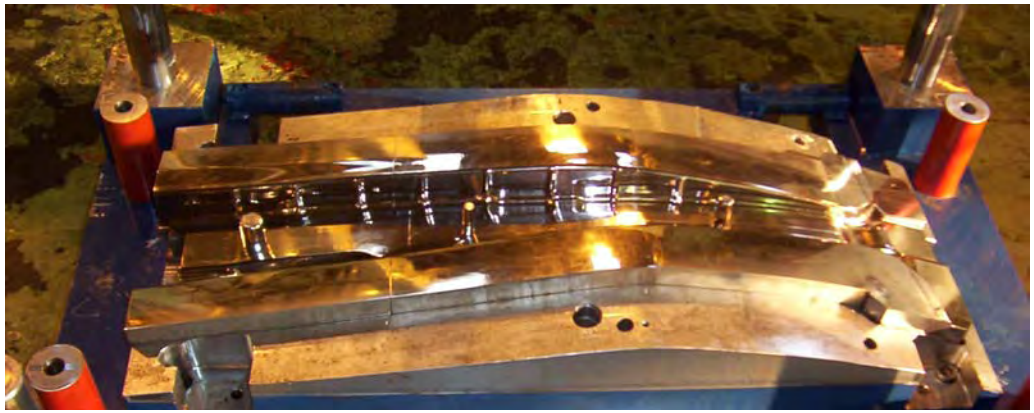
- Form Die
  - 8’ Overbend Wall (Max)
- Restrike Die
  - 8’ Overbend Wall
  - 15’ Overbend Flange
  - Increase Form Depth

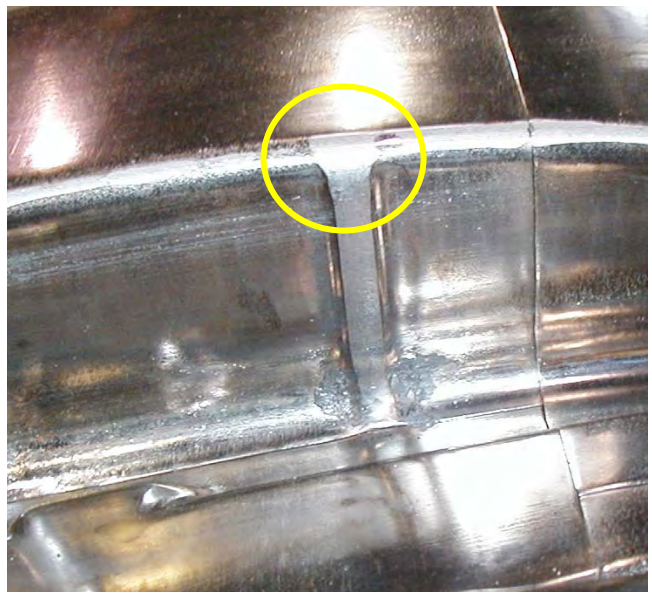
TOOL CONSTRUCTION

- D2 Coated Inserts Upper Cavity
- 4140 Post

LESSONS LEARNED

- Hardened inserts with coating to reduce wear and scoring
- Stripper Force – Additional Knockouts
- Draft Angle for Springback



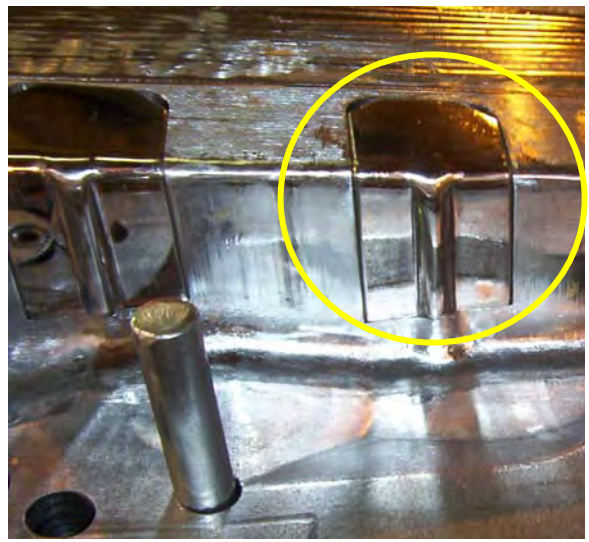


TOOL CONSTRUCTION

- M4 Powder Metal Coated Inserts in Upper Cavity
- 4140 Post

LESSONS LEARNED

- Coin Radius after Flanging to set geometry
- Pad Pressures Increased (2x 35ksi to 65 ksi)
- Post Stretch to net shape
- Hardened inserts with coating
- Adjustable Stiffening darts



TOOL CONSTRUCTION

- D2 cutting Steel
- CPM 3V & S7 Inserts

LESSONS LEARNED

- Shear 2-4x thickness (12”section)
- Trim Angles 10° -15° max
- Key all sections for thrust
- Trim Clearance 10% -12%
- Increase clearance to improve tool life and reverse burrs
- No Edge Splitting

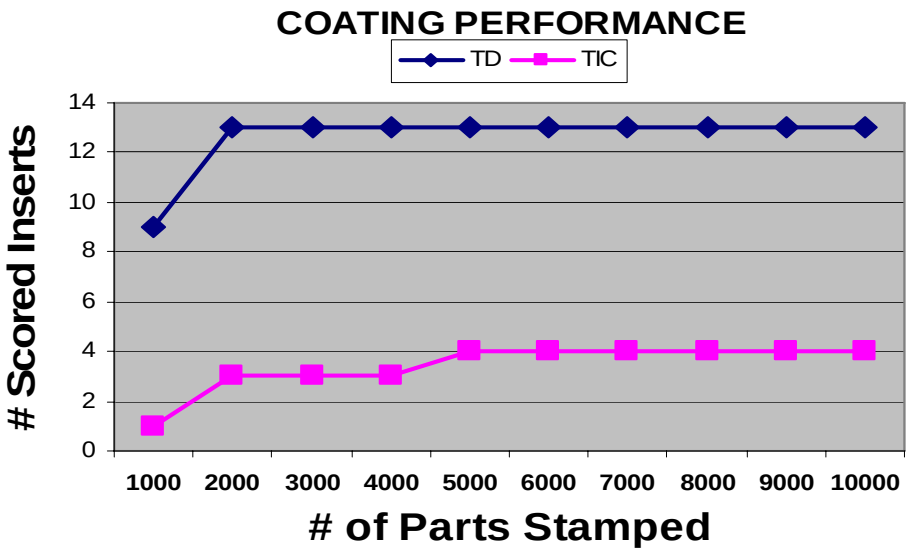

CPM 3V – SEVER ANGLE


D2 WITH S7 INSERT

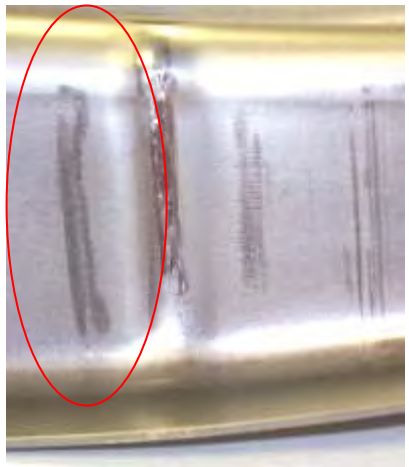

D2 PUNCH
- GALLING

TOOL WEAR

Tool Insert	Form	Restrike	Trim
A2	-	-	Poor
CPM 3V	-	-	Good
S7	-	-	Good
D2	Poor (100pcs)	Poor (< 1,000)	Fair
D2 + TIC	Good (>TBD)	-	-
D2 + TD	Good (>40,000)	Poor (< 2,400)	-
M4	-	Fair	-
M4 + TIC	-	Good (>10,000)	-
M4 + TD	-	Poor (< 2,400)	-



- The hardness of the incoming steel for draw is HV307 (~ Rc 30)
- The hardness of the steel in the bead area after forming is HRV 320-350 (~ Rc 34)
- Selection of appropriate coating is critical and needs further optimization



M4 Insert Coated w/ TiC

PRODUCTION EXPERIENCE SUMMARY

PRODUCT DESIGN & PROCESS SELECTION

- A Product That Can Be Processed In One Operation
- Good Product & Tooling Design Can Manage Springback And Wall Curl

COST

- Premium Die Grade With *Conventional Processes*
  - Use Hardened and Coated Inserts For Adjustability And Wear
- Longer Development Time

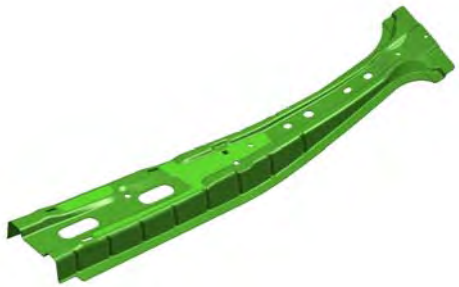
TECHNICAL SUPPORT

- Steel Supplier, Tooling Supplier and Product Designer

DP980 CAN BE USED FOR STAMPING B-PILLAR INNER REINFORCEMENTS!!!

An Economical and

And Manufacturable Product To Meet Future Needs



QUESTIONS ?