Die Development for AHSS
Case Study

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Diversified Tooling Group
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Superior Cam
Superior Cam has established itself as a technical leader in the Prototype Sheet Metal Industry during the past 30 years. We have built a reputation as an innovative, experienced and reliable full service operation which emphasizes production intent quality at every step of the tooling process.

Midland Design
Midland Design has 40 years of experience designing all types of vehicle sheet metal stamping dies. Midland Design is regarded as a leader in the field of “Solid CAD Die Design.”

Bespro Pattern
During the past 45 years Bespro Pattern has developed an excellent reputation for quality, timing and competitive prices. We are a respected leader in the CNC machining of poly patterns off solid CAD die design.

American Tooling Center
American Tooling Center is a modern state-of-the-art Tool and Die facility. Our full service operation was designed and constructed in 1989 as a world class production die facility which emphasizes a CAD/CAM/CNC utilization.

4 companies
1 goal: Full Service
Defining the Part

- Fiat 500 Cabrio C-Pillar
- Material Specs:
  - 1.2mm gage
  - Dual Phase 590 steel
C-Pillar Concerns

- Dimensional Tolerance
- Edge Fractures
- Splits
- Zinc Pick-up
- Excessive Die Wear
- Excessive Tonnage Requirements
Product Design Modifications

Changes driven by FEA results

New design in blue

Past design in red

New product design also affected assembly features resulting in modified weld sequence

Nose section
Fractures in Stamping

- Dual phase steel is susceptible to fracture prior to localized necking
Zinc Pick-up on Die Steels

- Dies for dual phase material are prone to excessive zinc flaking from the material during the forming process.
Excessive Die Wear

- Dual phase steel drives heavy wear on side walls in forming dies, requiring upgraded die materials and heat treatments / coatings.
• Effect of Material Strength
  - Increases in material strength result in increases of forming force requirements for typical automotive parts
C-Pillar “Givens”

- Have to meet dimensional requirements (nominal)
- Lead time is short (22 weeks including design)
- Little time for physical rework loops
- Restrike operations have minimal effect
- Parts have to run double
  - Die investment
  - Piece cost
Goals

• Plan for Advanced High Strength Steel Success
• Reduce / Eliminate Iterations in the press
• Increase Capability of Math-based system and process
• Drive the iterations into Math
• Meet the short lead time requirements
• Meet the dimensional requirements
## C-Pillar Concerns - Addressed

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<td>Full Cycle Simulation With Part Compensation &amp; Minor Product Chgs.</td>
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C-Pillar Overall Approach

- Examine the historic process
- Implement every technological advantage
- Intense focus on FEA / Full cycle process
- Implement upgraded machining process
- Implement upgraded tryout process
- Intense focus on Project Management
- Meet the requirements
Historical Die Development Process

Binder Development + Die Design + Duplicating Mill = $ Quality

Tryout Iterations
Latest Die Development Process

- Full Cycle Simulation
- 3D Solid Model
- High Speed NC
- Accurate!

Press Validation (include scanning + CMM)
C-Pillar Process
C-Pillar Process
C-Pillar Process
Forming Simulation

• Full Cycle Simulation per 3D Die Process
  – Analyze every operation in the line
  – Morph required die faces to accommodate results
  – Iterate in math to get to nominal
• Commercial Codes
• Proprietary Process and Methods
• Resolve forming issues in math (Virtual)
• Cut dies to morphed shape
• Inspect and compare to nominal
Full cycle explained

Start

Build / Adjust Binder Development

Assess Draw Die

Assess Trim Die (with draw results)

Assess Form Die (with trim results)

Analyze Results

Results OK?

Yes

No
Keep iterating & adjusting binder development and Morphing until final results produce a nominal product.
White Light / Cloud Scanning

- Part Inspection
- Die Inspection
- Die Duplication
- Matching Events – Launch Support
- Reverse engineering with point cloud verification
New Process in the Die Shop

- Review / validate 3D Die Process
- Full cycle simulation (virtual tryout loop)
- Kick-off meeting
- NC cutter path generation
- High Speed NC machining
- Specific Bench Criteria prior to Tryout
- Die Tryout
- Inspection / Validation
Kick-off Meeting

- Use full cycle simulation results
- Changes to cutter path programming
- Bearing maps
- Clearance for side walls
- Variation in metal clearance
- Different tryout process
Tryout process changes

- Blank outline
- Blank location
- Binder tonnage / Ram tonnage
- Binder travel
- Lube
- Metal draw-in map
- Engineered beads per FEA force factor

Engineering = Design = Physical Reality
Blank Outline & Location

Blank location to punch
Binder Travel / Tonnage

Die set-up / binder travel

Technical Data
- Material Spec: 590 Dual Phase
- Material Code: 1182 Chrysler Code
- Thickness: 1.2 mm
- Blank holder force: 80 approximate tons
- Total force: 450 approximate tons
- Ring Travel: 65 mm ring

65.0mm ring travel
Metal Draw-in Maps

Blank run-in measured from binder set
First Panel Results

- First panel through the line within 1.8mm of nominal on the checking fixture
- Still had one iteration to morph (3 days)
Process used for Iteration

- White Light Scan
- Color map inspection reports
- Morph 120% correction factor
- Re-cut
- Re-scan
- Results after morph = OK

Total lead time = 22 weeks, including die design
Part met nominal criteria
Recommendations

- Use formability analysis through the line
- Die design & analysis must agree 100%
- Blank outline and location match
- Tryout drives the process from the beginning
- Match the metal draw-in
- Use the same material throughout (eliminate potential variables)
Thank you