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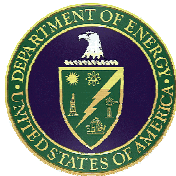
STEEL

Great Designs in Steel is Sponsored by:

*ArcelorMittal Dofasco, ArcelorMittal USA, Nucor Corporation,
Severstal North America, Inc. and United States Steel Corporation*



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Investigation of Tooling Durability for Advanced High-Strength Steel

Darryl Young-Ford Motor Company
Tareena Mulholland-General Motors Corporation
Mike Klein-Chrysler LLC





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Team Members and **Contributors**

- Datum Industries
- Competition Engineering
- Ion Bond
- Century-Sun
- MPD Welding
- ArcelorMittal USA
- Unisteel
- Rovalma
- Crucible

- Connie Yao
- Bohler-Uddeholm
- Dayton-Progress
- General Motors Corporation
- Ford Motor Company
- Chrysler LLC
- Severstal North America, Inc.
- United States Steel Corporation
- Nucor Corporation
- ArcelorMittal Dofasco



- Simulate Production Process
- Progressive Die with Duplicate Operations
- Flanging, Trimming, and Piercing





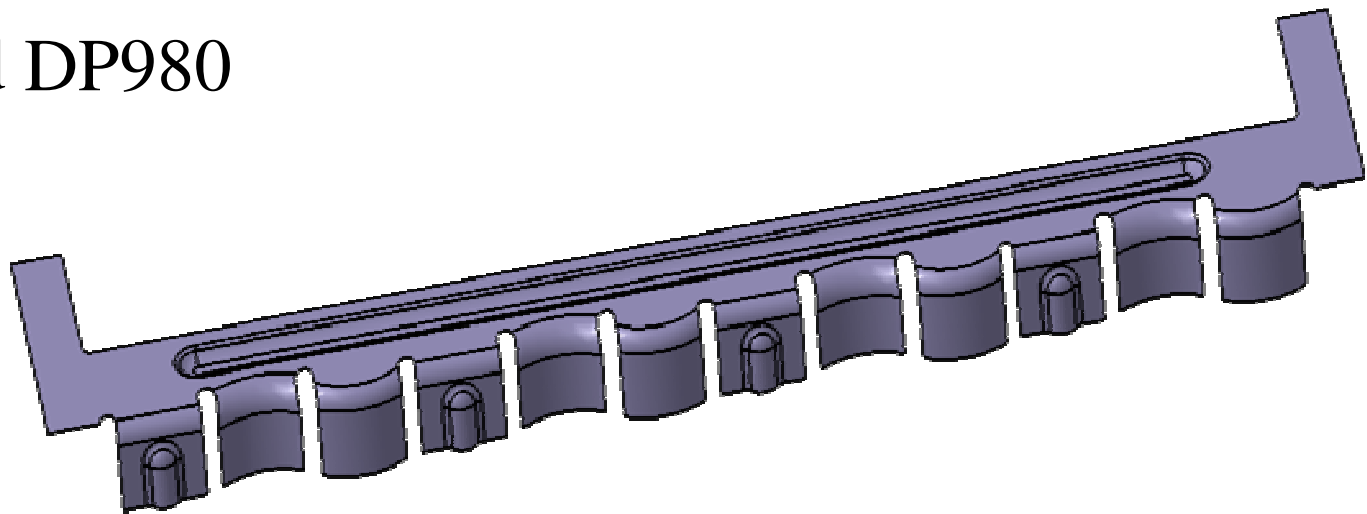
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Part

- “Thing” – Not a saleable part

- Uncoated DP980 Material

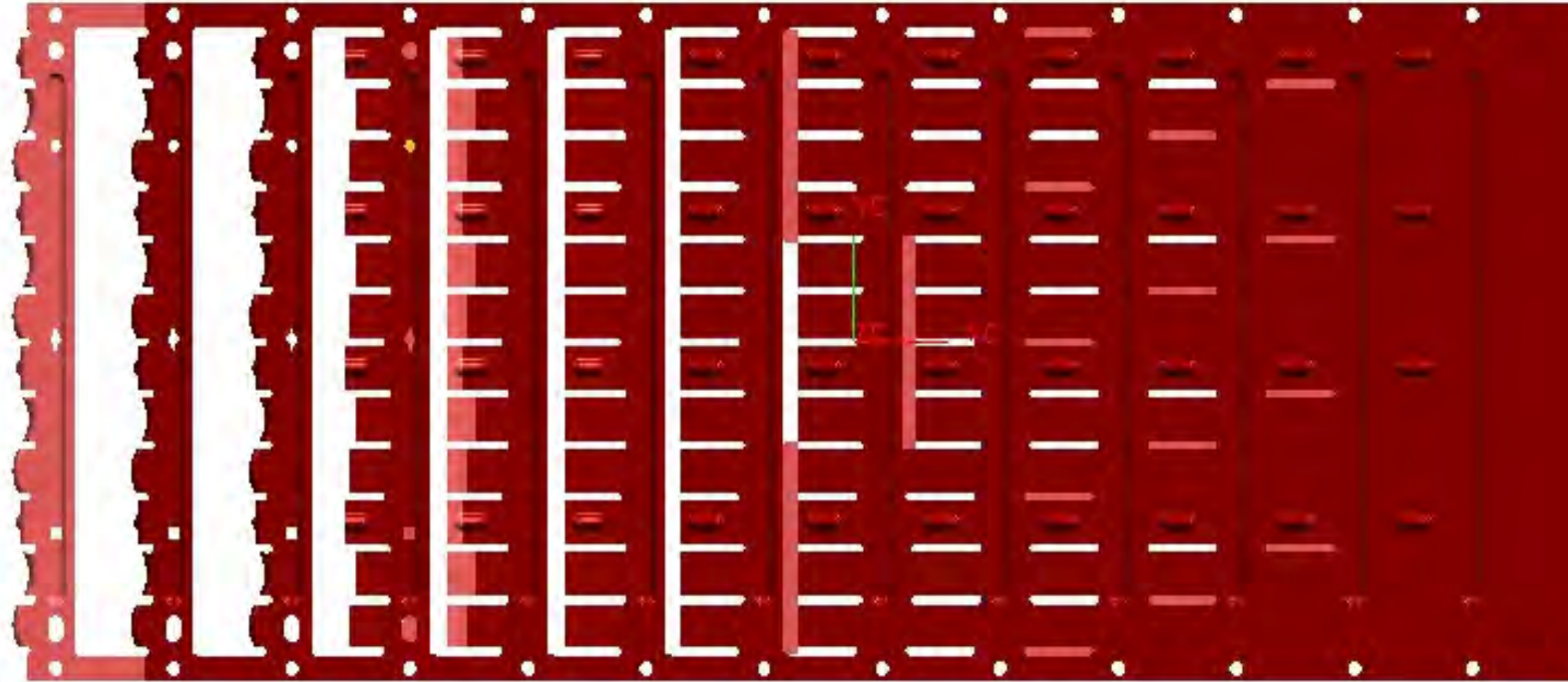




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Progression Strip



Cut Off

Flange

Pierce

Trim

Form Up 20 Deg

Idle

Trim

Trim

Pierce

Pierce

Pierce

Form Beads Up
& Stamp ID

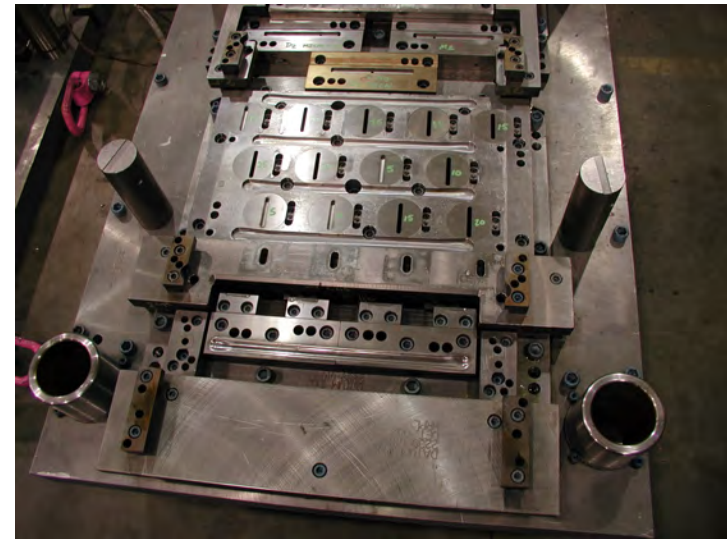
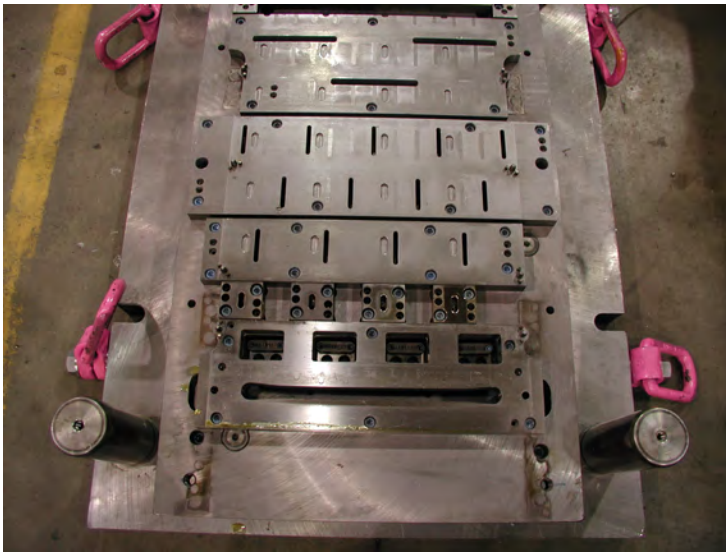
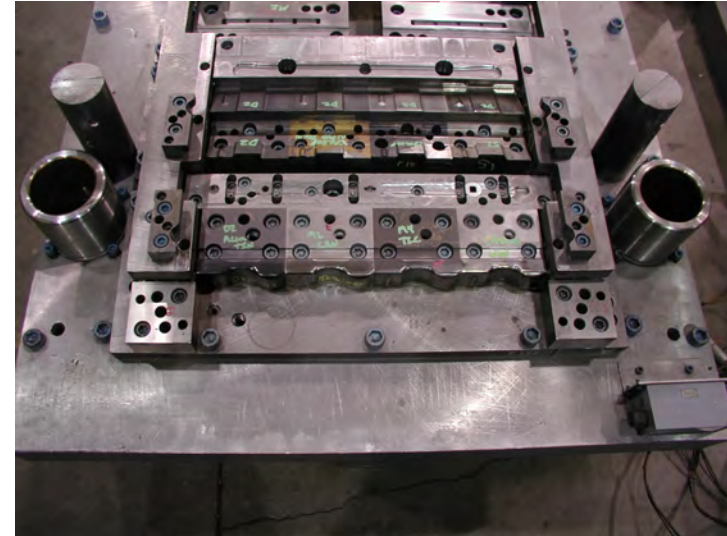
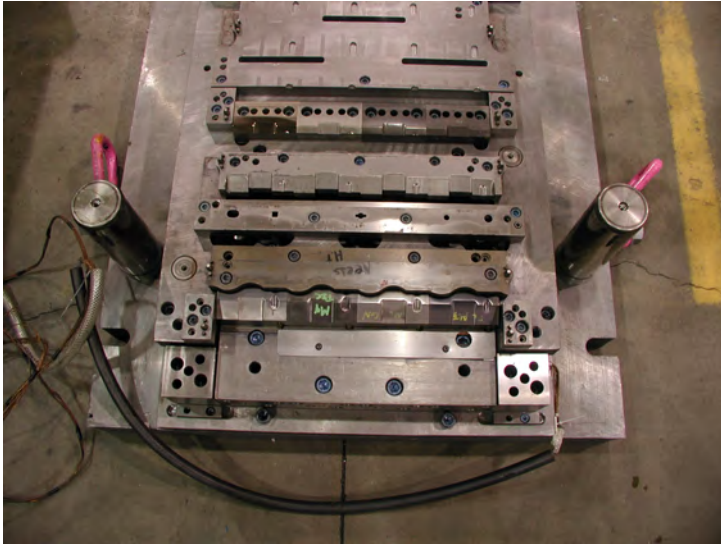
Prc & Form
Down



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Progressive Die

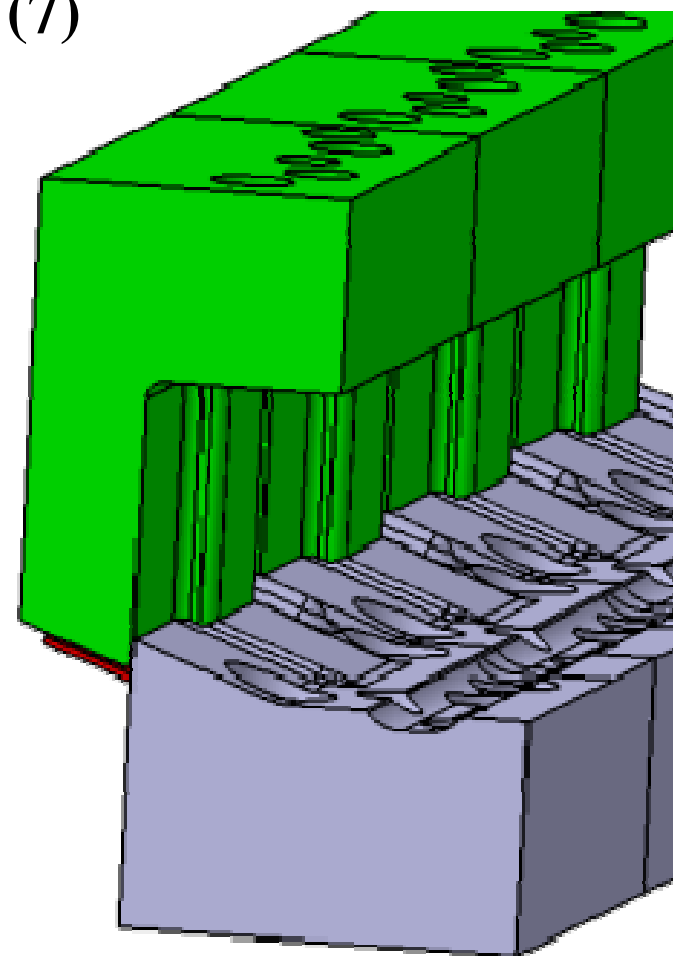


- A Total of 62,000 hits Were Run
- Flange Steels Swapped Out When Heavily Galled
- Preliminary Results for Flanging are Available
- Mechanical Problems with Trim Station



Initial Plan was to Evaluate Seven (7) Die Materials/Coatings

- **AISI-D2**
- **AISI_S7**
- **AISI-M4**
- **Uddeholm CALDIE™ with Plasma Nitride and PVD TiCN**
- **Nelson Associates Cast Cut® #1**
- **Crucible CPM 10V®**
- **Uddeholm VANADIS 4E®**





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Special Learning

- Five Different Grades from Three Different Manufacturers Chipped out or Plastically Deformed.





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Special Learning

Die Inspection

- Unbalanced Wear Pattern on Pierce Punches
- Galling Observed on Diagonally Opposite Guide Pins and Bushing





- Dies Flex Elastically
 - Die Needs Heals
- Pin and Bushing Dies are Difficult to Open
 - Die Needs Ball Bearing Guide Sleeves

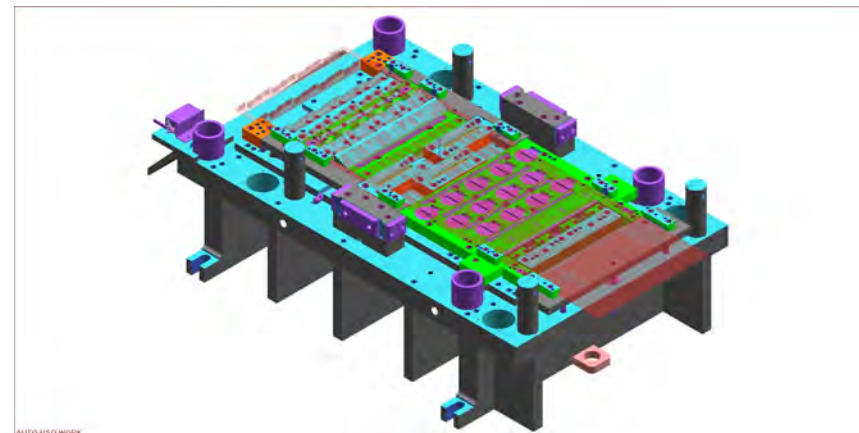
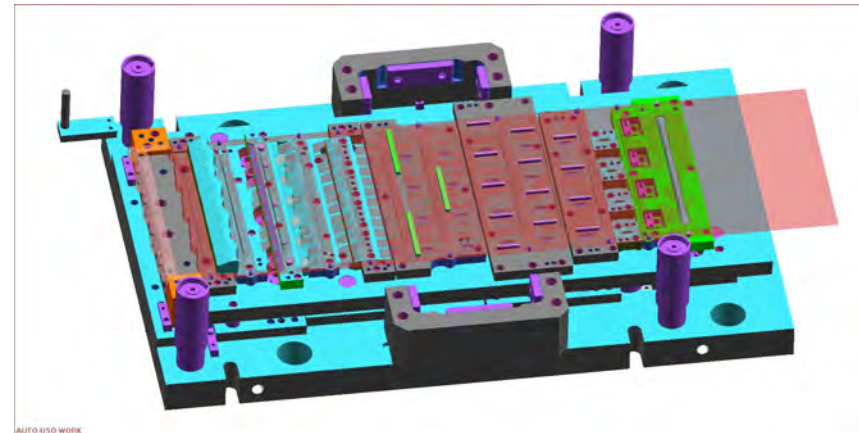




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Re-Designed Tool





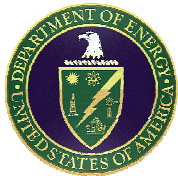
Eleven (11) Die Material/Coatings were Evaluated

- AISI D2
- AISI D2 with CVD TIC
- Uddeholm Carmo® with Plasma Nitride and PVD CrN
- Uddeholm Vanadis 4E®
- AISI M2
- AISI M4
- AISI M4 with CVD TIC
- Uddeholm Vanadis 4E® with Micro-Plasma (HVOF-WC)
- AISI M4 with Hard Chrome
- AISI D2 with PVD AlTiN
- AISI M2 with PVD CrN

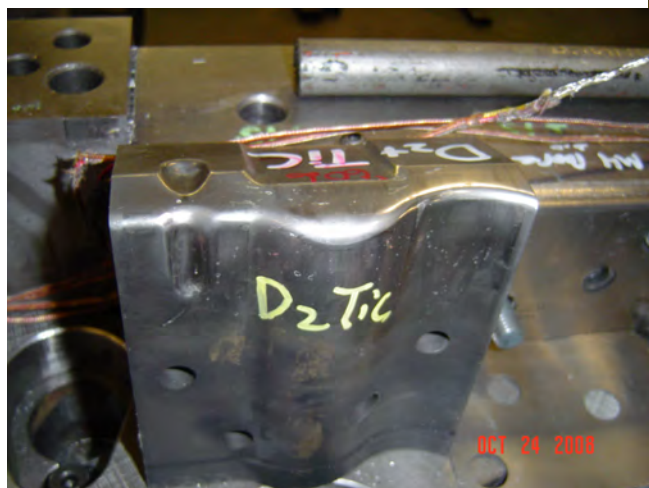




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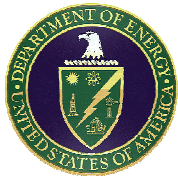


Audience Participation





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Audience Participation



- AISI D2
 - Heavy Galling at 34,000 Hits
- AISI D2 with CVD TIC
 - Good/Clean at 52,000 Hits
- Uddeholm Carmo® with Plasma Nitride and PVD-CrN
 - Good/Clean at 52,000 Hits
- Uddeholm Vanadis 4E®
 - Heavy Galling at 34,000 Hits
- AISI M2
 - Heavy Galling at 18,000 Hits
- AISI M4
 - Heavy Galling at 18,000 Hits



AISI M4 with CVD TIC

Good/Clean at 8000 hits

Uddeholm Vanadis 4E® with Micro-Plasma (HVOF-WC)

Heavy Gallling Immediately

AISI M4 with Hard Chrome

Heavy Gallling at 3000 Hits

AISI D2 with PVD AlTiN

Galling Appearing at 8000 - 32000 Hits

AISI M2 with PVD CrN

Galling Appearing at 8000 Hits





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Preliminary Flanging **Conclusions**

- Un-Coated Tool Steels Fail
- Cool Coatings (Chrome, Micro Plasma) Fail
- CVD or PVD Coatings are Necessary
- Plasma Nitriding Improves the Performance of PVD Coatings





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Preliminary Piercing Results

- 62,000 hits accumulated on piercing components to date
- Visual inspection of the pierce showed optimum clearance between 10-15%
 - 15% and above showed increasing burr
 - 5% showed a slightly pinched edge





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Ongoing Work **-Piercing**

- Evaluate Materials and Clearance in Piercing Operations
 - AISI Grades A2, M2, M4
 - Clearances 5,10,15,20,25,30 %
 - Burr Height Measurements



- Accumulate More Hits
 - AISI D2
 - AISI S7
 - AISI M4

- New/Replacement
 - CALDIE™ with Plasma Nitride and PVD-TiCN
 - CALDIE™
 - HWS®
 - NAAMS G25HP





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Ongoing Work -Flanging

- Accumulate More Hits
 - AISI D2 with CVD-TiC
 - Carmo with Plasma Nitride and PVD-CrN
- Evaluate Lower Cost Alternatives in Flanging
 - NAAMS G3500 Gary Cast Iron
 - NAAMS S0050A Cast Steel
 - Tempered and Un-Tempered Condition





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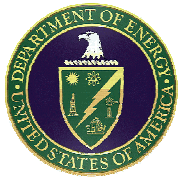
Future Work

- Evaluate More Material and Coating Combinations
 - Flanging
 - Trimming
 - Piercing
- Production Correlation for Tool Life Prediction
 - Preventative Maintenance Schedules
 - Less Expensive Materials for Shorter Runs
- Optimize Trim and Pierce Clearances
 - Effect of Material Type and Gauge





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Questions ?



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