

**30° SENAFOR – 14<sup>a</sup> International Forging Conference**  
Porto Alegre, RS, Brazil, 20.-22. October 2010

## **Analysis of Tooling failures using FEA**

**- industrial applications**

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### **Analysis of Tooling failures using FEA**

The presentation shows industrial applications of FEA.

The aim of using FEA is to enable the design engineer to develop long lasting tooling by using simulation instead of costly trial and error procedures.

To show the ability of FEA examples were chosen in which the engineer used FEA to solve existing tooling problems. By getting experience from these the design engineer is able to foresee such problems in future and therefore avoid a lot of costs.

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Die failure in a multi station process

Die of operation 4 fails premature



Five station cold forging process

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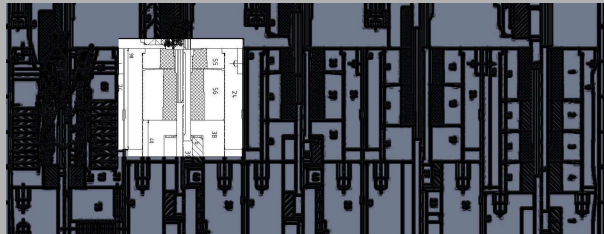
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Five station  
cold forging  
process

Initial tool design in operation 4

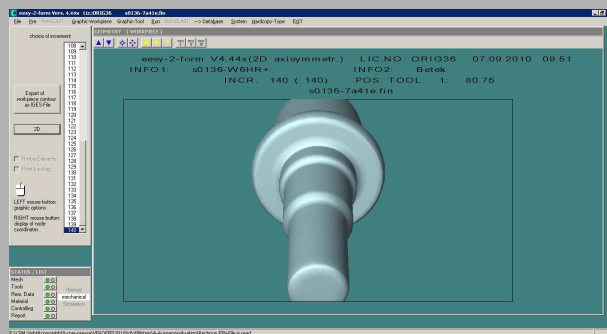
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Five station  
cold forging  
process

forming in operation 4

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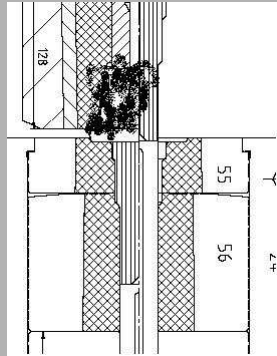
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Initial design  
 of the  
 die in  
 operation 4  
 (carbide – pre  
 stressed with  
 a single ring)



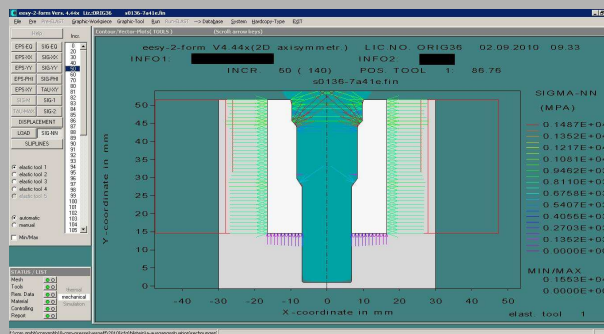
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Five station  
 cold forging  
 process

Pressure on the carbide

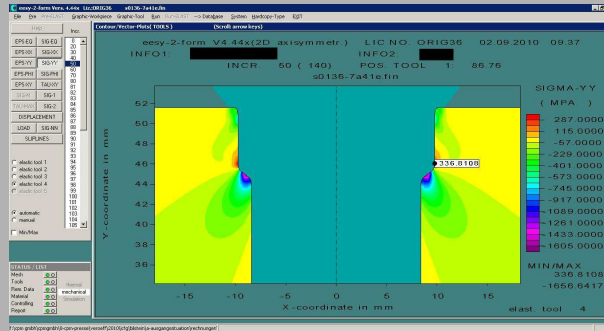
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Positive axial stress in the carbide => tool failure

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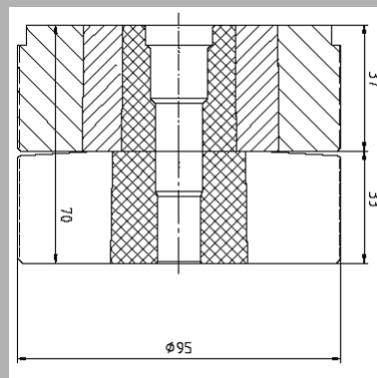
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new design of the die in operation 4 (carbide – pre stressed with two rings)



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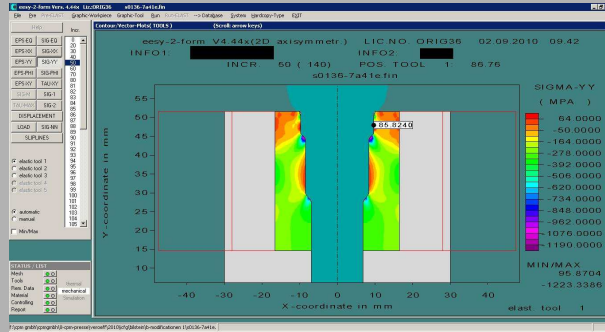
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Five station cold forging process

Still positive axial stress in the carbide => tool failure  
 (the carbide has to be split as well due to the positive axial stress further down)

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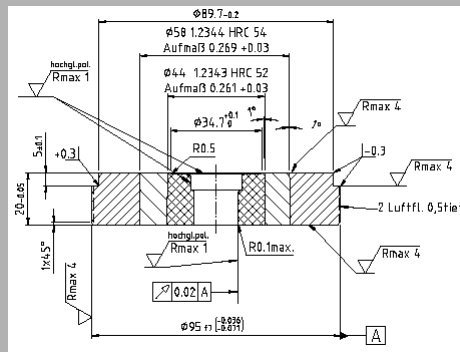
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new design of the die in operation 4 (carbide split – pre stressed with two rings)



Five station cold forging process

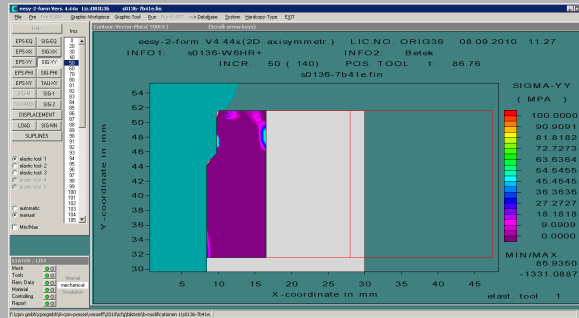
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Five station  
cold forging  
process

Still positive axial stress in the carbide => tool failure

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Five station  
cold forging  
process

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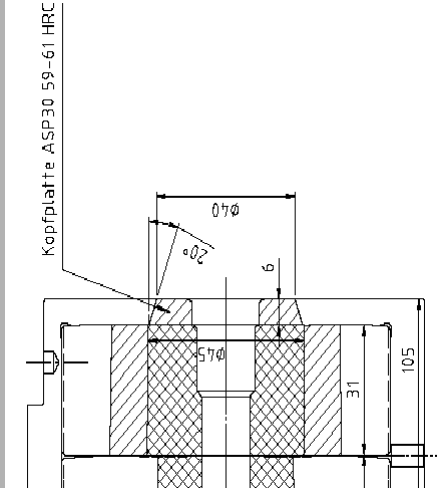
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Kopfplatte ASP30 59-61 HRC

new design of the die in operation 4 (Disc made of ASP 30 – carbide pre stressed with two rings)

Five station cold forging process



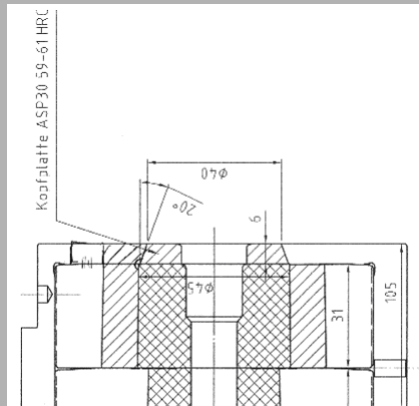
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Kopfplatte ASP30 59-61 HRC

corrected new design of the die in operation 4 (Disc made of ASP 30 – carbide and disk pre stressed with two rings)

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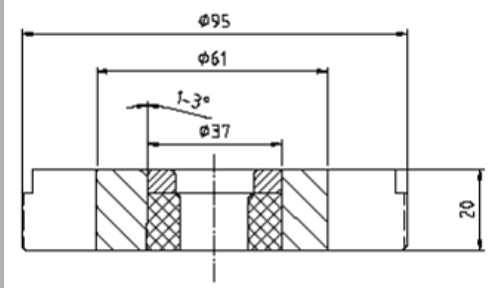


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final design of the die in operation 4 (Disc made of ASP 30 – carbide and disk pre stressed with two rings)



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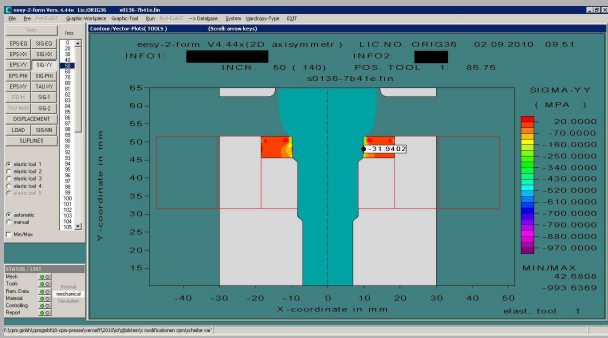
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Five station cold forging process

Stress is compressive - tool life increased from 1.000 to 25.000 pieces

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Punch failure in a multi station process

Punches of operation 5 fail premature



Five station cold forging process

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Punch failure in a multi station process

Punches of operation 5 fail premature



Five station cold forging process

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Punch failure in a multi station process

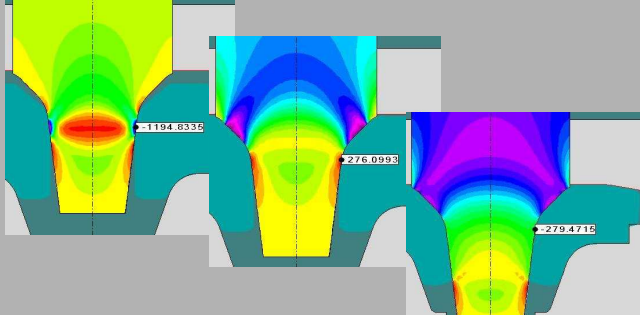
Punches of operation 5 fail premature



Five station cold forging process


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Five station cold forging process

Alternating StressFailure due to fatigue

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Stress (N/mm<sup>2</sup>)

Time (sec)

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Alternating Stress in short time period

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Failure due to fatigue

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SIGMA-NN (MPa)

MIN/MAX

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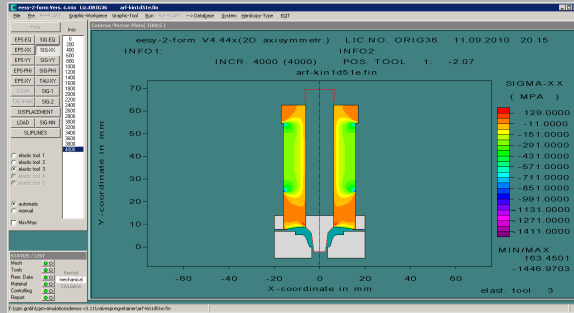
Reason for failure: material loose contact to the tooling

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High stress concentration at the point of breakage (Sig xx)

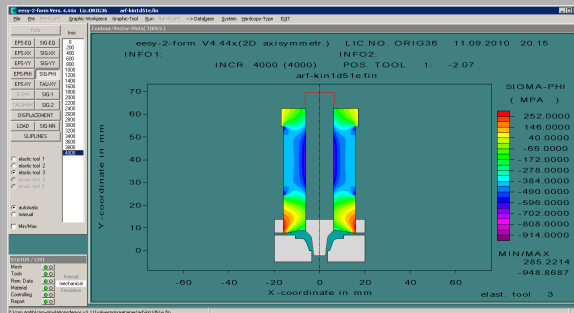
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Five station cold forging process

positive tangential stress below the point of breakage

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Crack initialization



Five station  
cold forging  
process

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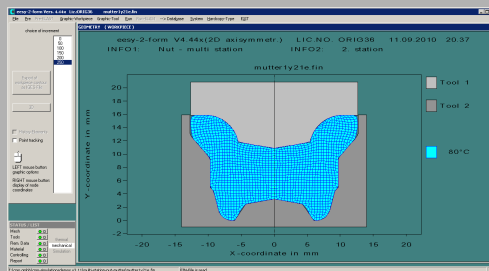


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Punch failure in a multi station process

Punch of  
operation 3  
fails



Nut making  
cold forging  
process

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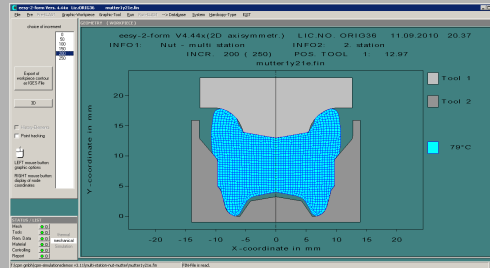
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Punch of operation 3 fails



Nut making cold forging process

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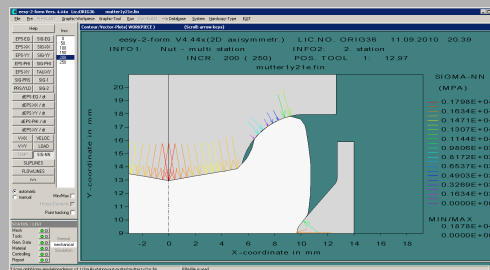
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Material flow causes severe stress distribution



Nut making cold forging process

Result: positive stress in the punch -> punch failure

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Material flow causes severe stress distribution



Nut making cold forging process

Result: positive stress in the punch -> punch failure

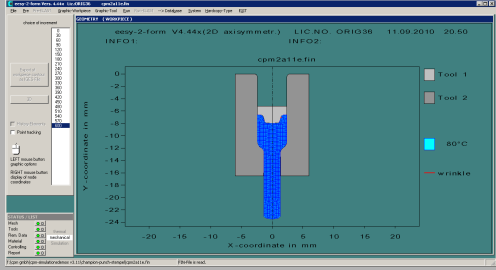
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Punch failure in extrusion process

Punch of operation 2 fails



Cold forging process

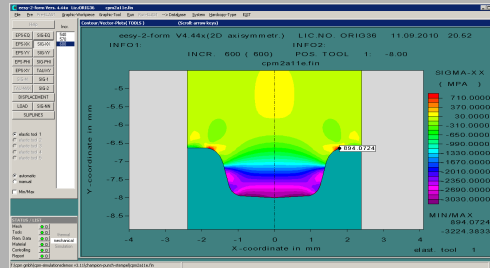
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Punch of  
 operation 2  
 fails



Cold forging  
 process

High local positive radial stress -> punch failure

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Punch of  
 operation 2  
 fails



Cold forging  
 process

Picture of a similar failure (picture from ICFG)

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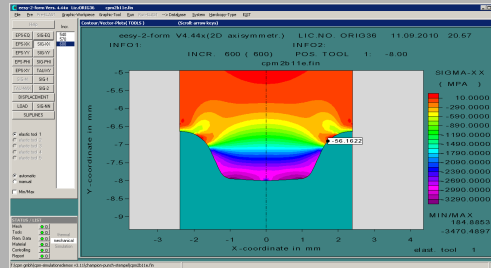
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Punch of operation 2 changed



Cold forging process

No high local positive radial stress after change of radius

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Conclusion



A lot of tooling problems can be solved or avoided by consequent use of FEA during the design stage

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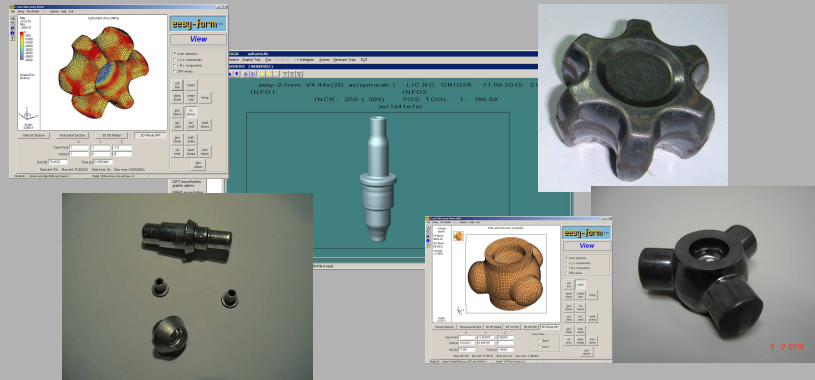
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Thank you for your attention



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