43rd ICFG Plenary Meeting, Darmstadt, Germany,13.09.2010
Subgroup on simulation

Analysis of Tooling failures using FEA

- industrial applications

G. H. Arfmann, M. Twickler*)

*)G. H. Arfmann and M. Twickler are joint managing directors of CPM GmbH, Germany

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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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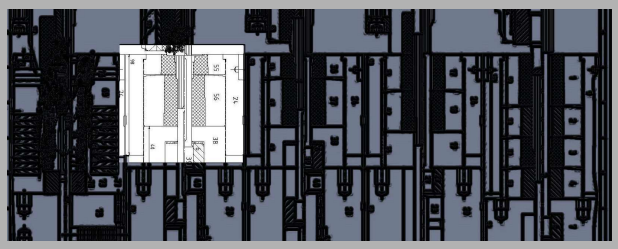

Five station cold forging process

Initial tool design in operation 4

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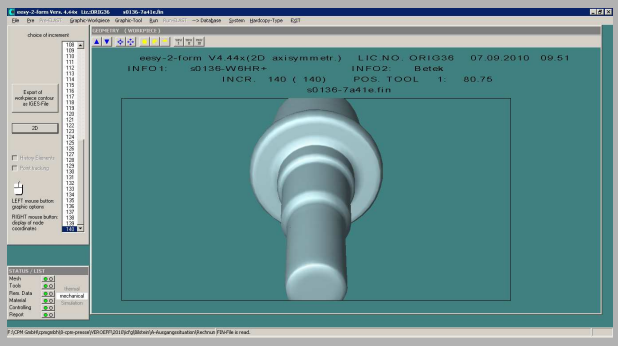

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forming in operation 4

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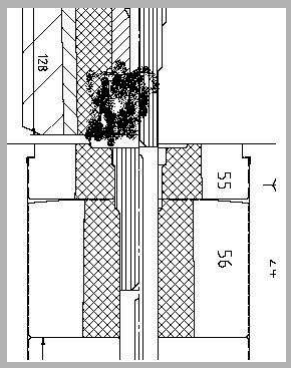
Initial design of the die in operation 4 (carbide – pre stressed with a single ring)



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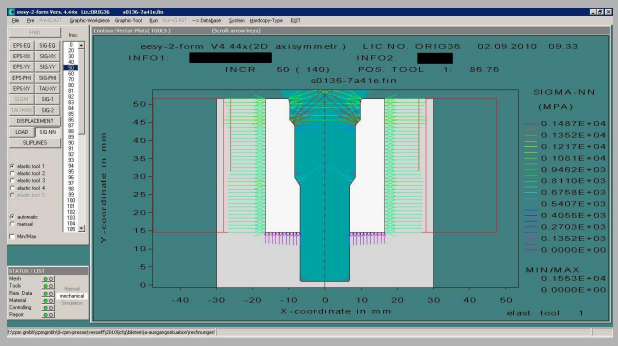

Five station cold forging process

Pressure on the carbide

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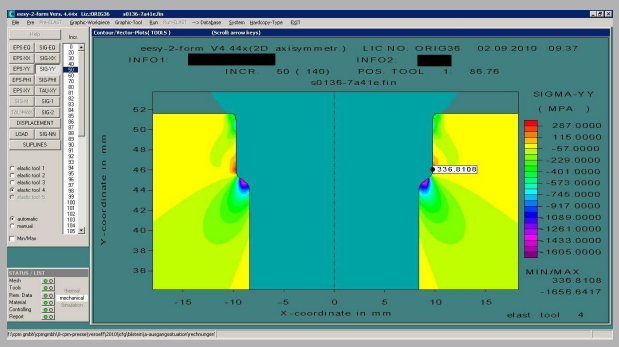

Five station cold forging process

Positive axial stress in the carbide => tool failure

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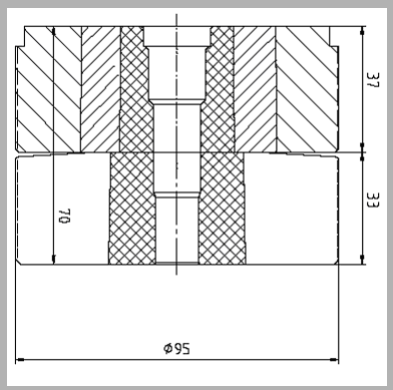
new design of the die in operation 4 (carbide – pre stressed with two rings)



Five station cold forging process

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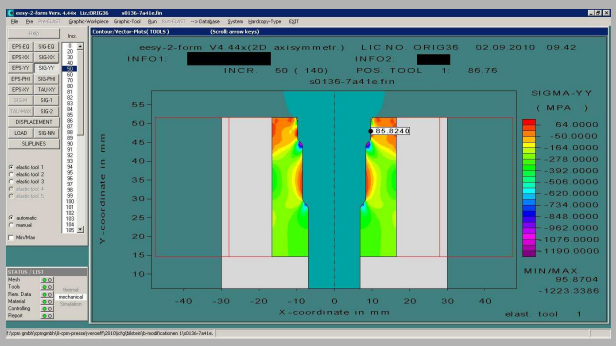

Five station cold forging process

Still positive axial stress in the carbide => tool failure

(the carbide has to be split as well due to the positive axial stress further down)

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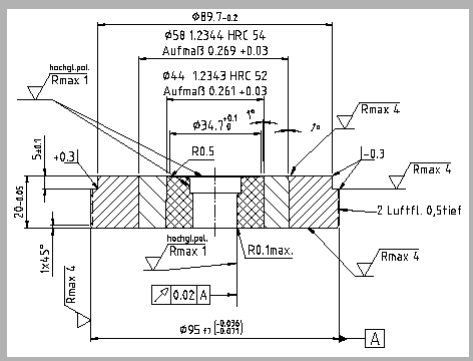
new design of the die in operation 4 (carbide split – pre stressed with two rings)



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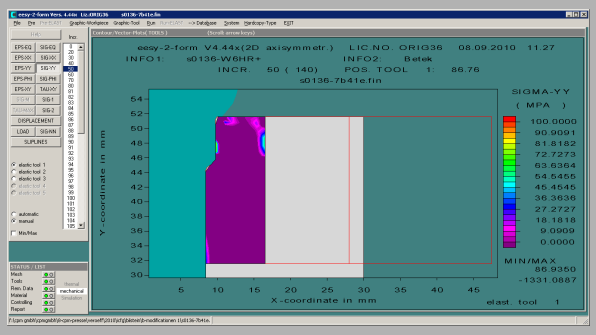

Five station cold forging process

Still positive axial stress in the carbide => tool failure

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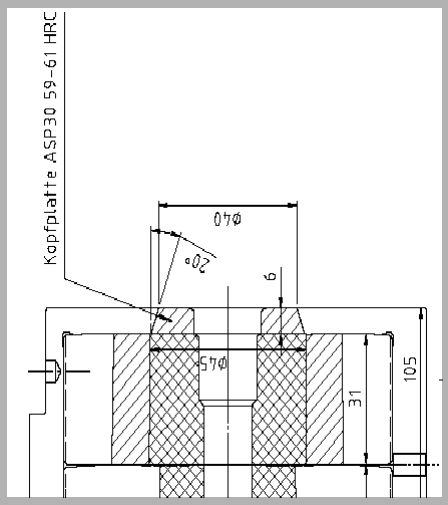
new design of the die in operation 4 (Disc made of ASP 30 – carbide pre stressed with two rings)



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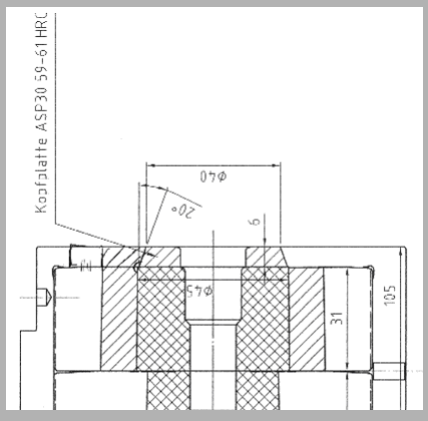
corrected new design of the die in operation 4 (Disc made of ASP 30 – carbide and disk pre stressed with two rings)



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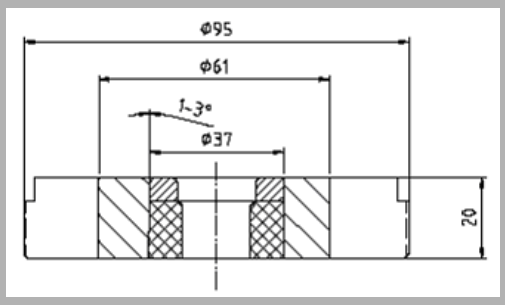
final design of the die in operation 4 (Disc made of ASP 30 – carbide and disk pre stressed with two rings)



Five station cold forging process

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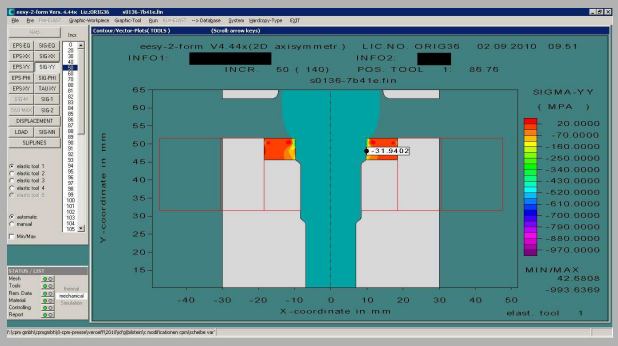

Five station cold forging process

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

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Analysis of Tooling failures using FEA

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

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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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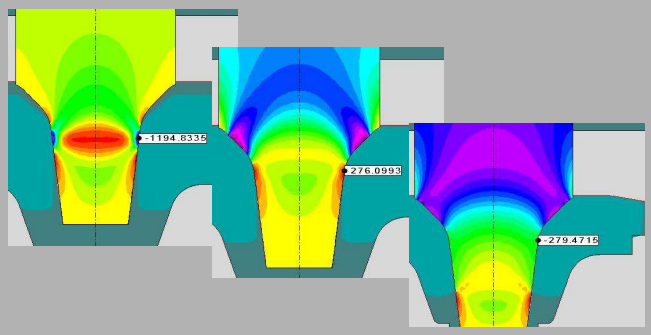
Analysis of Tooling failures using FEA



Five station cold forging process

Alternating Stress Failure due to fatigue

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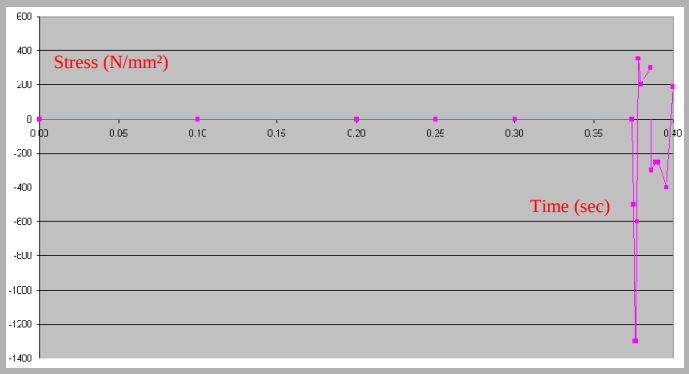

Five station cold forging process

Alternating Stress in short time period

Failure due to fatigue

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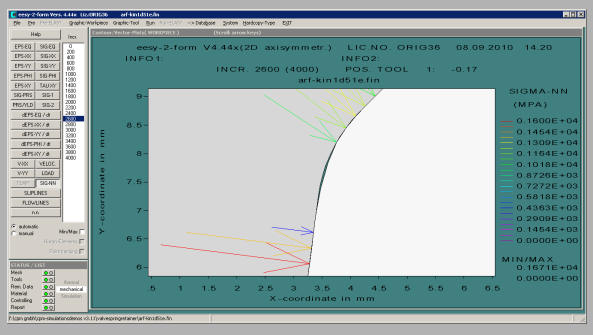
Analysis of Tooling failures using FEA



Five station cold forging process

Reason for failure: material loose contact to the tooling

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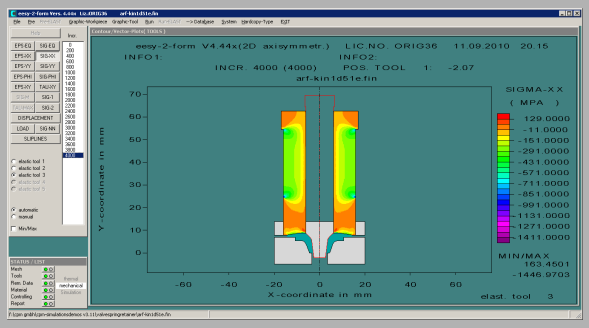

Five station cold forging process

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

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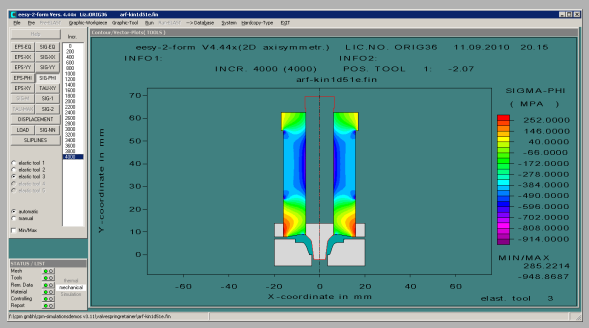

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positive tangential stress below the point of breakage

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Analysis of Tooling failures using FEA

Crack initialization

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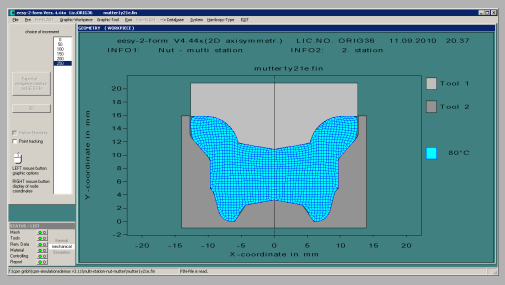
Punch failure in a multi station process

Punch of operation 3 fails



Nut making cold forging process

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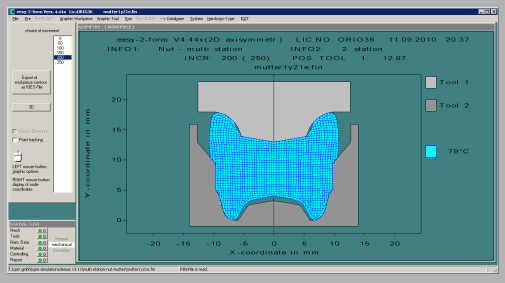
Analysis of Tooling failures using FEA

Punch of operation 3 fails



Nut making cold forging process

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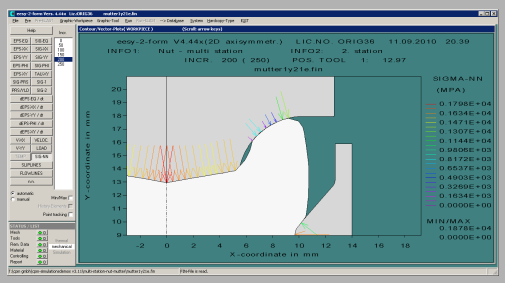
Analysis of Tooling failures using FEA

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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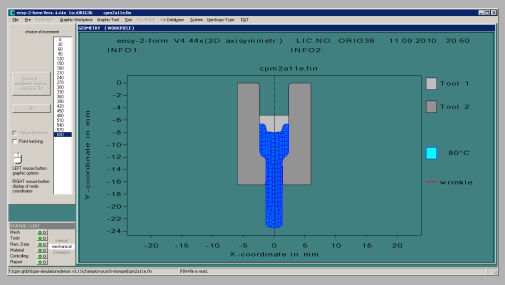
Punch failure in extrusion process

Punch of operation 2 fails



Cold forging process

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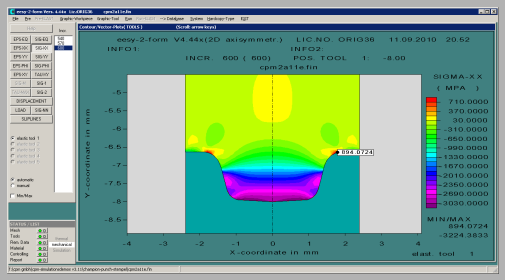
Punch of operation 2 fails



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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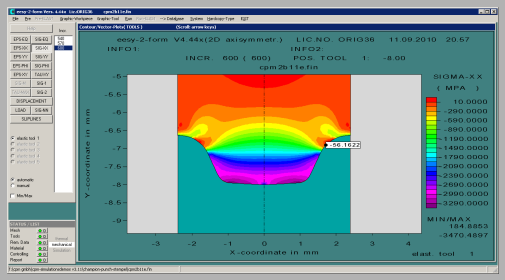
Punch of operation 2 changed



Cold forging process

No high local positive radial stress after change of radius

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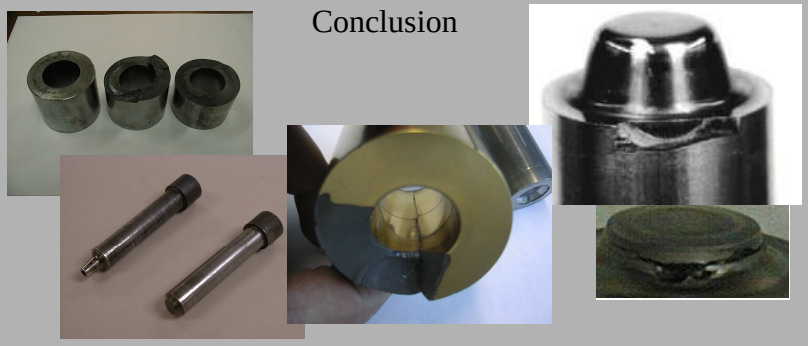
Conclusion



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

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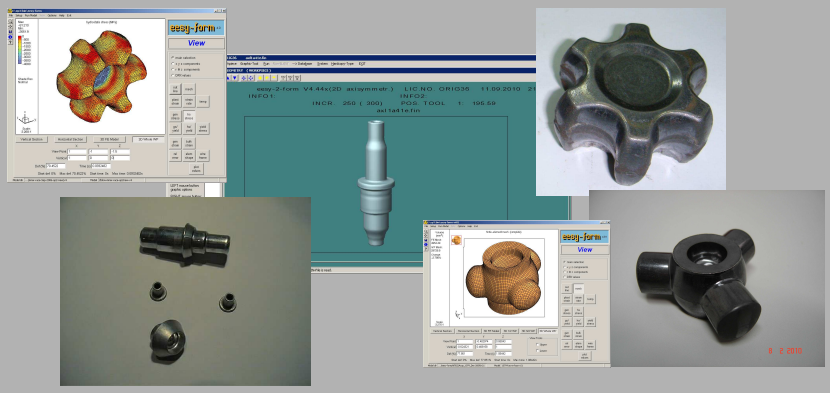
Thank you for your attention



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