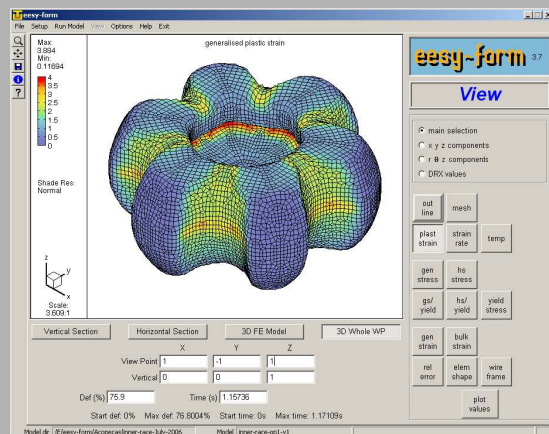


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Modern process engineering - solving difficult tasks

Dr. G.H. Arfmann, Dr. M. Twickler



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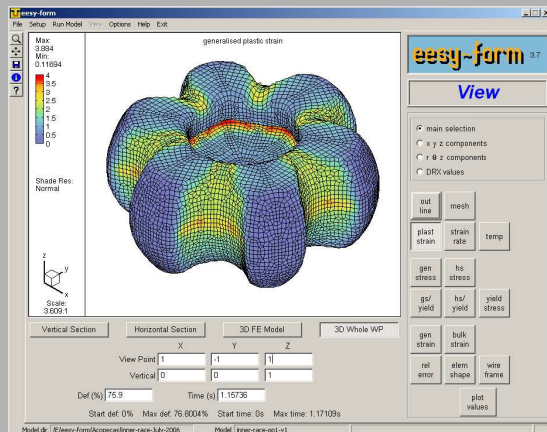
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Introduction

Examples of application

Conclusion

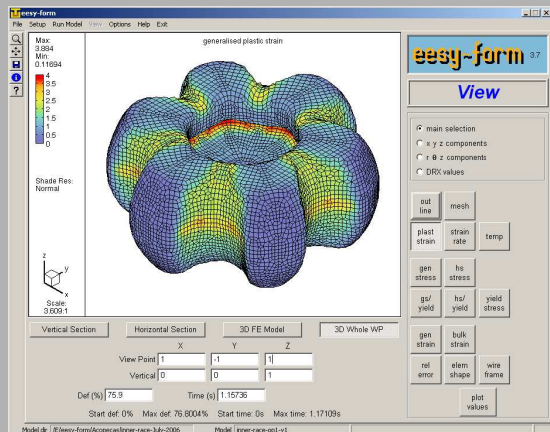


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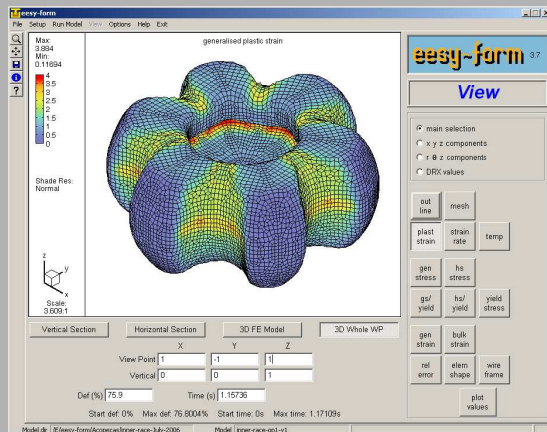


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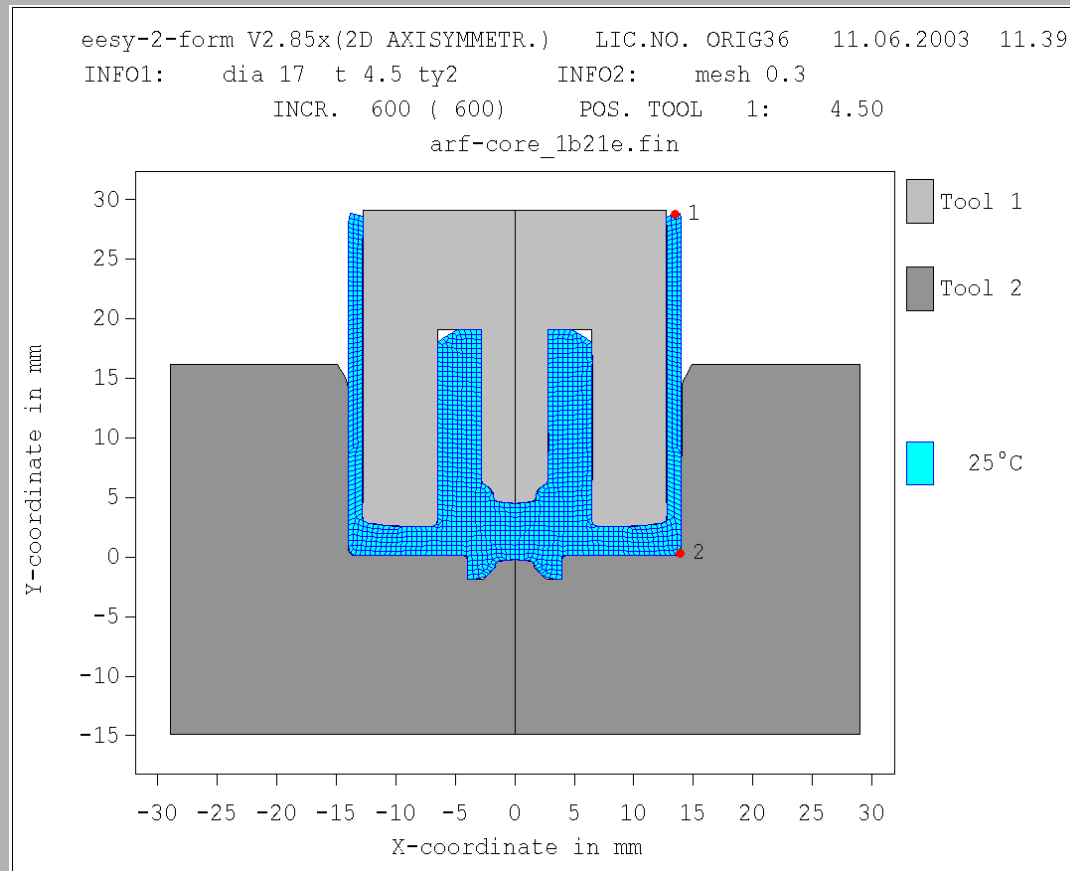
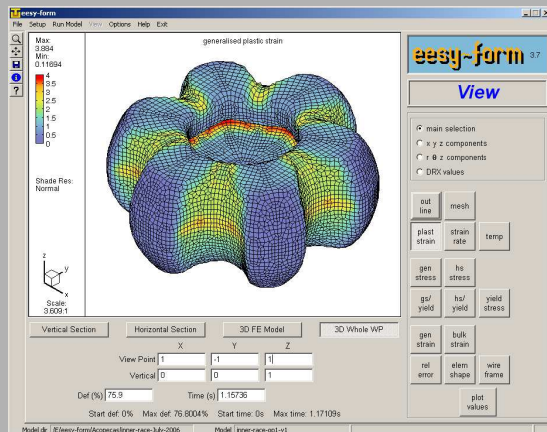


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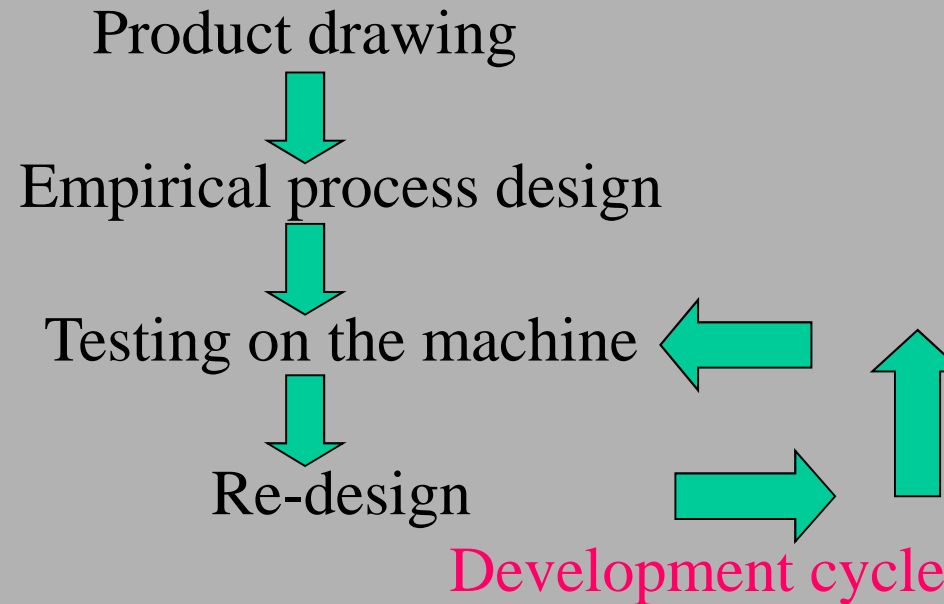
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Principle of Process Design Work



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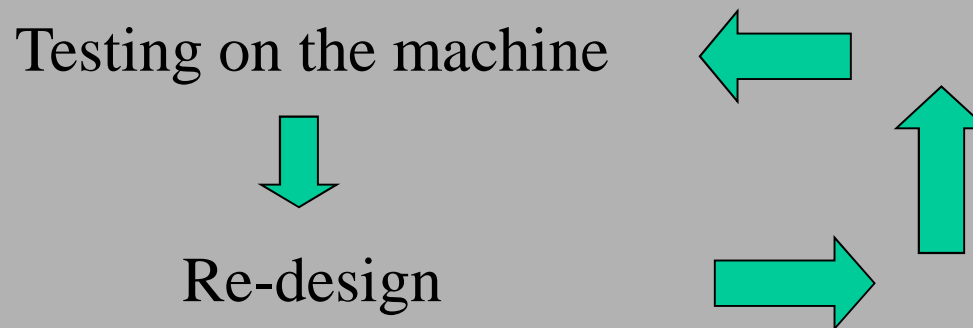
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Principle of Process Design Work

**This development cycle is very cost intensive
and covers a lot of uncertainties**



Development cycle

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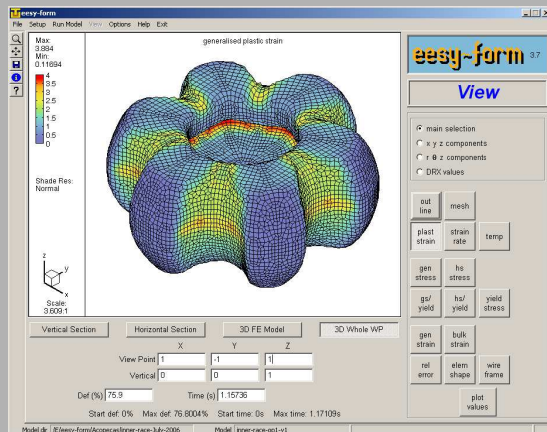
**Besides reducing the costs of the product development
Simulation can help**

- **To develop specific product properties**
- **To analyze the product application**
- **To train production and engineering personal**
- **To explain production tasks to a customer during common development**
- **To build up technological „know why“**
- **.....**

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Examples of application



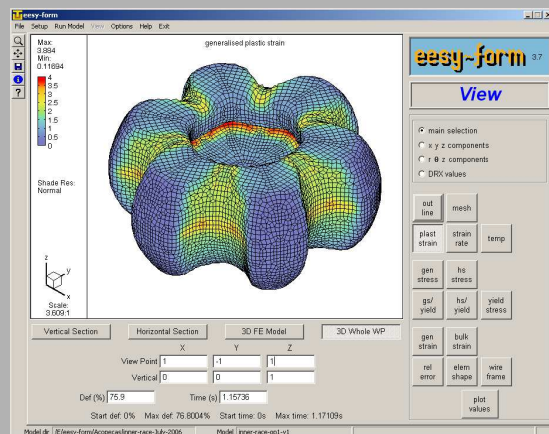
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Examples of application

- Tool failure in production of a valve spring retainer
- Folding of material
- Failure of punch because of contact problems
- Cracking of a screw head do to tangential stress
- Die failure
- Die design
- Forming station with spring loaded die
- Difficult tool design for a combined forward and backward extrusion
- Microstructure prediction in forging



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Tool failure in production of a valve spring retainer



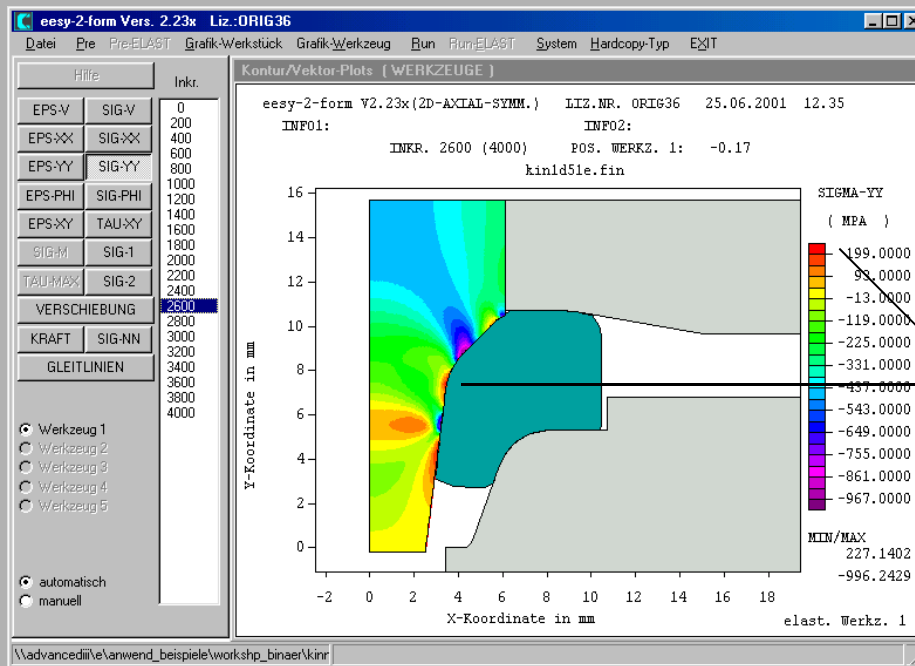
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Tool failure in production of a valve spring retainer

- Searching for Failure of punch
- High stresses!



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Tool failure in production of a valve spring retainer



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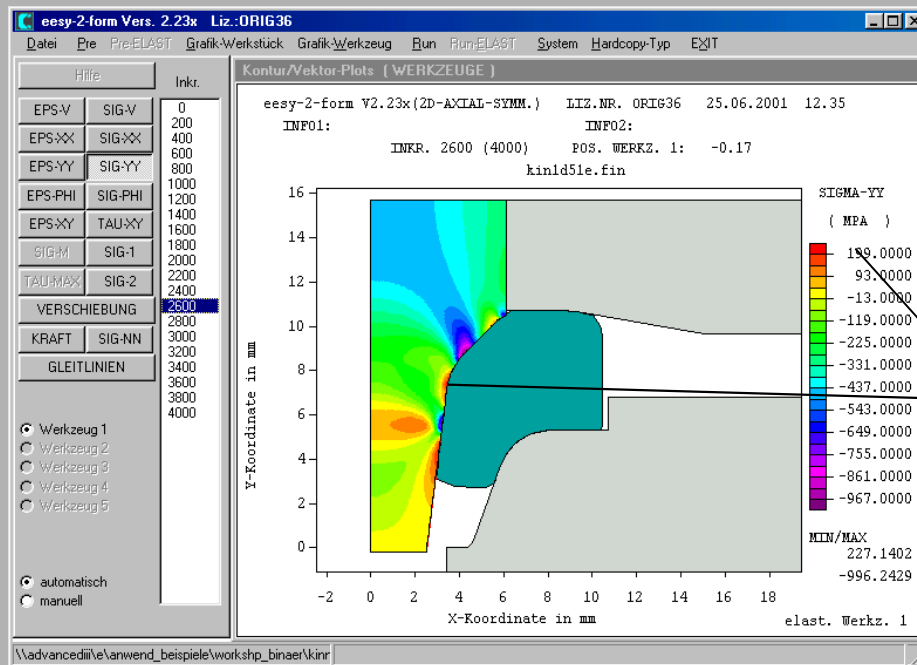


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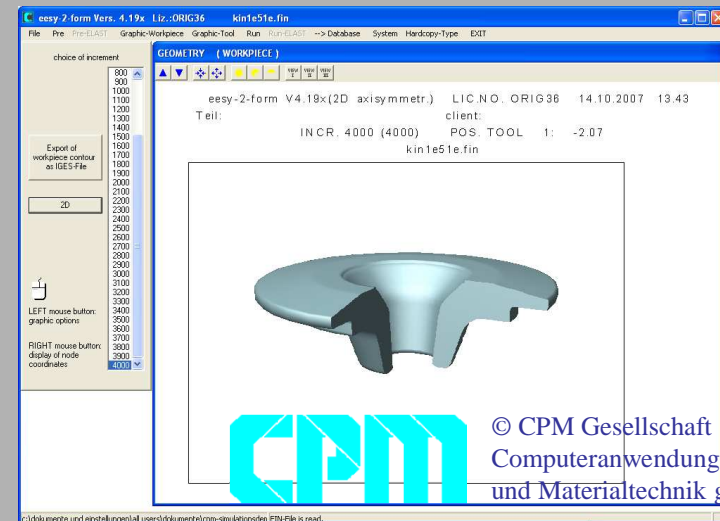
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Tool failure in production of a valve spring retainer



- Avoiding of failures
- ## Failure of a punch

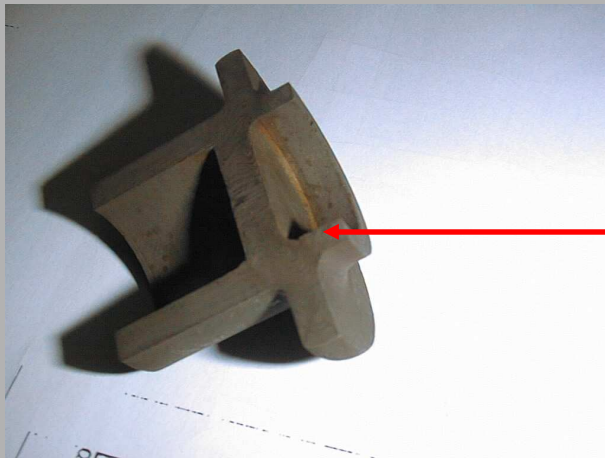


wrong pre-form design!

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Folding of material



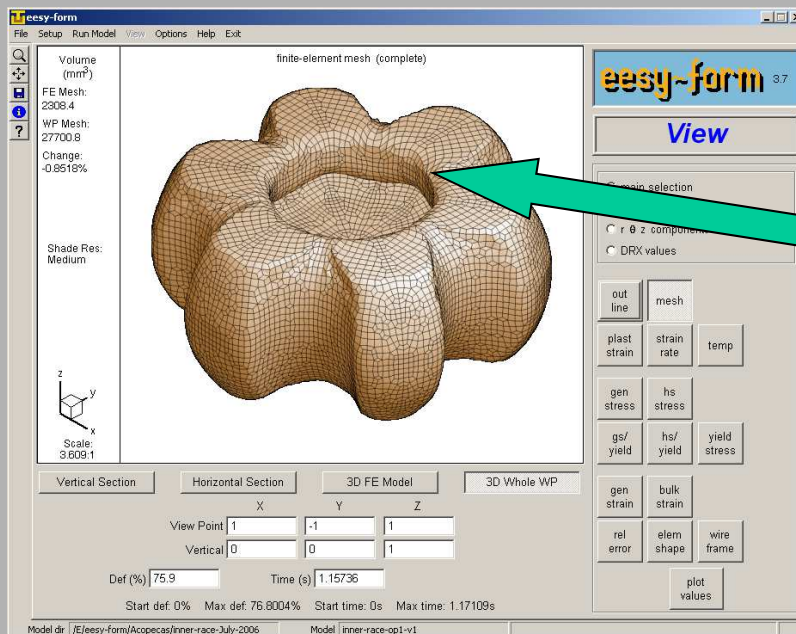
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Folding of material



**Folding / Underfilling
on an inner race**

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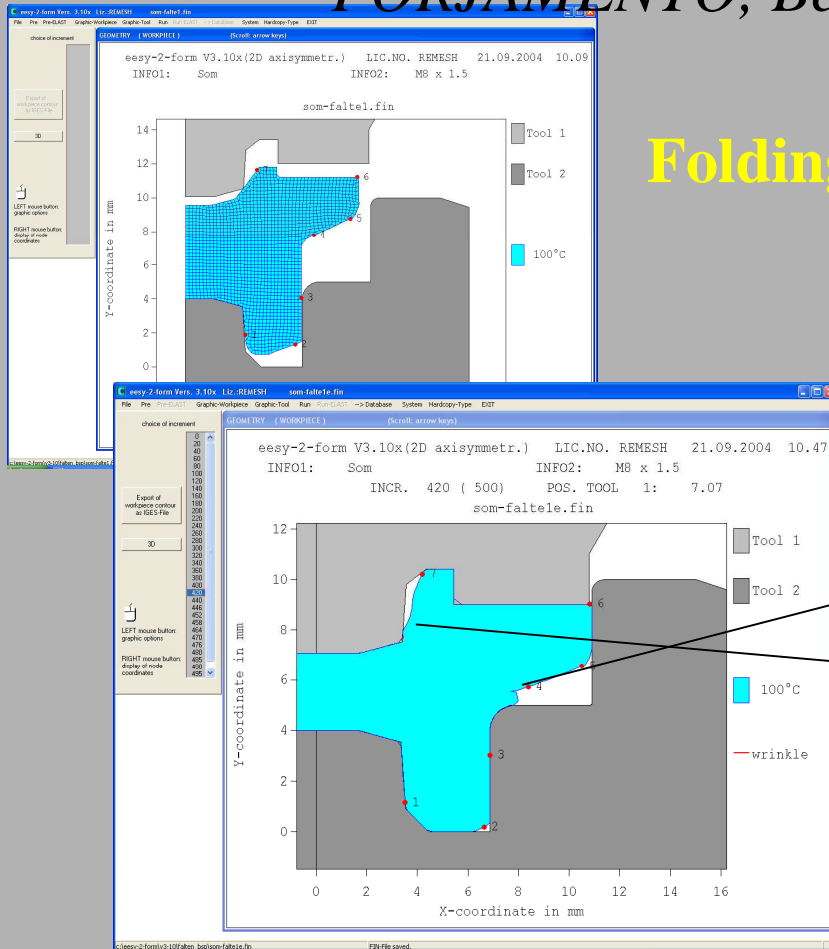


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Folding of material



Folding at nut in

- Surface and
- Thread area

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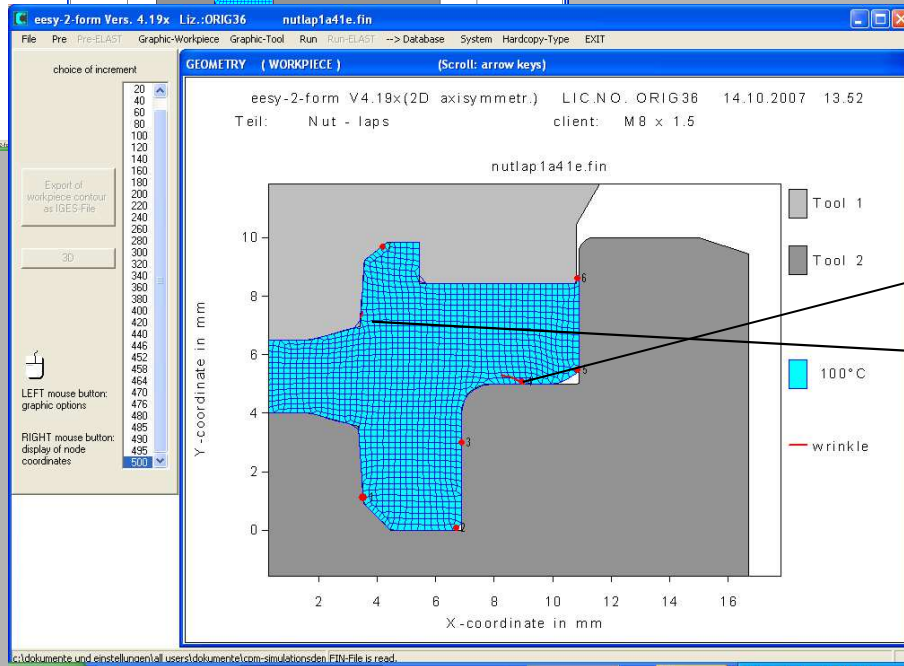
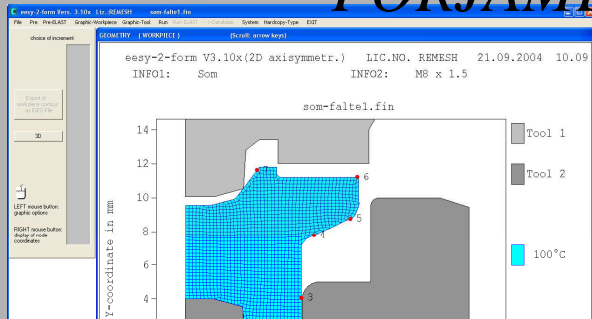


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Folding of material



Folding at nut in

- Surface and
- Thread area

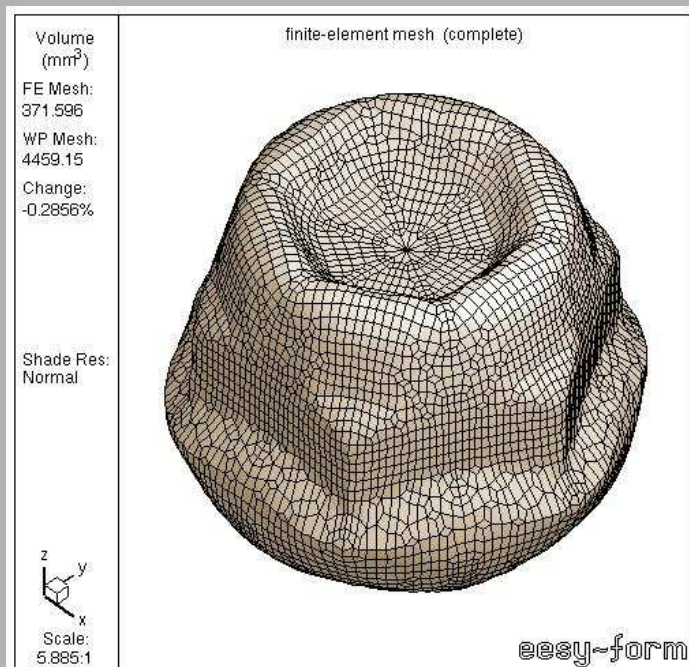
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Failure of punch because of contact problems



Flansh nut 2nd. Station

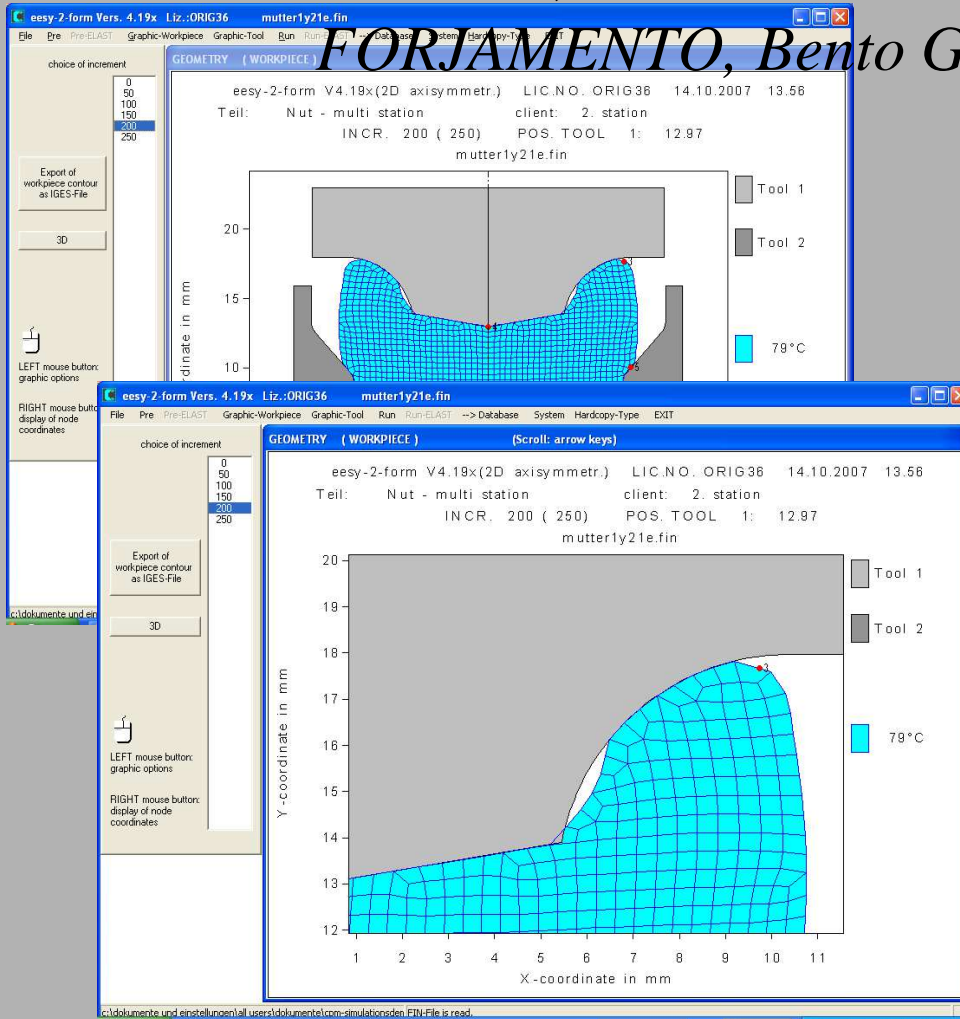
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Failure of punch because of contact problems

Flansh nut 2nd. Station

Non sufficient contact between punch and material!

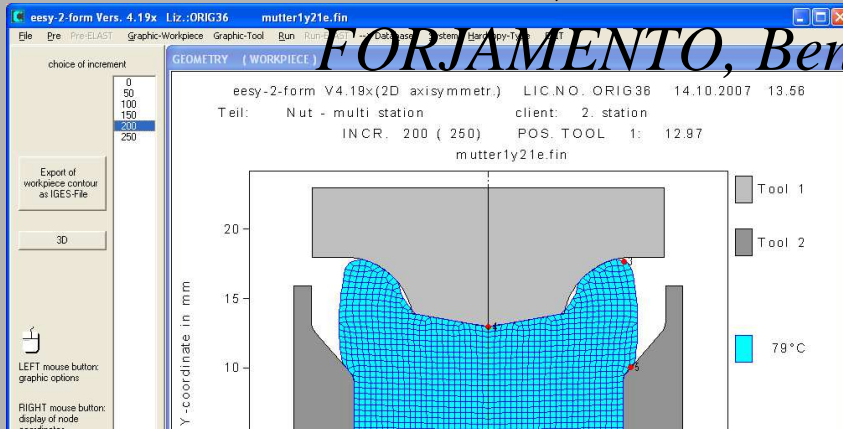
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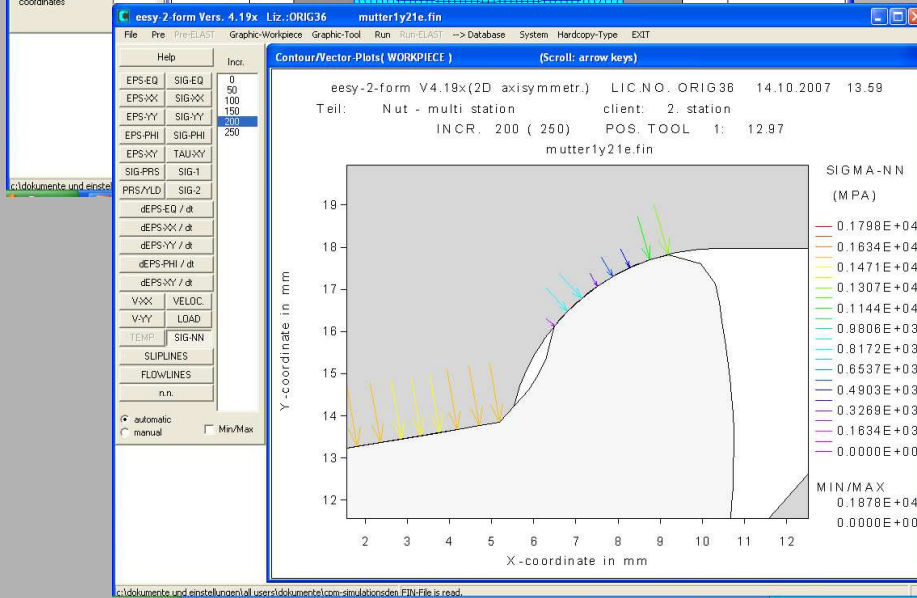
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Failure of punch because of contact problems



Flansh nut 2nd. Station

inhomogeneous stress situation!

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**Failure of punch because
of contact problems**

**Failure of a punch in another
nut making process due
to the same reason**

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Cracking of a screw head do to tangential stress



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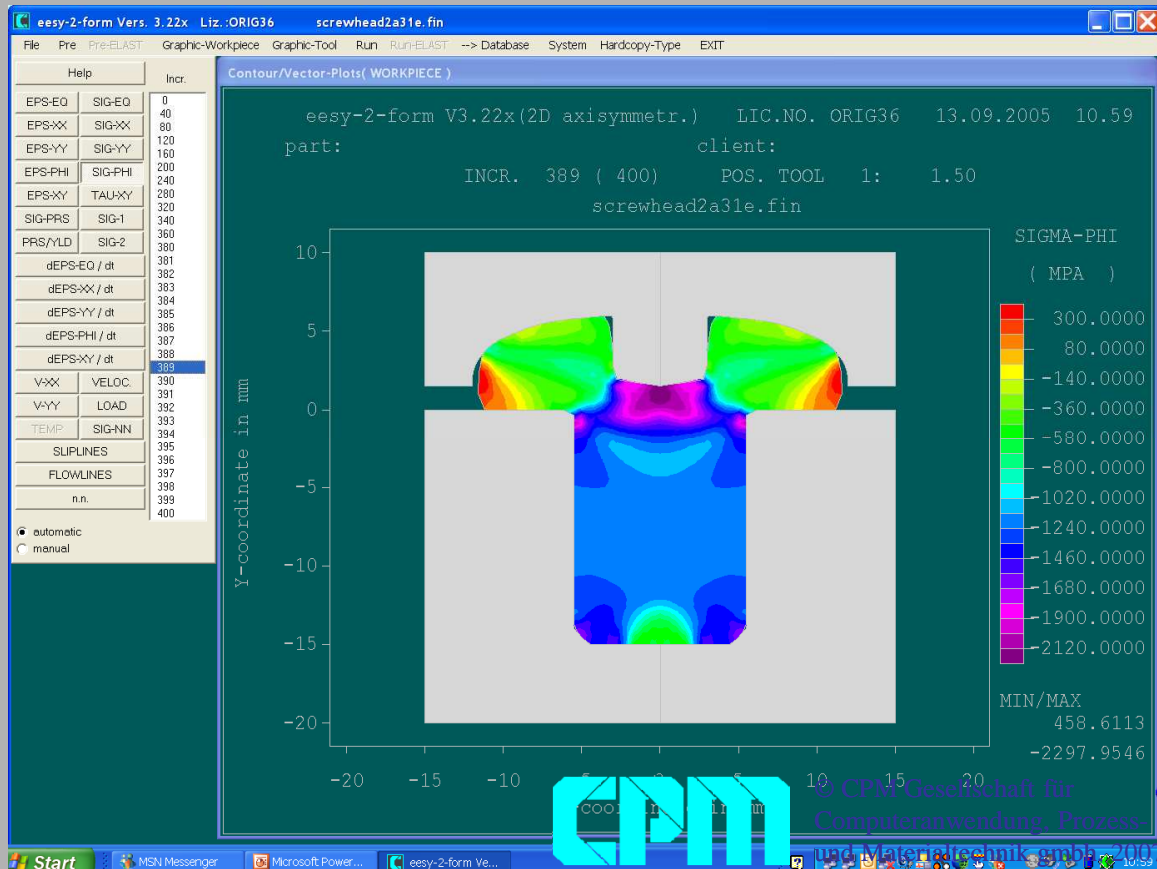


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Cracking of a screw head do to tangential stress



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Die failure



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Die failure

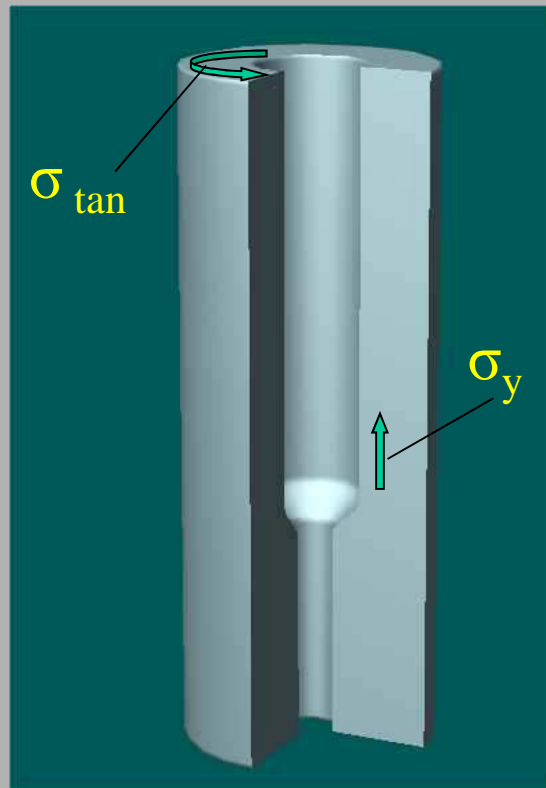


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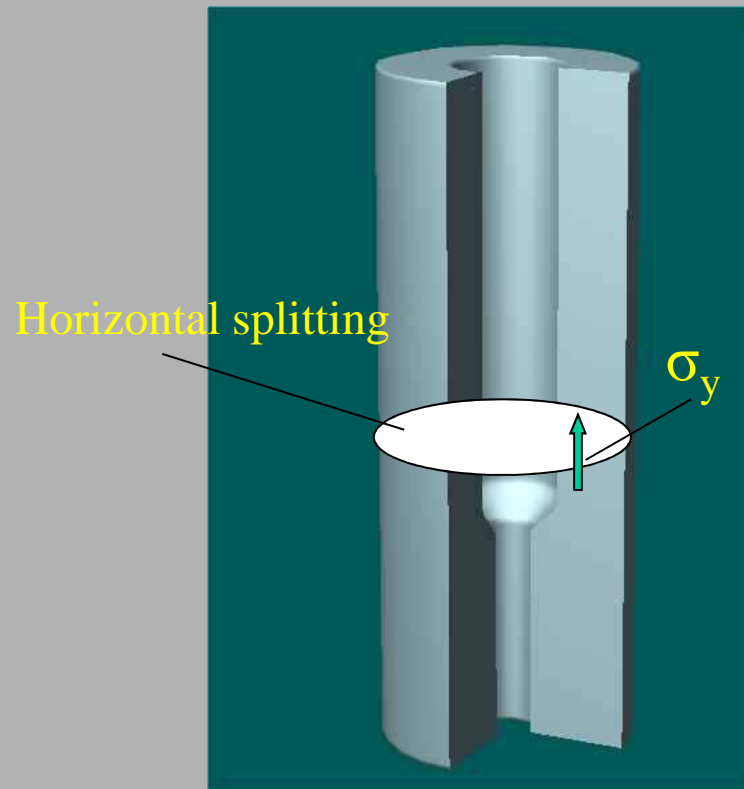
Die failure

Principle of Die Design

σ_{tan} : critical for axial crack

σ_y : critical for horizontal crack

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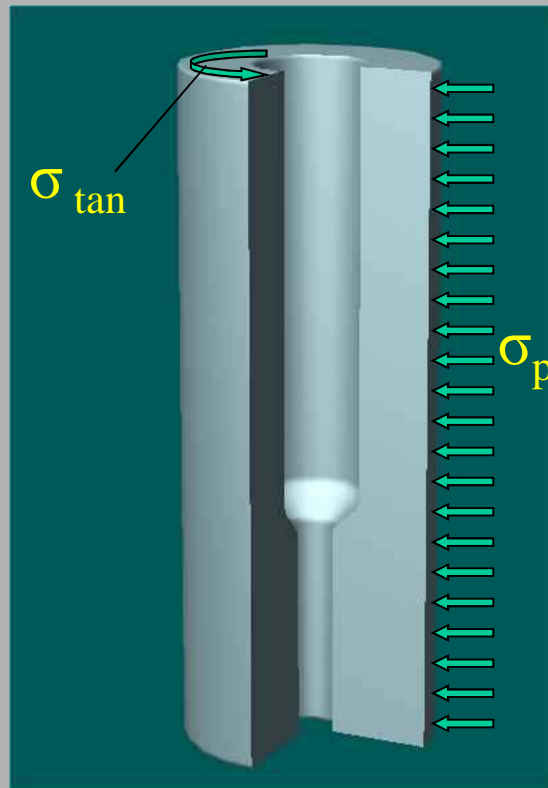
Die failure

Principle of Die Design

σ_y : critical for horizontal crack

➔ horizontal split of the insert

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Die failure

Principle of Die Design

σ_{tan} : critical for axial crack

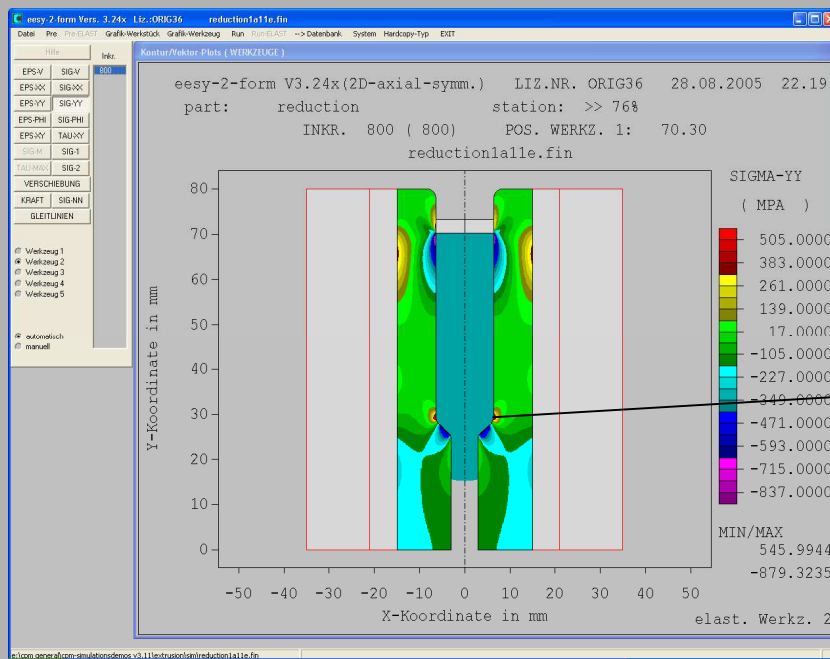
➔ Pre-stressing of the insert

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Die failure

- Avoiding of failures (elastic analysis of the insert with FEM)
- Splitting the die to avoid too high axial stresses



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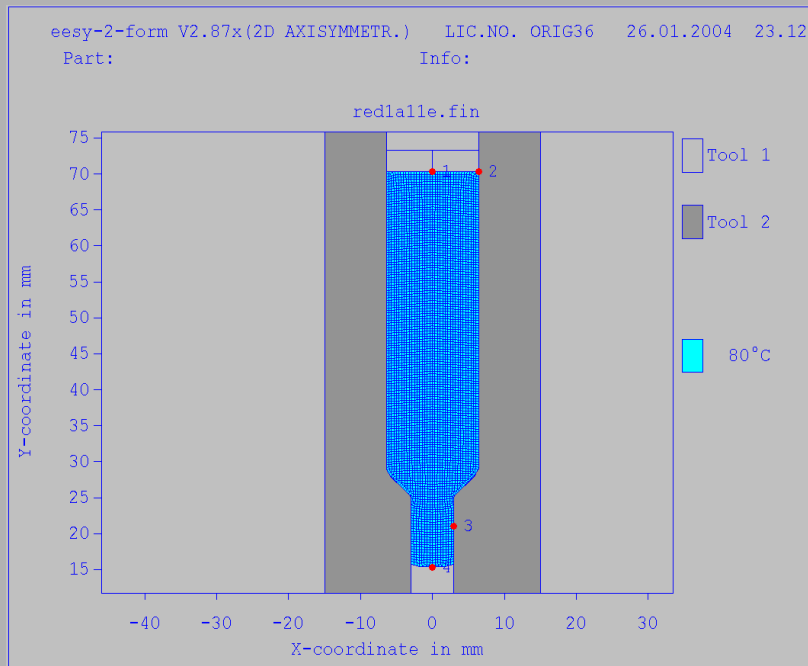
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Die design

Pre-straining of dies

to avoid axial die
breakage



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Die design

Calculation of Die Layout

eesy-DieOpt Vers. 1.92 Lizenz für: CPM GmbH, Herzogenrath, Deutschland

Datei 2-RING-SYSTEM (kalt) 2-RING-SYSTEM (warm) 3-RING-SYSTEM 4-RING-SYSTEM Sprache System EXIT

3-RING-SYSTEM Lizenz für: CPM GmbH, Herzogenrath, Deutschland

	Einsatz	1. Schrumpfring	2. Schrumpfring
Innendurchmesser Di	12.80 mm	1.2344, 56.0	1.2344, 49.9
Aussendurchmesser Da	70.00 mm		
Fugendurchmesser D1	23.00 mm		
Schrumpfmaß S1	0.187 mm		
	8.1 0/00		
Fugendurchmesser D2	43.00 mm		
Schrumpfmaß S2	0.178 mm		
	4.1 0/00		
Innendruck Pi	1621.9 MPa	1757.5	1396.5
Fugendruck P1	1062.1 MPa		
Fugendruck P2	434.8 MPa		
Konus-Winkel (für D1)	1.0 °		
Pressweg	5.36 mm		
Vergleichsspannung [MPa]	1621.9	1757.5	1396.5
Tangentialspannung [MPa]	0.0	695.4	961.7
Verengung (-) / Aufweitung (+):	von Di 0.012 mm	von Da 0.171 mm	

Werkstoffname: Einsatz G55, 1. Schrupfring X40CrMoV51, 2. Schrupfring X40CrMoV51
Werkstoffnummer: 1.2344, 1.2344
E-Modul [MPa]: 450000, 216000, 216000
Poisson'sche Zahl [-]: 0.25, 0.28, 0.28
Zugfestigkeit [MPa]: 2050.0, 1670.0
Streckgrenze [MPa]: 1850.0, 1470.0
Anlasstemperatur [°C]: 520, 600

Zusammenbau: (2.Schrumpfring + 1.Schrumpfring) <- Einsatz
 (Einsatz + 1.Schrumpfring) -> 2.Schrumpfring
 Ohne Zwischenbearbeitung

Neu Berechnung Optimierung (Schrumpfmaß) Optimierung (Gesamt) Optimierung (nur D2) Hilfe Grafik

D:\eesy-dieopt(Layouts)\cfc.edo

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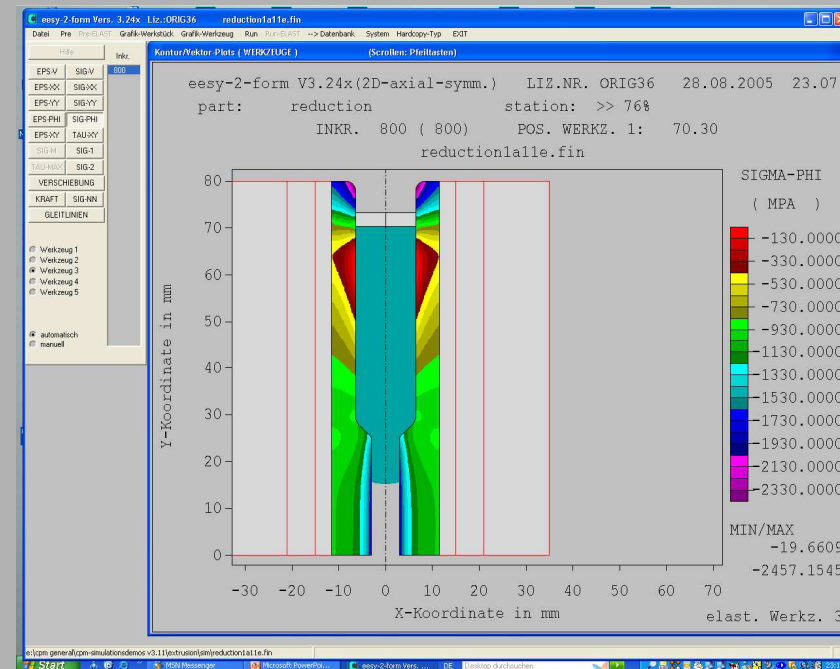
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Die design

The stress distribution in an insert with pre straining optimisation



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Punch die to form torx
recesses.

After systematic
optimization such a
punch produces more
than 2.000.000 parts!



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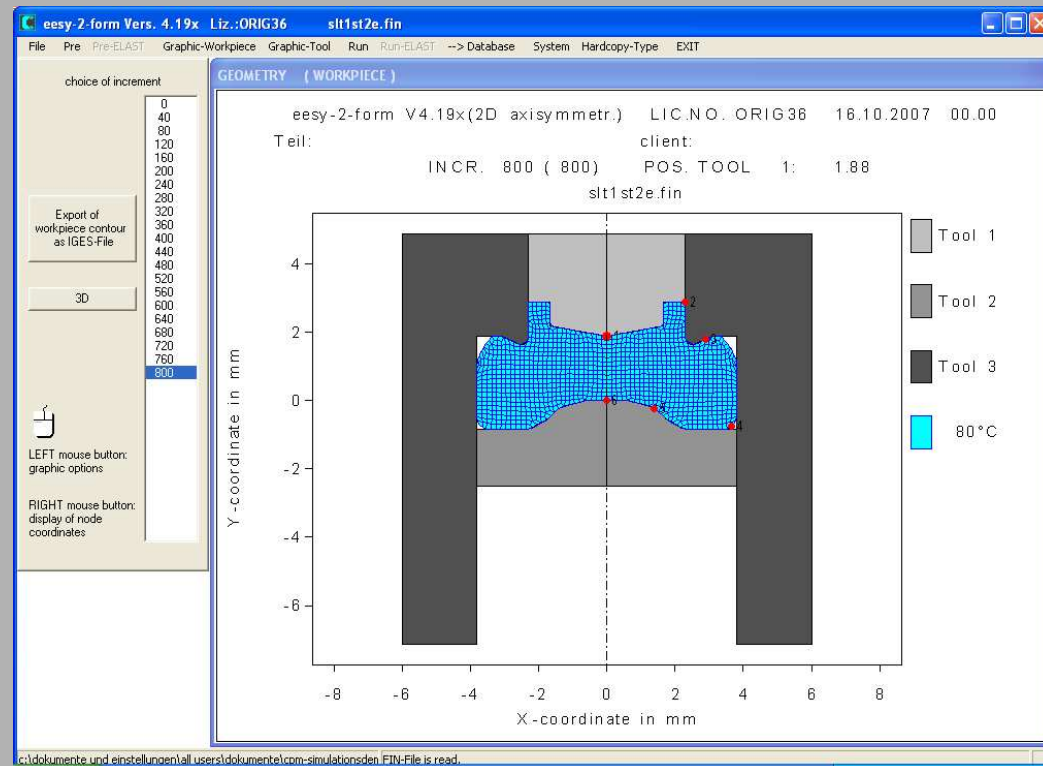


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Forming station with spring loaded die

**Layout of the spring
loaded die system
for a complex
operation**



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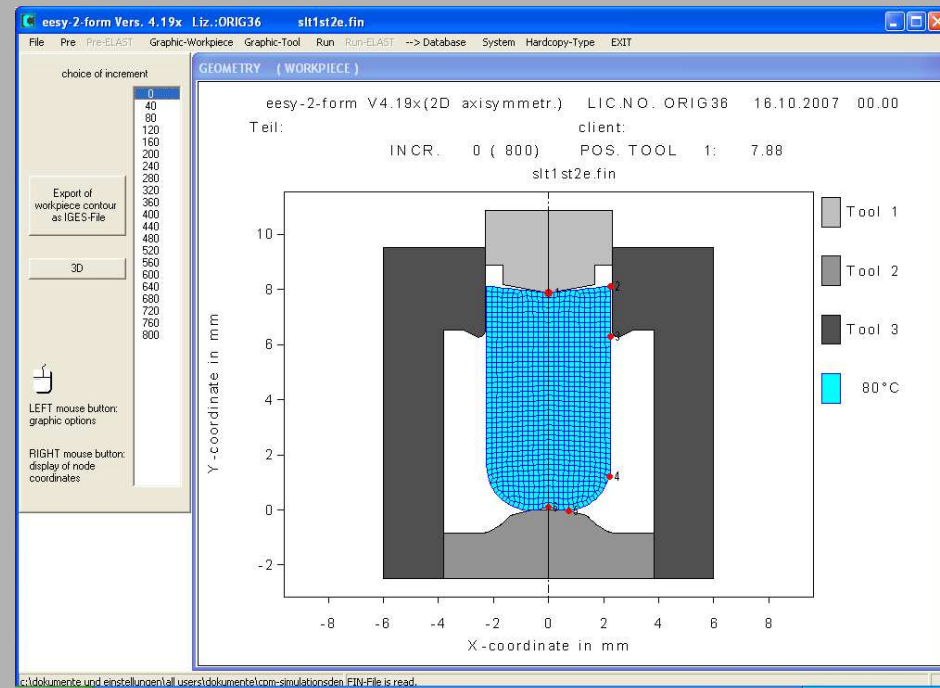
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Forming station with spring loaded die

**Layout of the spring
loaded die system
for a complex
operation**

Initial position



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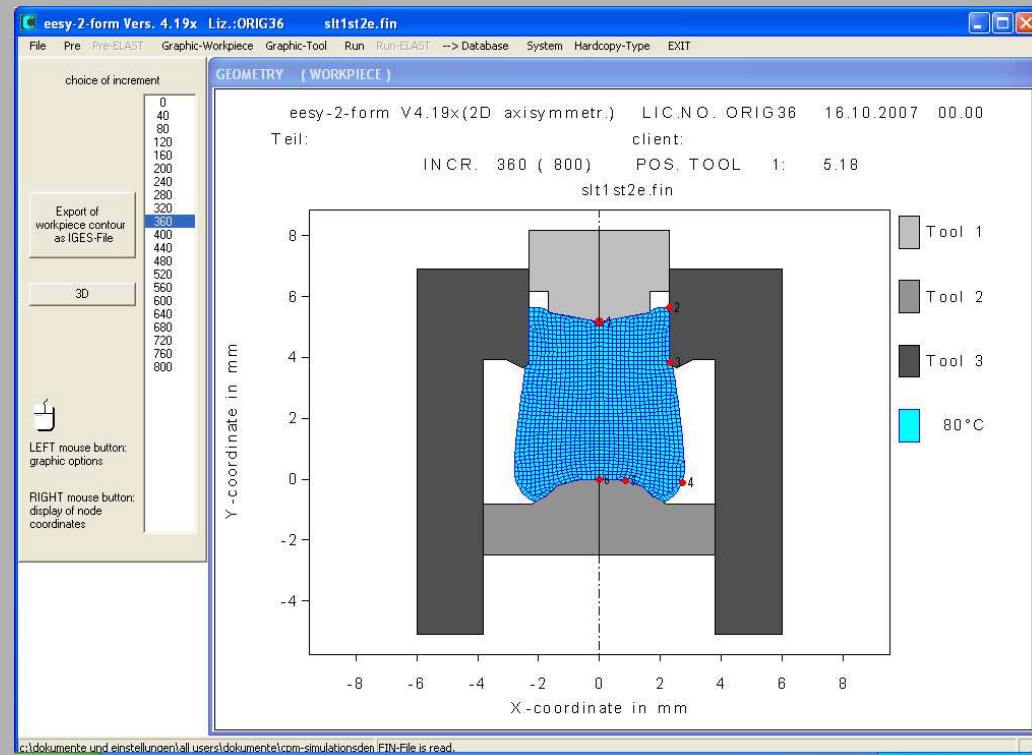
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Forming station with spring loaded die

**Layout of the spring
loaded die system
for a complex
operation**

Die starting to slide



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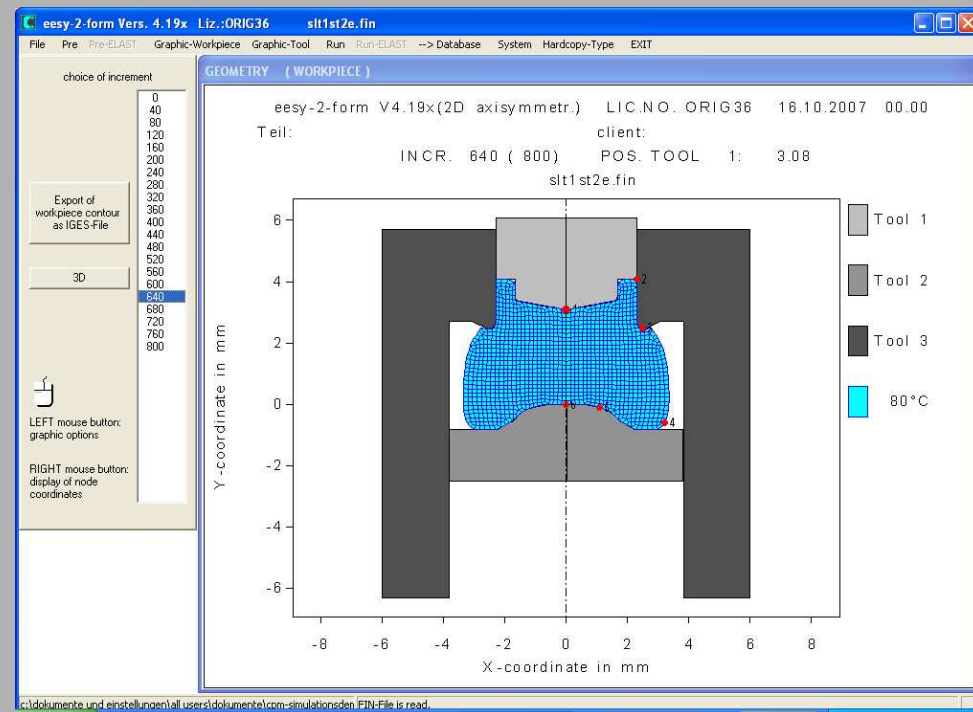
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Forming station with spring loaded die

**Layout of the spring
loaded die system
for a complex
operation**

Die sliding



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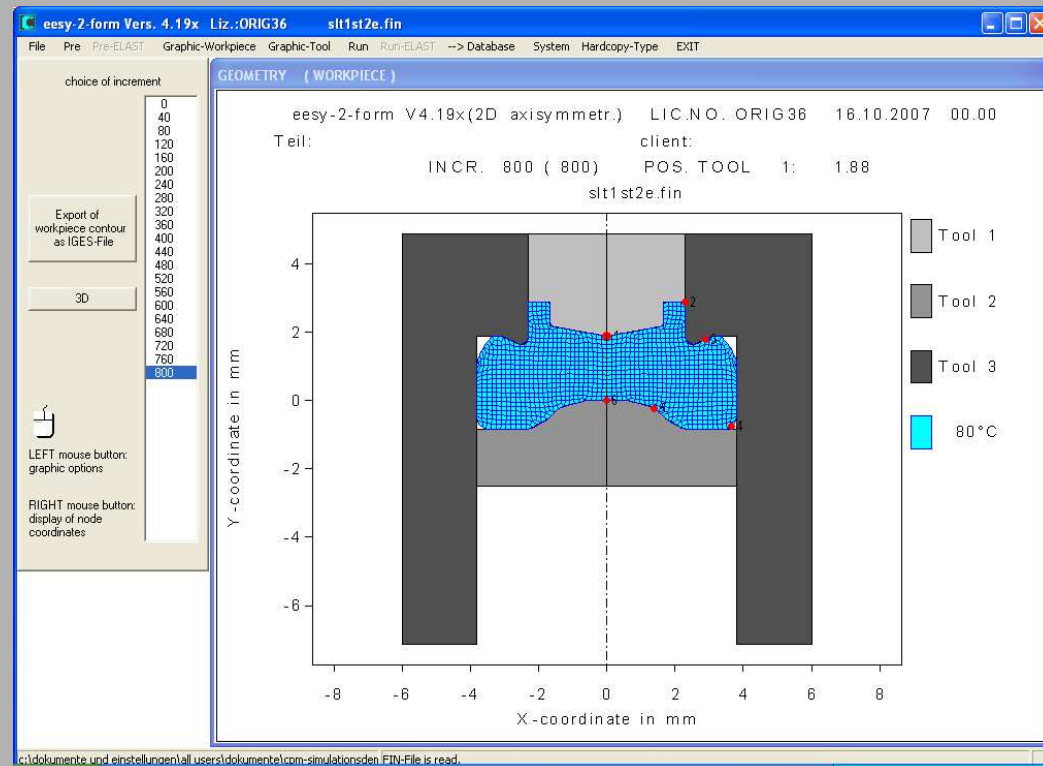
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Forming station with spring loaded die

**Layout of the spring
loaded die system
for a complex
operation**

Final position



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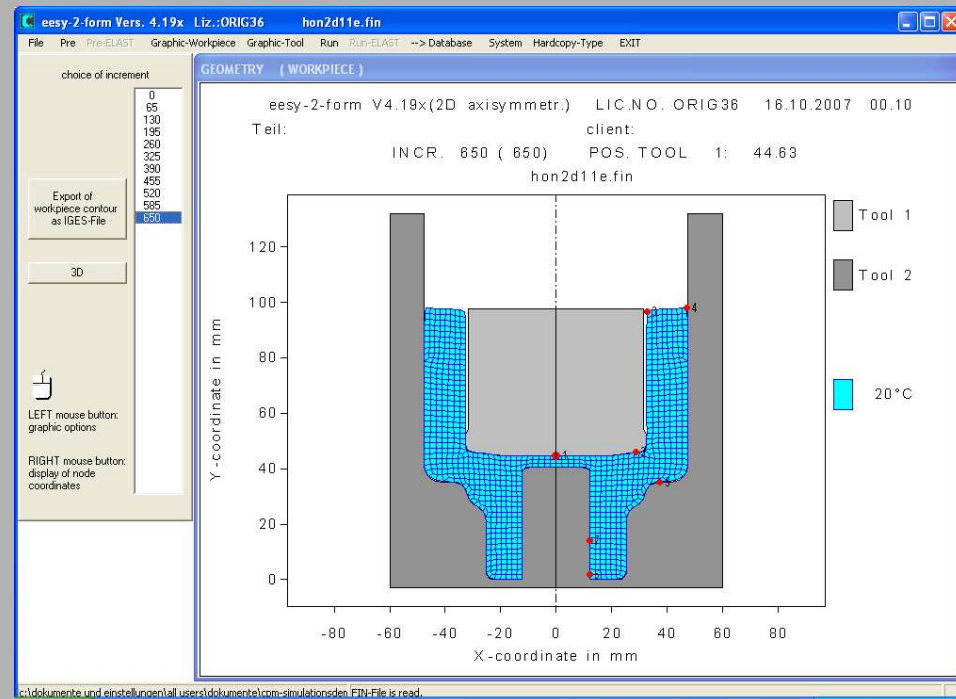


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Difficult tool design for a combined forward and backward extrusion

**Extream deformations
during extrusion with
tight tolerances**



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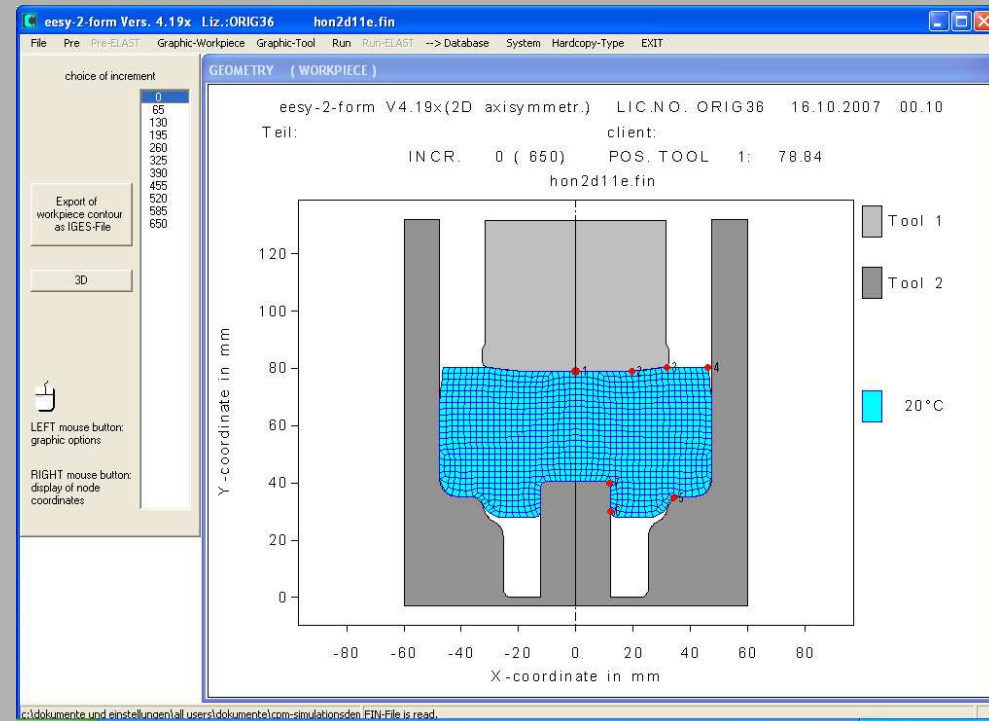
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Difficult tool design for a combined forward and backward extrusion

**Extream deformations
during extrusion with
tight tolerances**

Initial position



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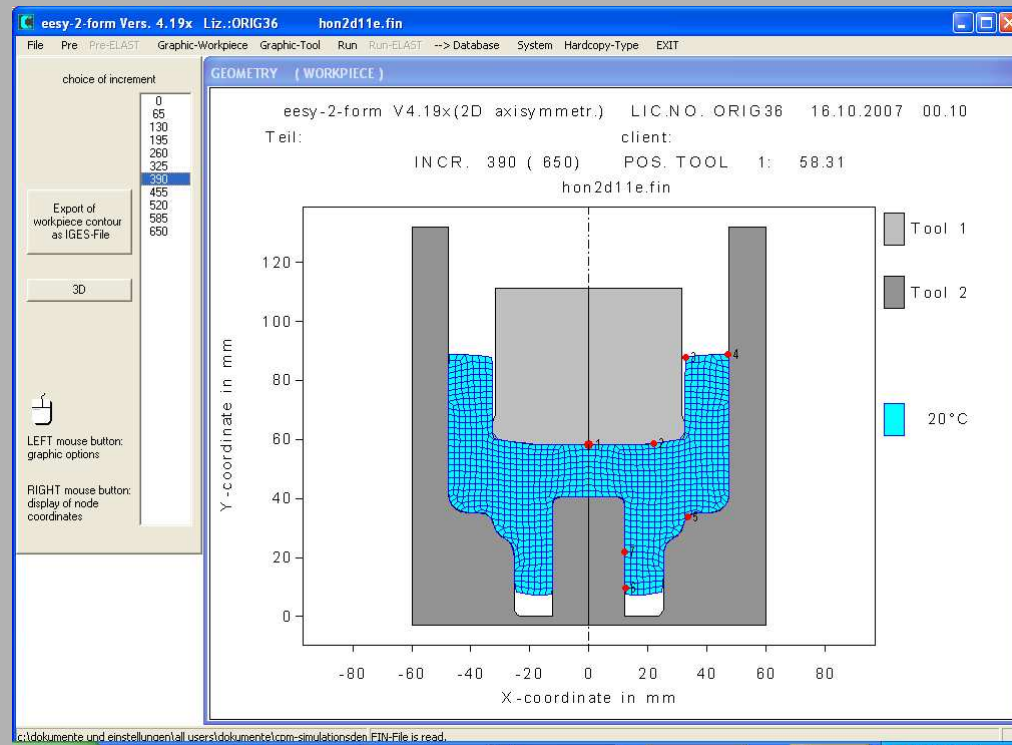
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Difficult tool design for a combined forward and backward extrusion

**Extream deformations
during extrusion with
tight tolerances**

intermediate position



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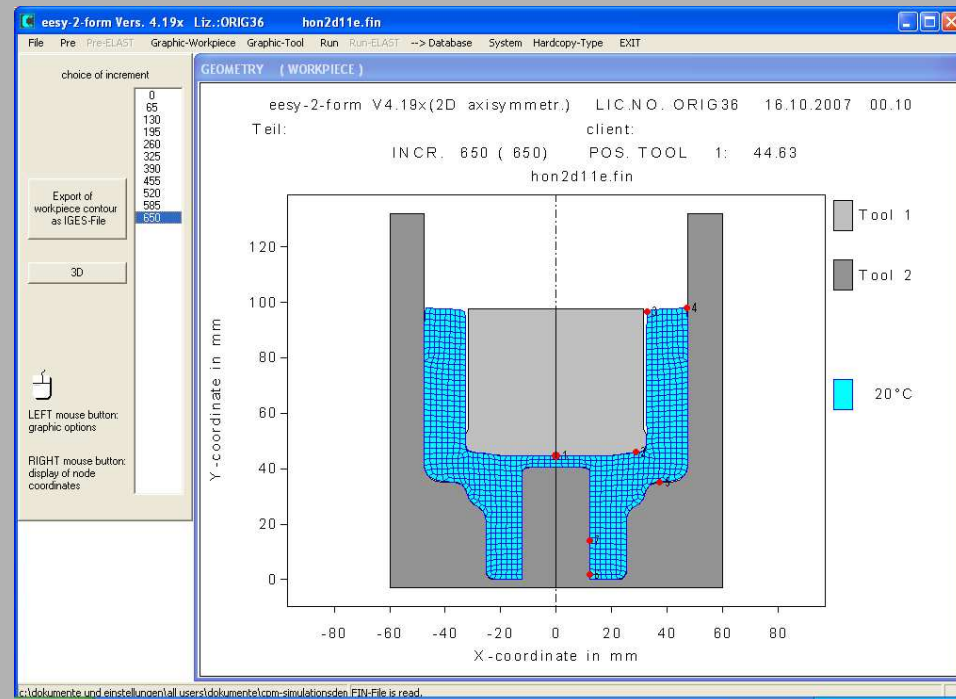
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Difficult tool design for a combined forward and backward extrusion

**Extream deformations
during extrusion with
tight tolerances**

Final position



18th of October 2007

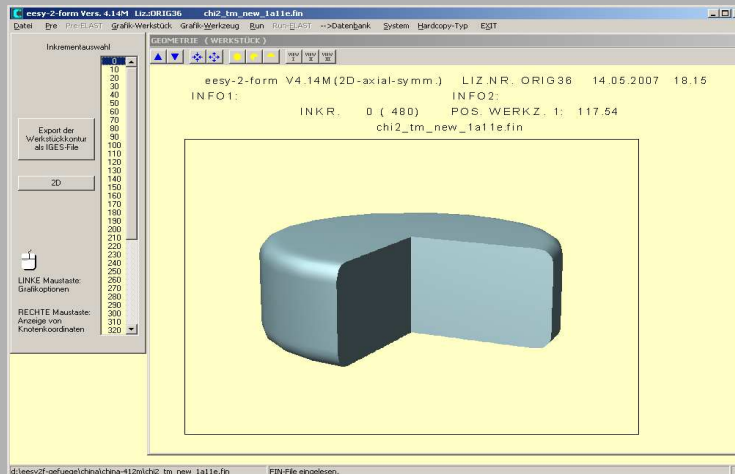


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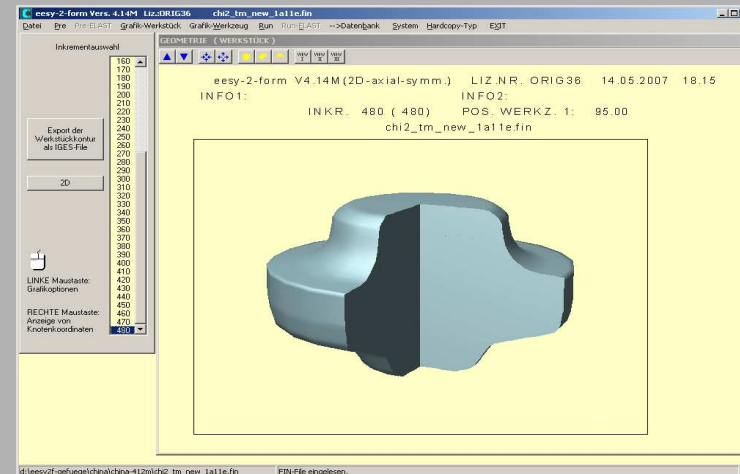
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Microstructure prediction in forging



Initial blank



Final shape

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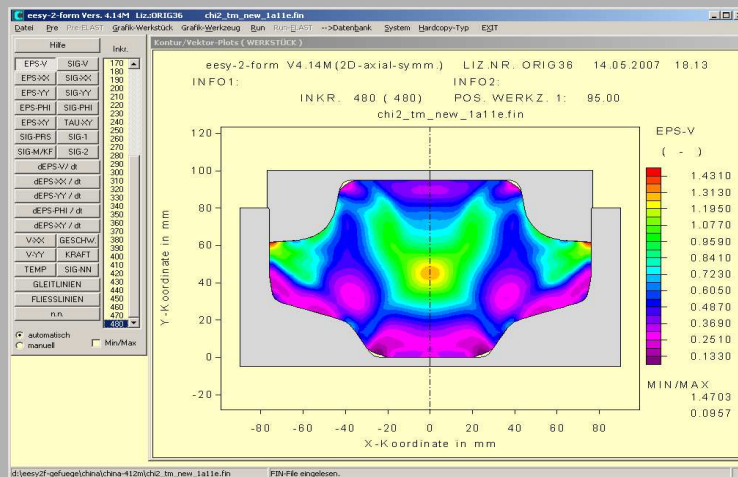


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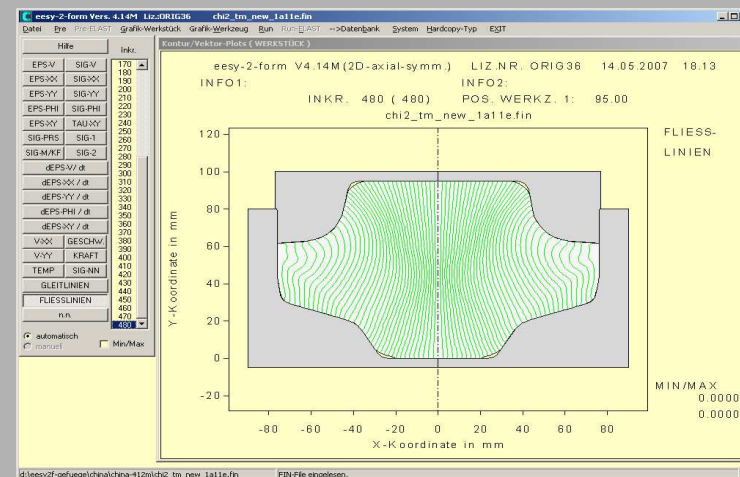
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Microstructure prediction in forging



Distribution of strain



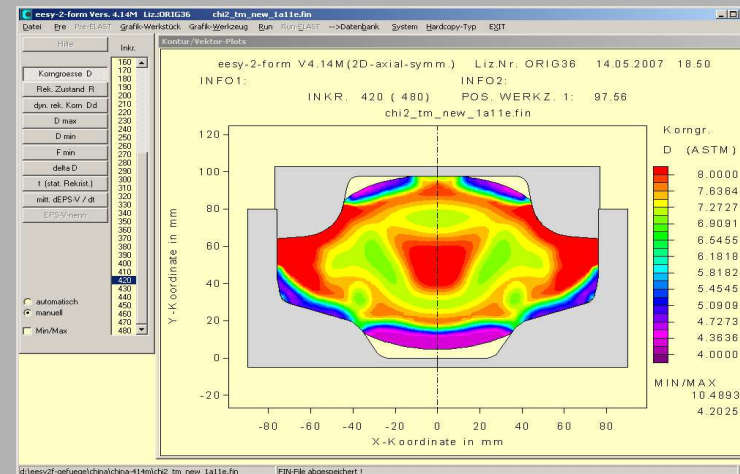
Fibre distribution

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Microstructure prediction in forging

- Grain size
- degree of re-cristallisation
- dynamic re-crist. fraction
- static re-crist. fraction
- grain-groth
- timing and recovering



Aims of simulation

Gain size distribution

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Conclusion

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Conclusion

Most of the daily problems in design of a metal forming process can be supported by today simulation technology.

Some special application need further development still.

Simulation is generally established as a design tool.

Hurry up to not miss the train .. But choose your simulation partner carefully he has to be expert in forging as well!

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Thank you for your attention !

**Like this bird knocking at my door
at a Chinese Hotel
in the early morning.....**

**I do not know whether he wanted
support and knowledge....**

18th of October 2007



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