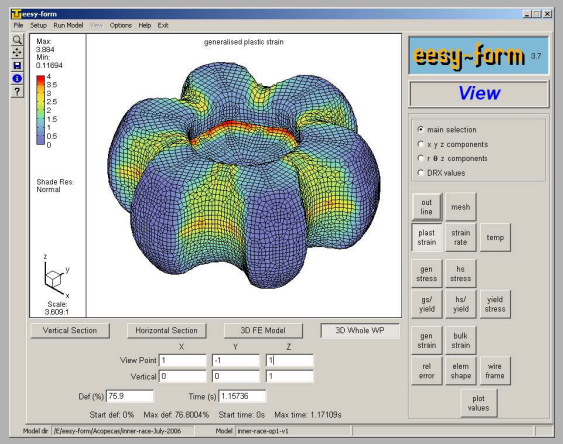
Modern process engineering –solving difficult tasks

XXVII SENAFOR, XI CONFERENCIA INTERNATIONAL DE FORJAMENTO, Bento Goncalves, RS, Brazil

Modern process engineering - solving difficult tasks

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



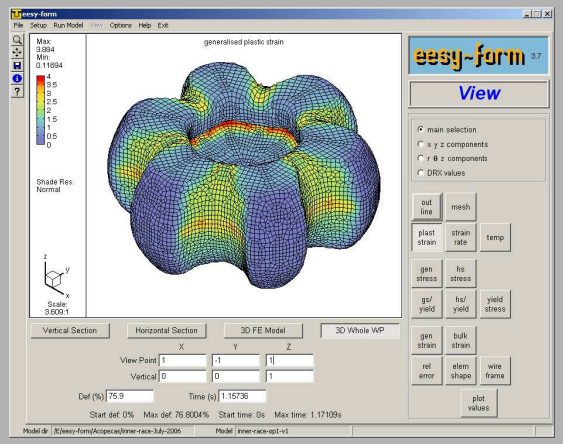
Modern process engineering –solving difficult tasks

XXVII SENAFOR, XI CONFERENCIA INTERNATIONAL DE FORJAMENTO, Bento Goncalves, RS, Brazil

Introduction

Examples of application

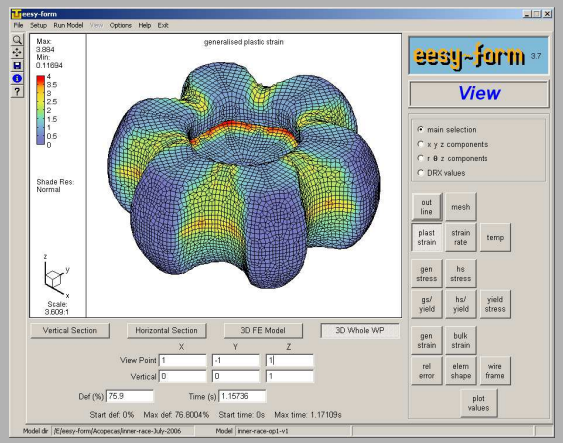
Conclusion



Modern process engineering –solving difficult tasks

XXVII SENAFOR, XI CONFERENCIA INTERNATIONAL DE FORJAMENTO, Bento Goncalves, RS, Brazil

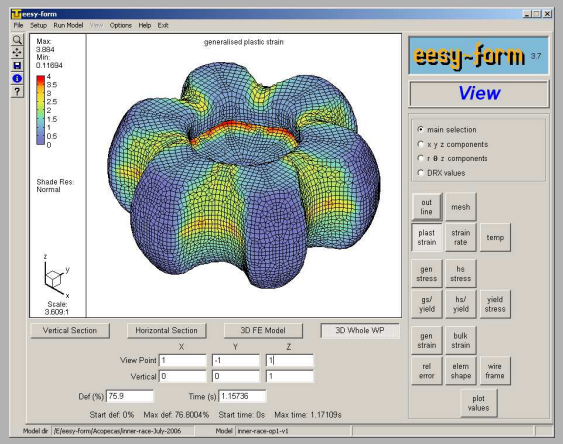
Introduction



Modern process engineering –solving difficult tasks

XXVII SENAFOR, XI CONFERENCIA INTERNATIONAL DE FORJAMENTO, Bento Goncalves, RS, Brazil

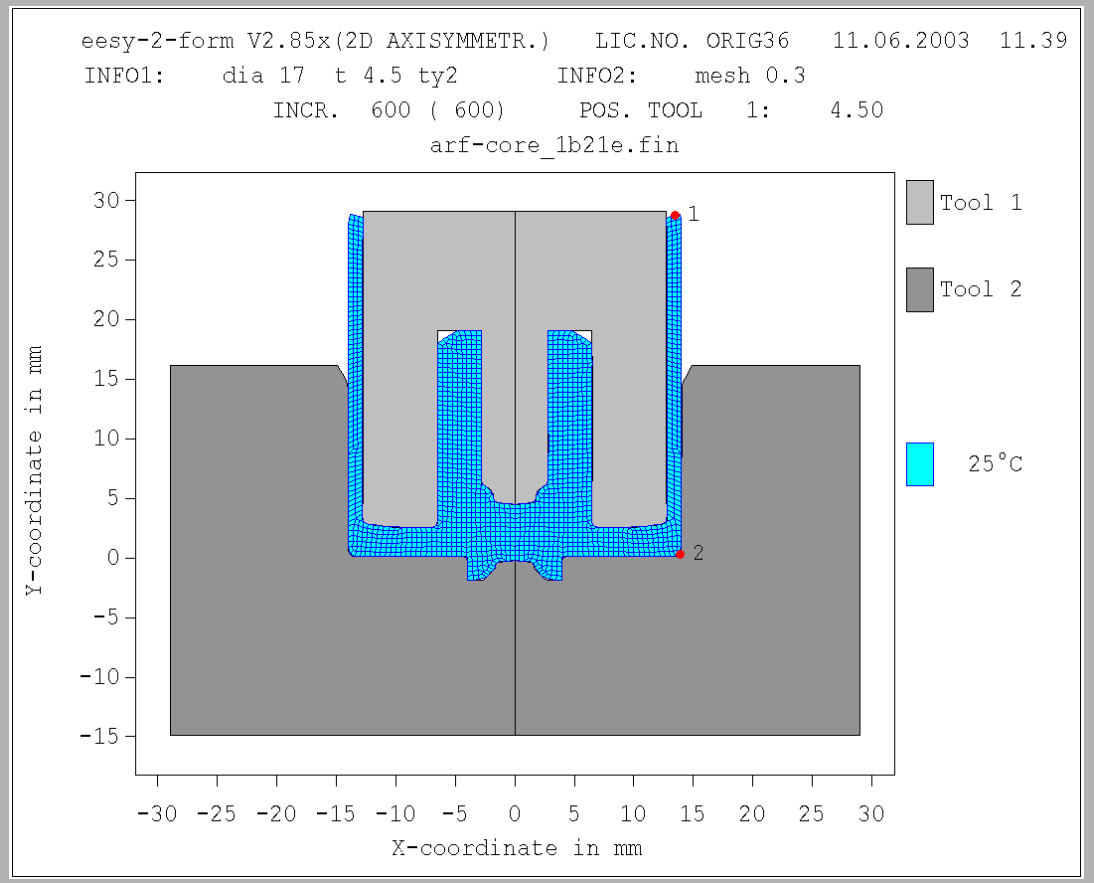
Introduction

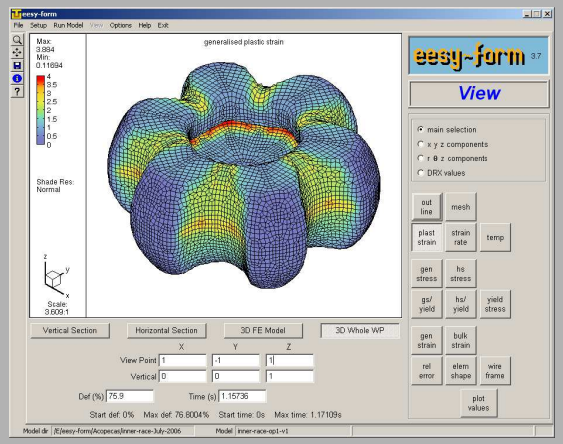


Modern process engineering –solving difficult tasks

XXVII SENAFOR, XI CONFERENCIA INTERNATIONAL DE FORJAMENTO, Bento Goncalves, RS, Brazil

Introduction

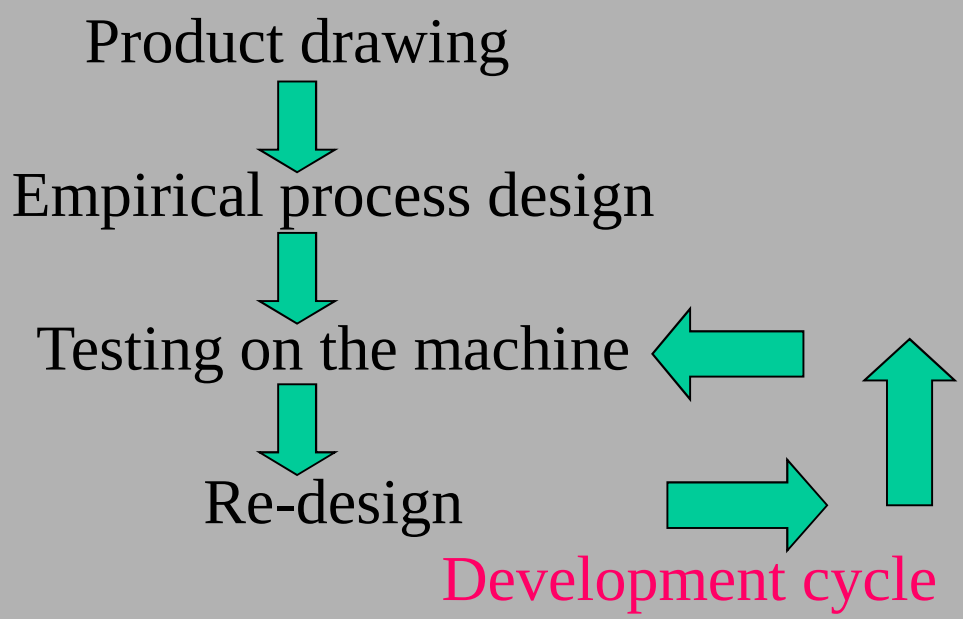




Modern process engineering –solving difficult tasks

XXVII SENAFOR, XI CONFERENCIA INTERNATIONAL DE FORJAMENTO, Bento Goncalves, RS, Brazil

Principle of Process Design Work



18th of October 2007

Modern process engineering –solving difficult tasks

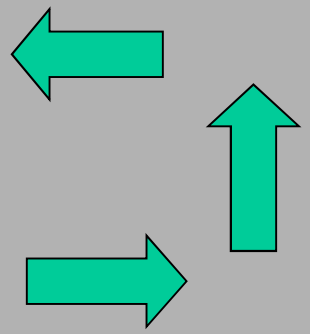
XXVII SENAFOR, XI CONFERENCIA INTERNATIONAL DE FORJAMENTO, Bento Goncalves, RS, Brazil

Principle of Process Design Work

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

Testing on the machine

Re-design



Development cycle

18th of October 2007

Modern process engineering –solving difficult tasks

XXVII SENAFOR, XI CONFERENCIA INTERNATIONAL DE FORJAMENTO, Bento Goncalves, RS, Brazil

Besides reducing the costs of the product development Simulation can help

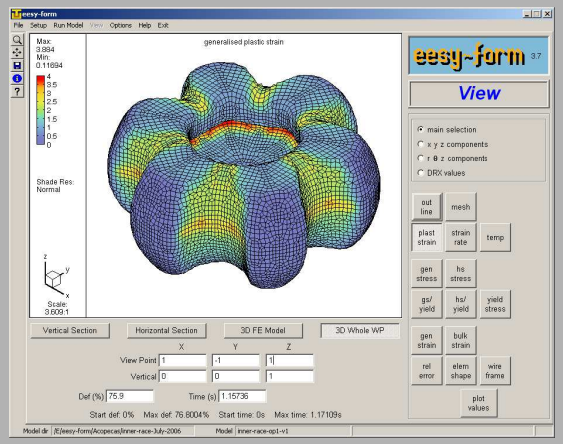
- **To develop specific product properties**
- **To analyze the product application**
- **To train production and engineering personal**
- **To explain production tasks to a customer during common development**
- **To build up technological „know why“**
- **…….**

18th of October 2007

Modern process engineering –solving difficult tasks

XXVII SENAFOR, XI CONFERENCIA INTERNATIONAL DE FORJAMENTO, Bento Goncalves, RS, Brazil

Examples of application

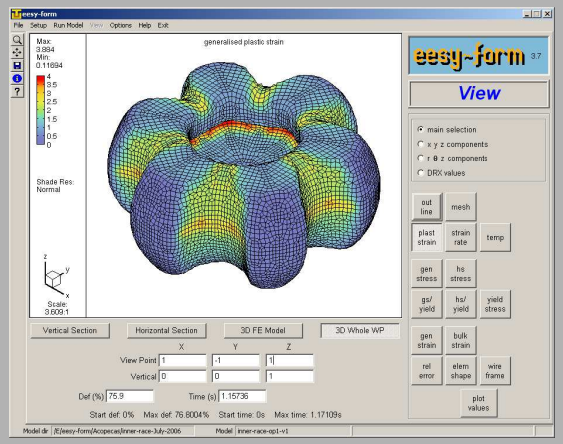


Modern process engineering –solving difficult tasks

XXVII SENAFOR, XI CONFERENCIA INTERNATIONAL DE FORJAMENTO, Bento Goncalves, RS, Brazil

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



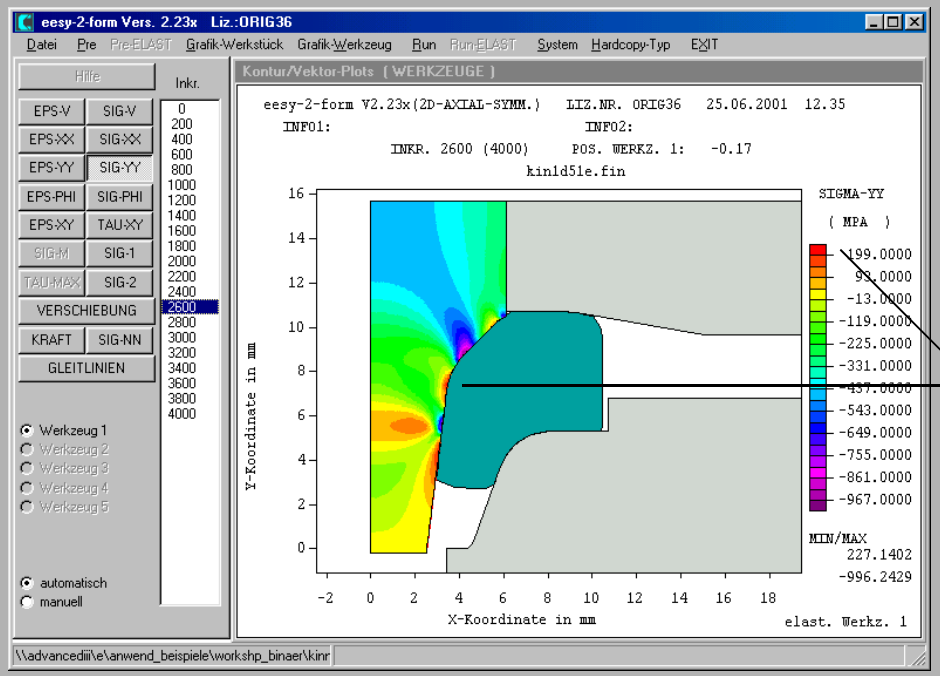
Modern process engineering –solving difficult tasks

XXVII SENAFOR, XI CONFERENCIA INTERNATIONAL DE FORJAMENTO, Bento Goncalves, RS, Brazil

Tool failure in production of a valve spring retainer

18th of October 2007

Tool failure in production of a valve spring retainer



- Searching for Failure of punch
- High stresses!

Modern process engineering –solving difficult tasks

XXVII SENAFOR, XI CONFERENCIA INTERNATIONAL DE FORJAMENTO, Bento Goncalves, RS, Brazil

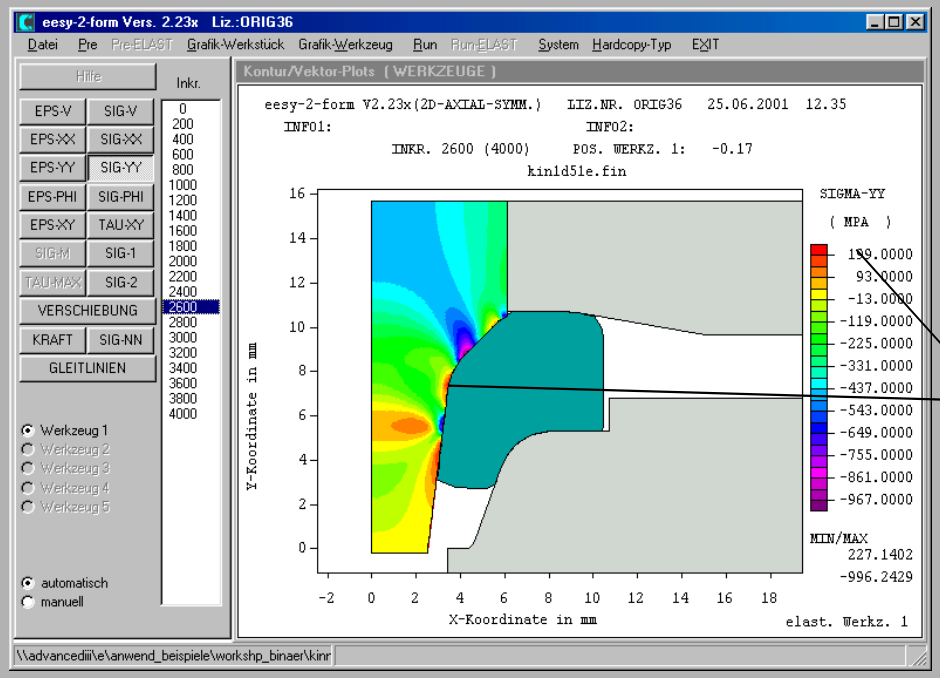
Tool failure in production of a valve spring retainer

18th of October 2007

Modern process engineering –solving difficult tasks

XXVII SENAFOR, XI CONFERENCIA INTERNATIONAL DE FORJAMENTO, Bento Goncalves, RS, Brazil

Tool failure in production of a valve spring retainer



- Avoiding of failures

Failure of a punch

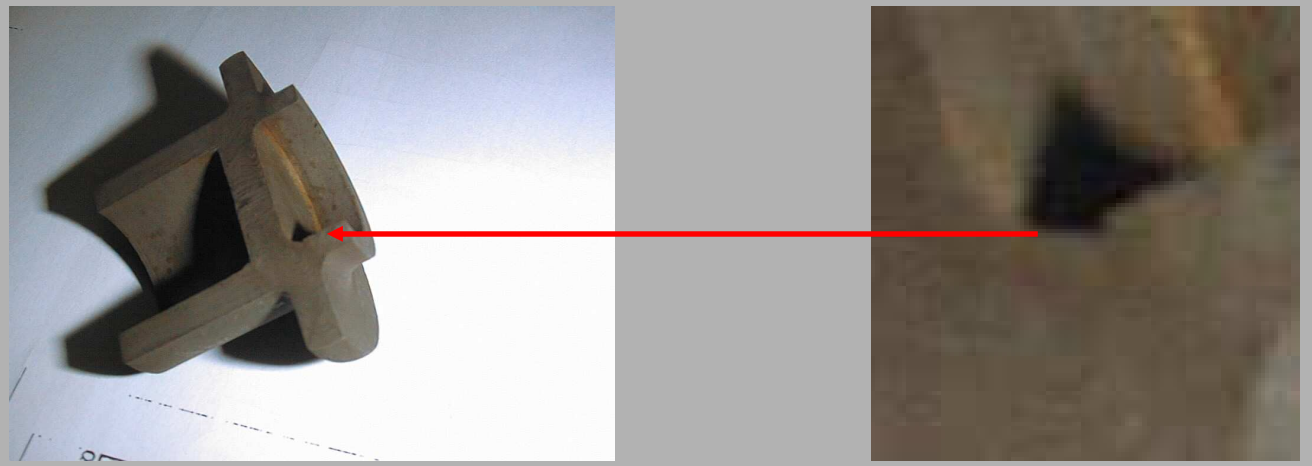
wrong pre-form design!

18th of October 2007

Modern process engineering –solving difficult tasks

XXVII SENAFOR, XI CONFERENCIA INTERNATIONAL DE FORJAMENTO, Bento Goncalves, RS, Brazil

Folding of material

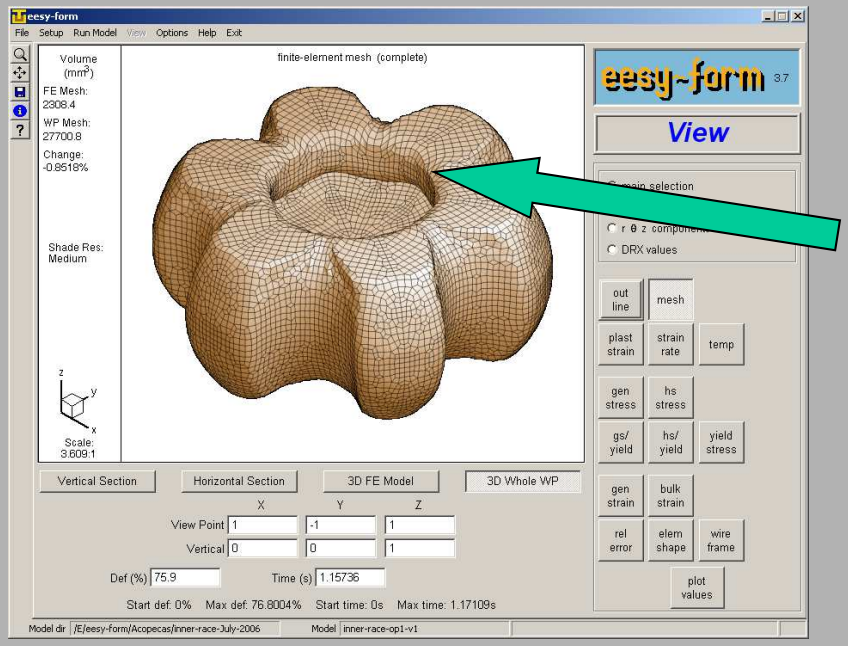


18th of October 2007

Modern process engineering –solving difficult tasks

XXVII SENAFOR, XI CONFERENCIA INTERNATIONAL DE FORJAMENTO, Bento Goncalves, RS, Brazil

Folding of material



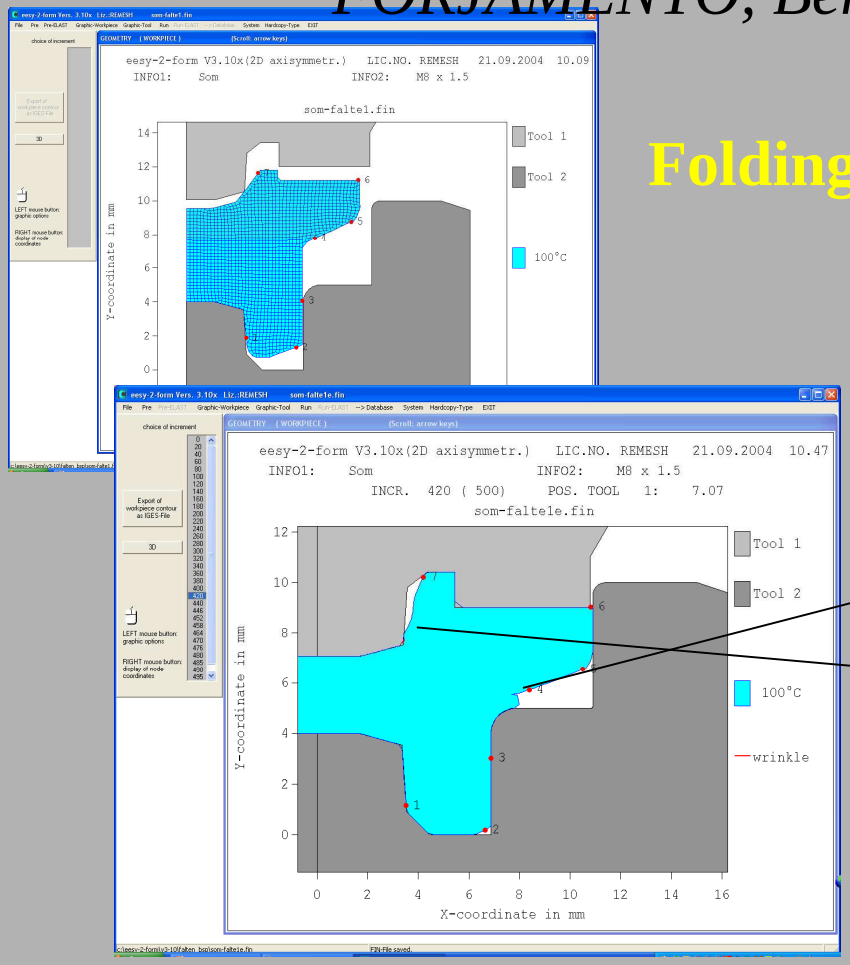
Folding / Underfilling

on an inner race

18th of October 2007

Modern process engineering –solving difficult tasks

XXVII SENAFOR, XI CONFERENCIA INTERNATIONAL DE FORJAMENTO, Bento Goncalves, RS, Brazil



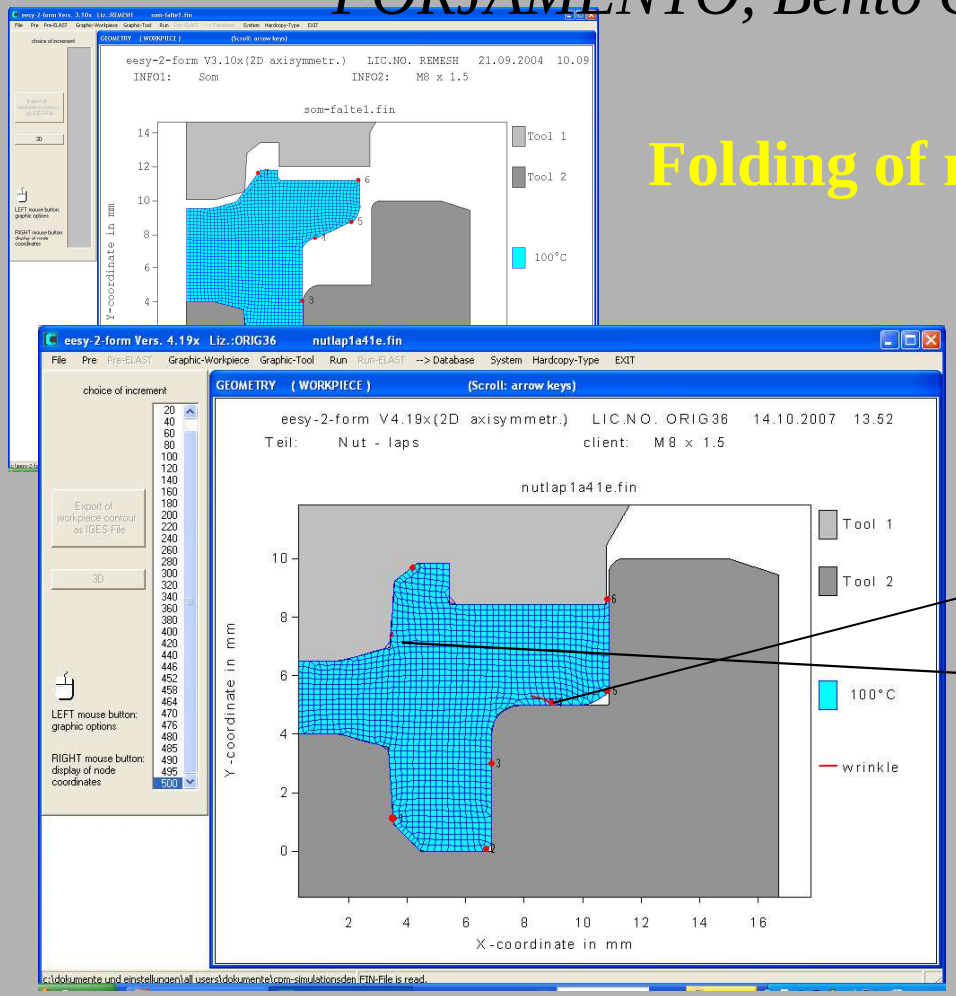
Folding of material

Folding at nut in
- Surface and
- Thread area

18th of October 2007

Modern process engineering –solving difficult tasks

XXVII SENAFOR, XI CONFERENCIA INTERNATIONAL DE FORJAMENTO, Bento Goncalves, RS, Brazil



Folding of material

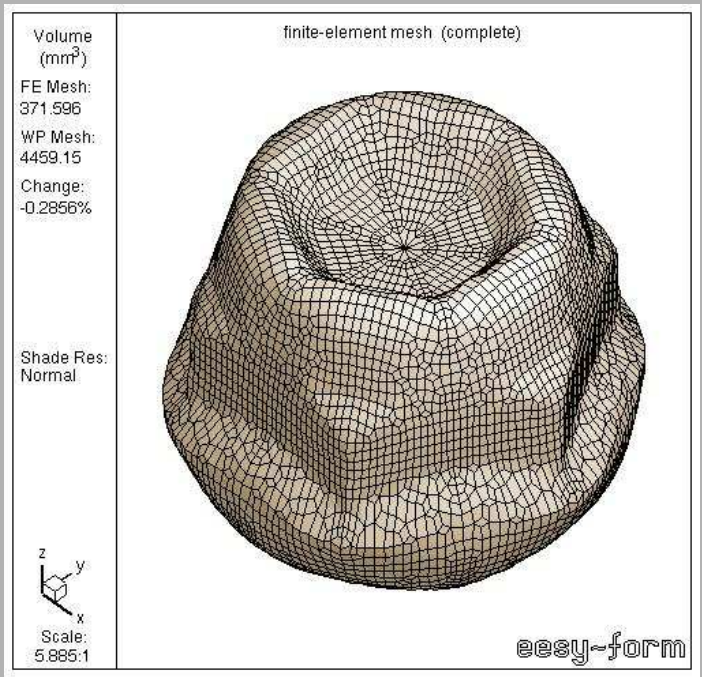
Folding at nut in

- Surface and
- Thread area

Modern process engineering –solving difficult tasks

XXVII SENAFOR, XI CONFERENCIA INTERNATIONAL DE FORJAMENTO, Bento Goncalves, RS, Brazil

Failure of punch because of contact problems

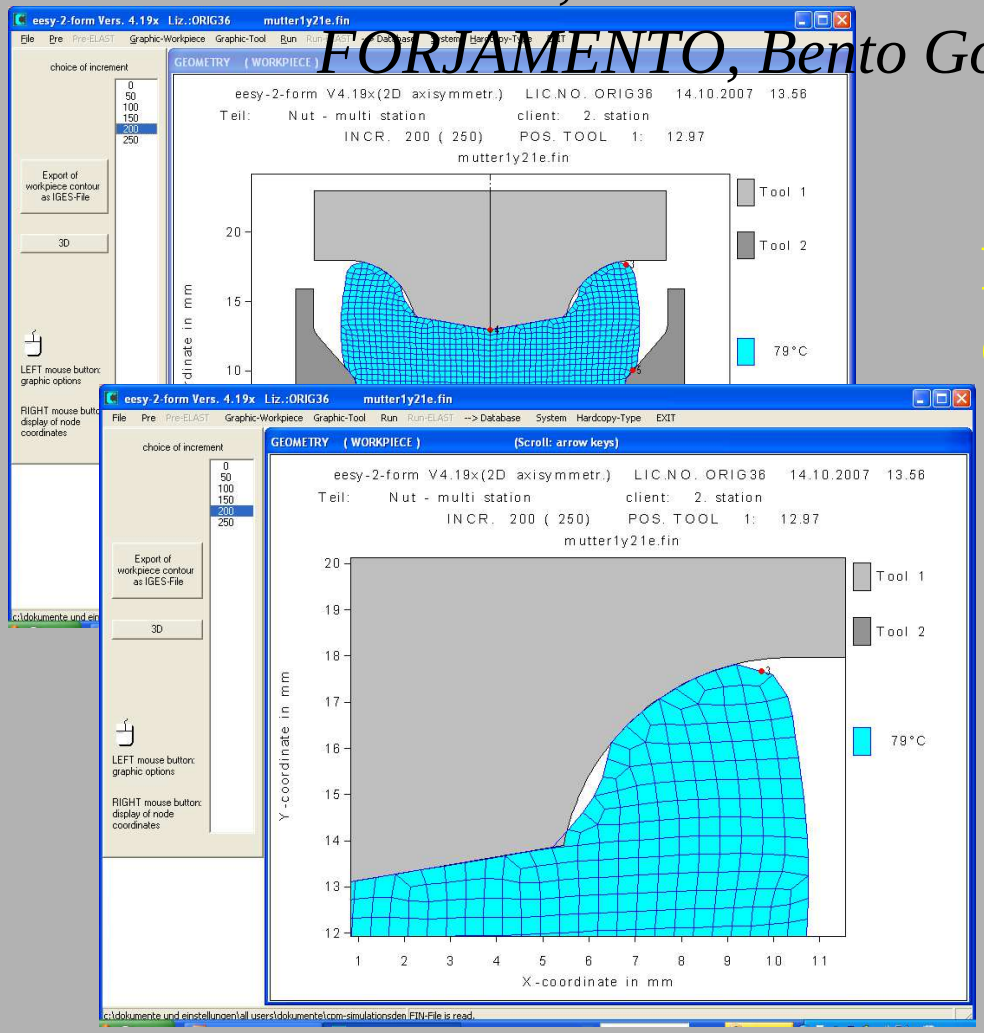


Flansh nut 2nd. Station

18th of October 2007

Modern process engineering –solving difficult tasks

XXVII SENAFOR, XI CONFERENCIA INTERNATIONAL DE FORJAMENTO, Bento Goncalves, RS, Brazil



Failure of punch because of contact problems

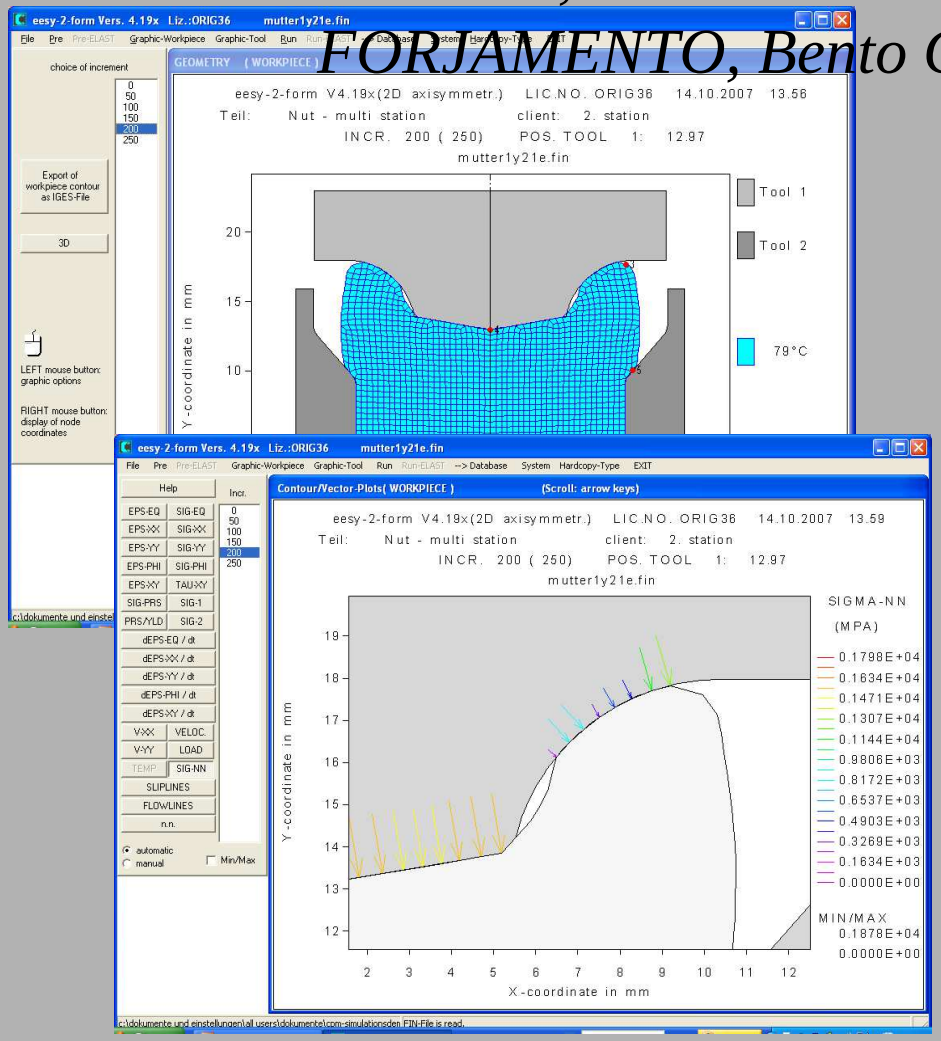
Flansh nut 2nd. Station

Non sufficient contact between punch and material!

18th of October 2007

Modern process engineering –solving difficult tasks

XXVII SENAFOR, XI CONFERENCIA INTERNATIONAL DE FORJAMENTO, Bento Goncalves, RS, Brazil



Failure of punch because of contact problems

Flansh nut 2nd. Station

inhomogeneous stress situation!

Modern process engineering –solving difficult tasks

XXVII SENAFOR, XI CONFERENCIA INTERNATIONAL DE FORJAMENTO, Bento Goncalves, RS, Brazil

Failure of punch because of contact problems

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

18th of October 2007

Modern process engineering –solving difficult tasks

XXVII SENAFOR, XI CONFERENCIA INTERNATIONAL DE FORJAMENTO, Bento Goncalves, RS, Brazil

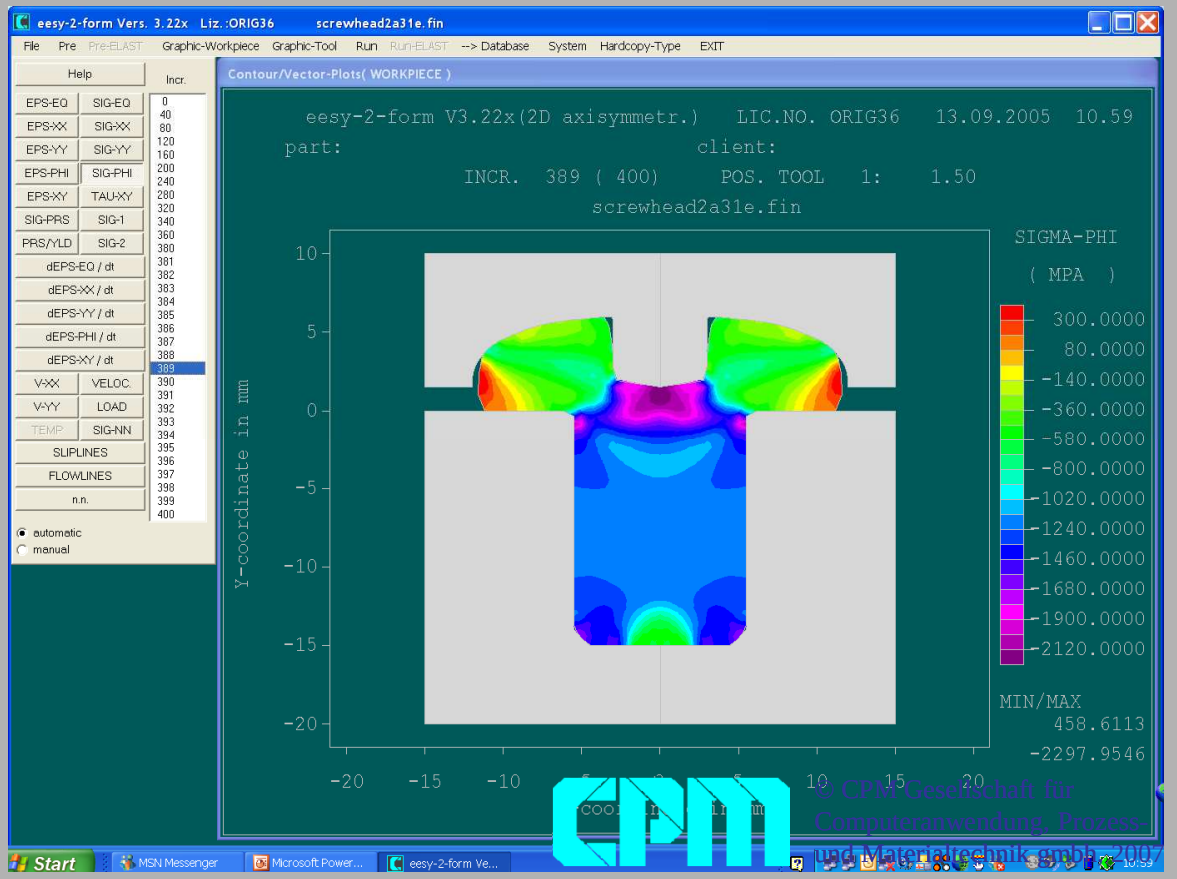
Cracking of a screw head do to tangential stress

18th of October 2007

Modern process engineering –solving difficult tasks

XXVII SENAFOR, XI CONFERENCIA INTERNATIONAL DE FORJAMENTO, Bento Goncalves, RS, Brazil

Cracking of a screw head do to tangential stress



18th of October 2007

Modern process engineering –solving difficult tasks

XXVII SENAFOR, XI CONFERENCIA INTERNATIONAL DE FORJAMENTO, Bento Goncalves, RS, Brazil

Die failure

18th of October 2007

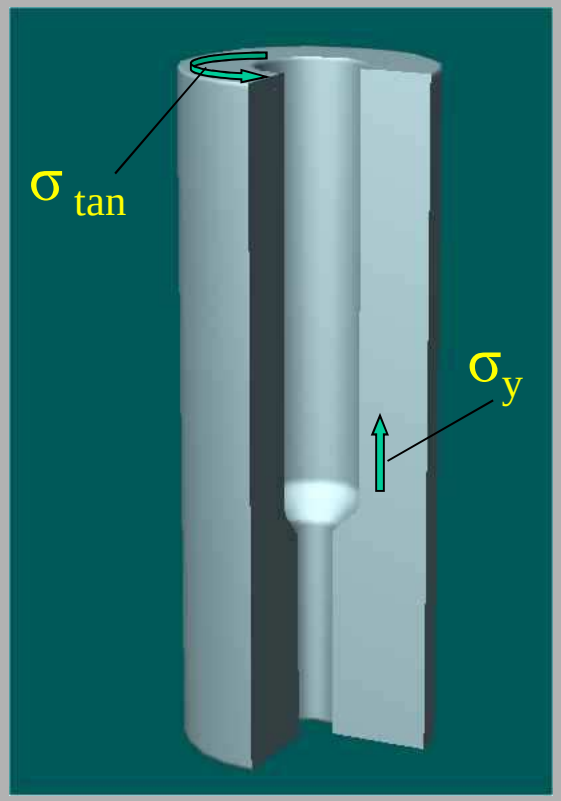
© CPM Gesellschaft für Computeranwendung, Prozess- und Materialtechnik gmbh, 2007

Modern process engineering –solving difficult tasks

XXVII SENAFOR, XI CONFERENCIA INTERNATIONAL DE FORJAMENTO, Bento Goncalves, RS, Brazil

Die failure

18th of October 2007

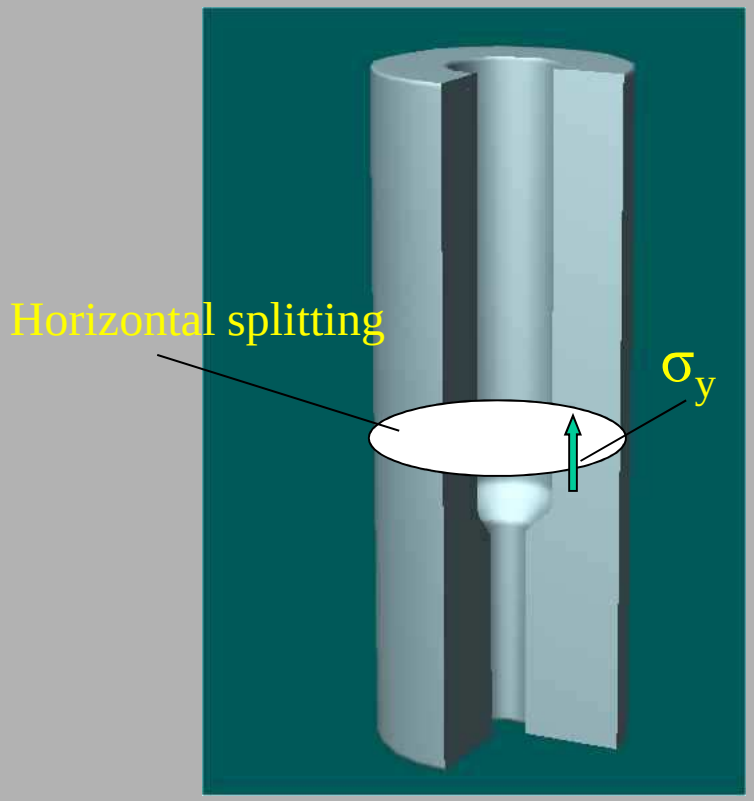


Die failure

Principle of Die Design

σ_{tan}: critical for axial crack

σ_y: critical for horizontal crack

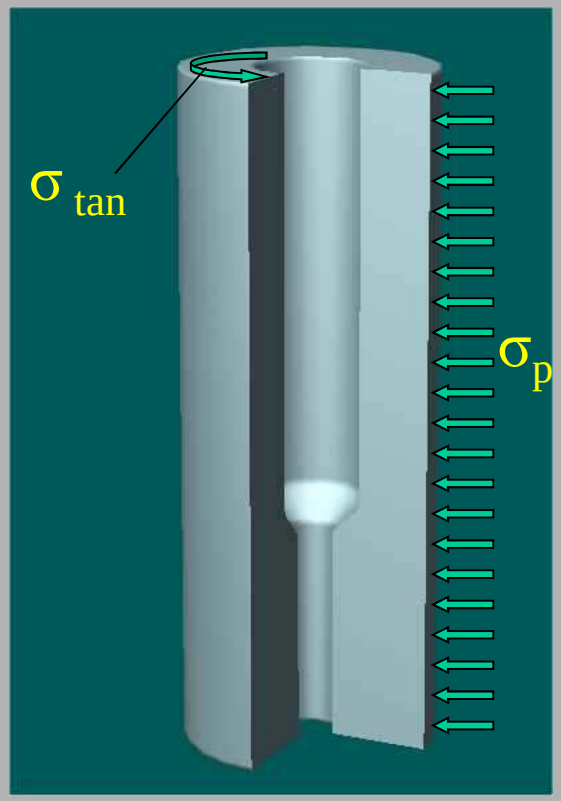


Die failure

Principle of Die Design

σ_y: critical for horizontal crack

⇒ horizontal split of the insert



Die failure

Principle of Die Design

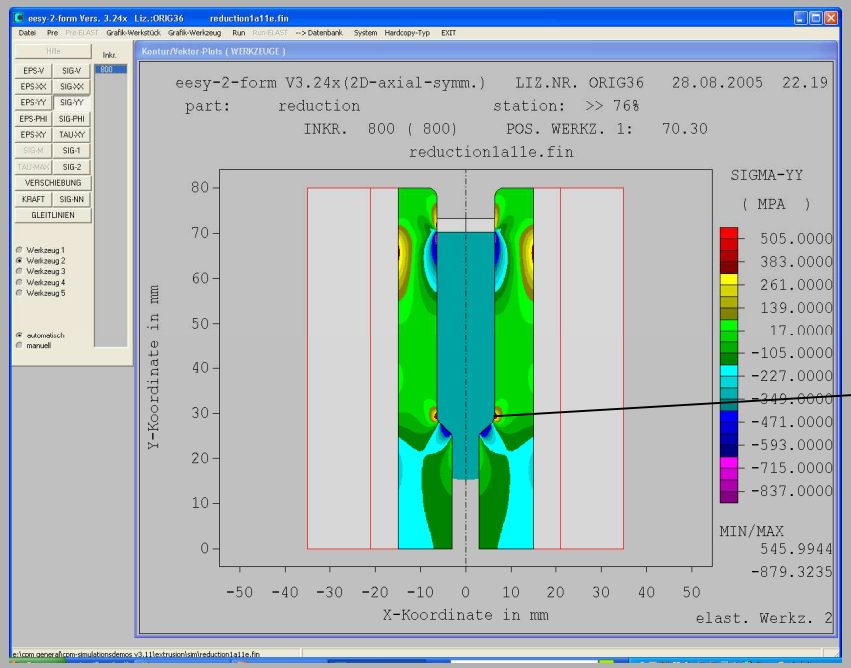
σ_{tan}: critical for axial crack

➡ Pre-stressing of the insert

Modern process engineering –solving difficult tasks

XXVII SENAFOR, XI CONFERENCIA INTERNATIONAL DE FORJAMENTO, Bento Goncalves, RS, Brazil

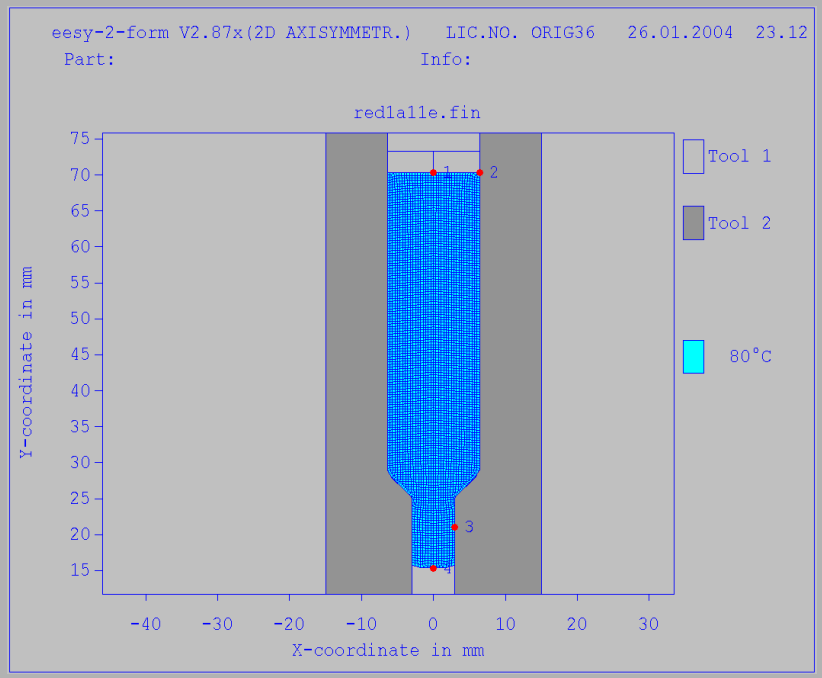
Die failure



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

Modern process engineering –solving difficult tasks

XXVII SENAFOR, XI CONFERENCIA INTERNATIONAL DE FORJAMENTO, Bento Goncalves, RS, Brazil



Die design

Pre-straining of dies

to avoid axial die breakage

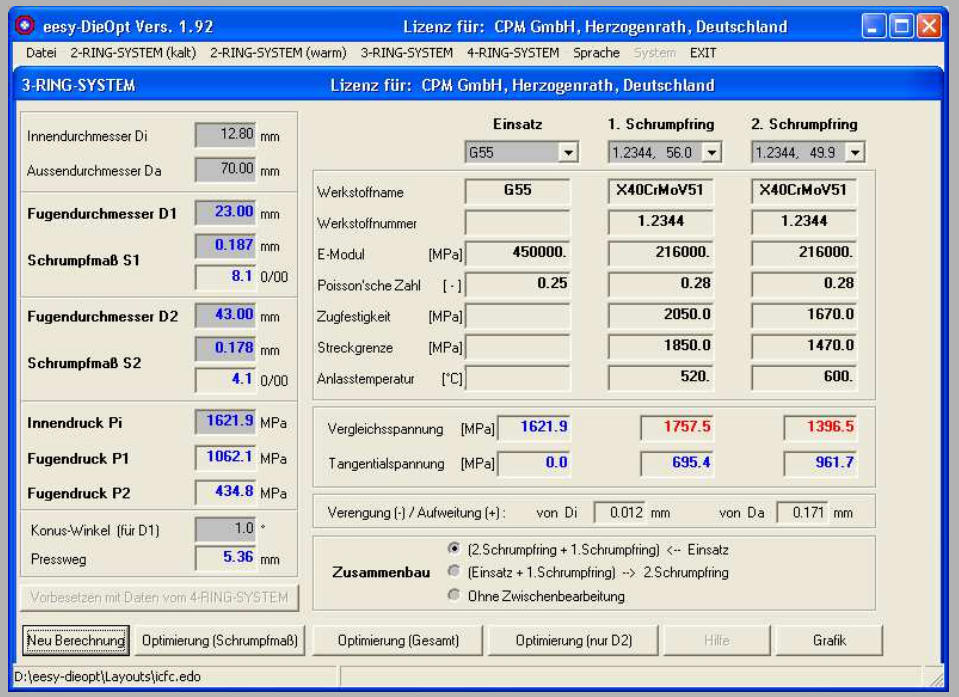
18th of October 2007

Modern process engineering –solving difficult tasks

XXVII SENAFOR, XI CONFERENCIA INTERNATIONAL DE FORJAMENTO, Bento Goncalves, RS, Brazil

Die design

Calculation of Die Layout



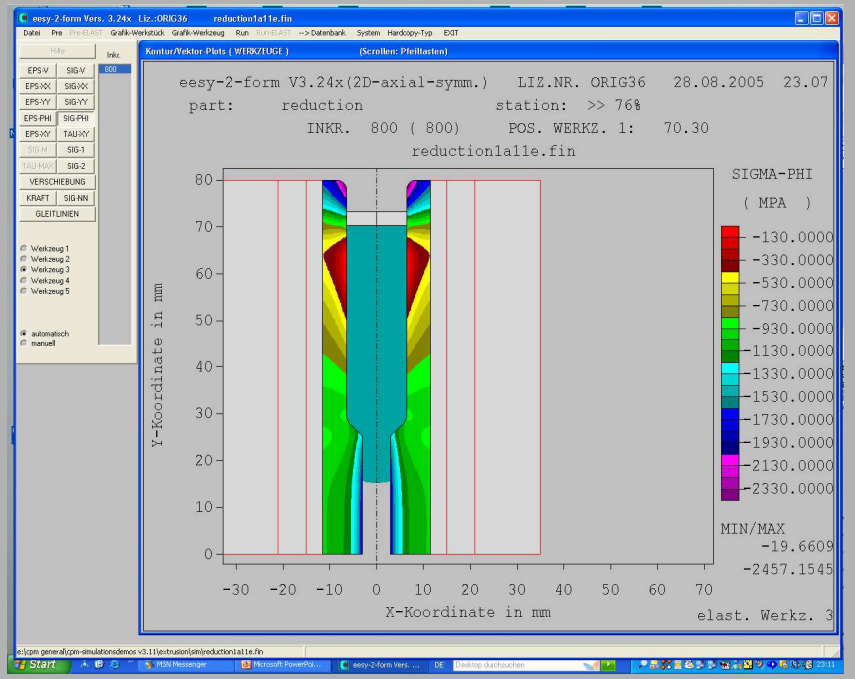
18th of October 2007

Modern process engineering –solving difficult tasks

XXVII SENAFOR, XI CONFERENCIA INTERNATIONAL DE FORJAMENTO, Bento Goncalves, RS, Brazil

Die design

The stress distribution in an insert with pre straining optimisation



18th of October 2007

Modern process engineering –solving difficult tasks

XXVII SENAFOR, XI CONFERENCIA INTERNATIONAL DE FORJAMENTO, Bento Goncalves, RS, Brazil

Punch die to form torx recesses.

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

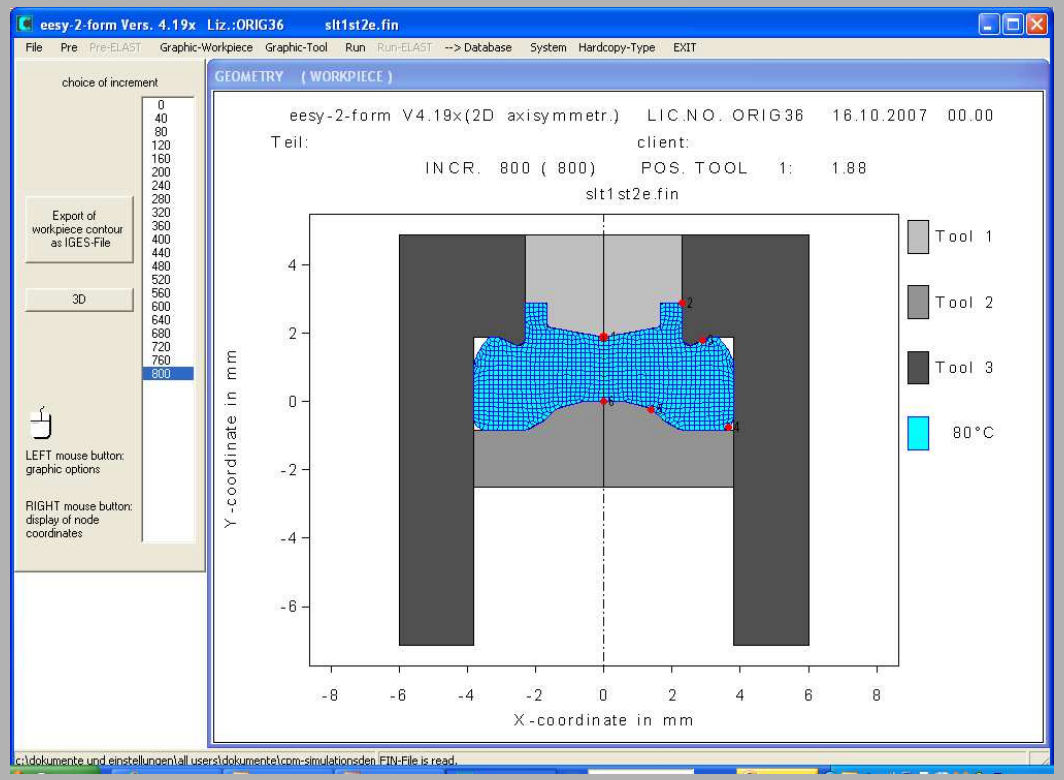
18th of October 2007

Modern process engineering –solving difficult tasks

XXVII SENAFOR, XI CONFERENCIA INTERNATIONAL DE FORJAMENTO, Bento Goncalves, RS, Brazil

Forming station with spring loaded die

Layout of the spring loaded die system for a complex operation



18th of October 2007

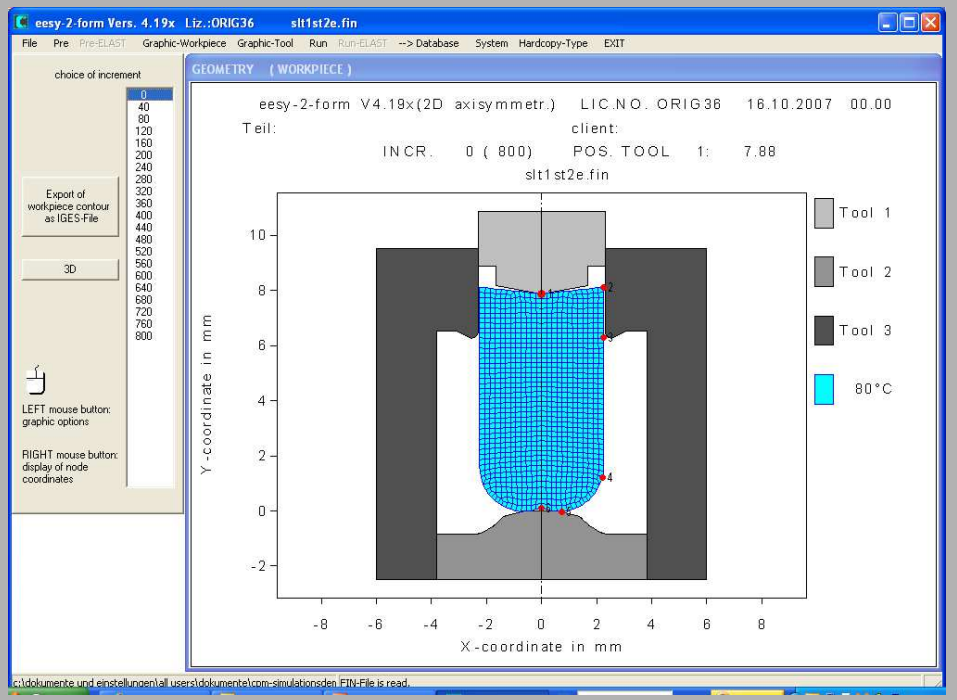
Modern process engineering –solving difficult tasks

XXVII SENAFOR, XI CONFERENCIA INTERNATIONAL DE FORJAMENTO, Bento Goncalves, RS, Brazil

Forming station with spring loaded die

Layout of the spring loaded die system for a complex operation

Initial position



18th of October 2007

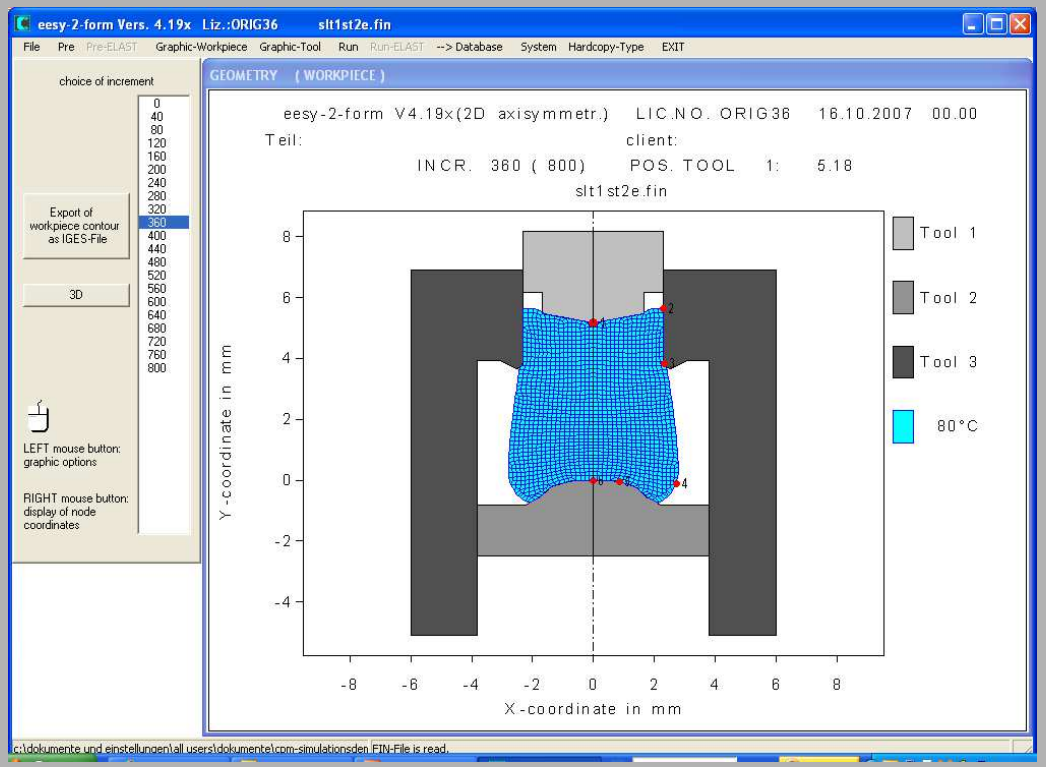
Modern process engineering –solving difficult tasks

XXVII SENAFOR, XI CONFERENCIA INTERNATIONAL DE FORJAMENTO, Bento Goncalves, RS, Brazil

Forming station with spring loaded die

Layout of the spring loaded die system for a complex operation

Die starting to slide



18th of October 2007

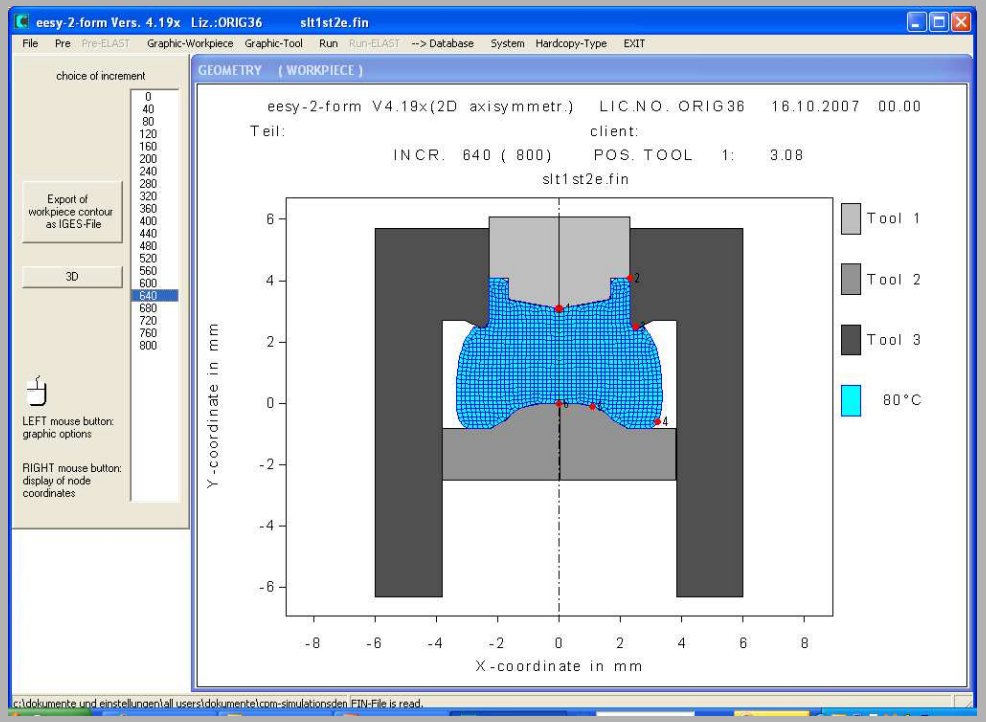
Modern process engineering –solving difficult tasks

XXVII SENAFOR, XI CONFERENCIA INTERNATIONAL DE FORJAMENTO, Bento Goncalves, RS, Brazil

Forming station with spring loaded die

Layout of the spring loaded die system for a complex operation

Die sliding



18th of October 2007

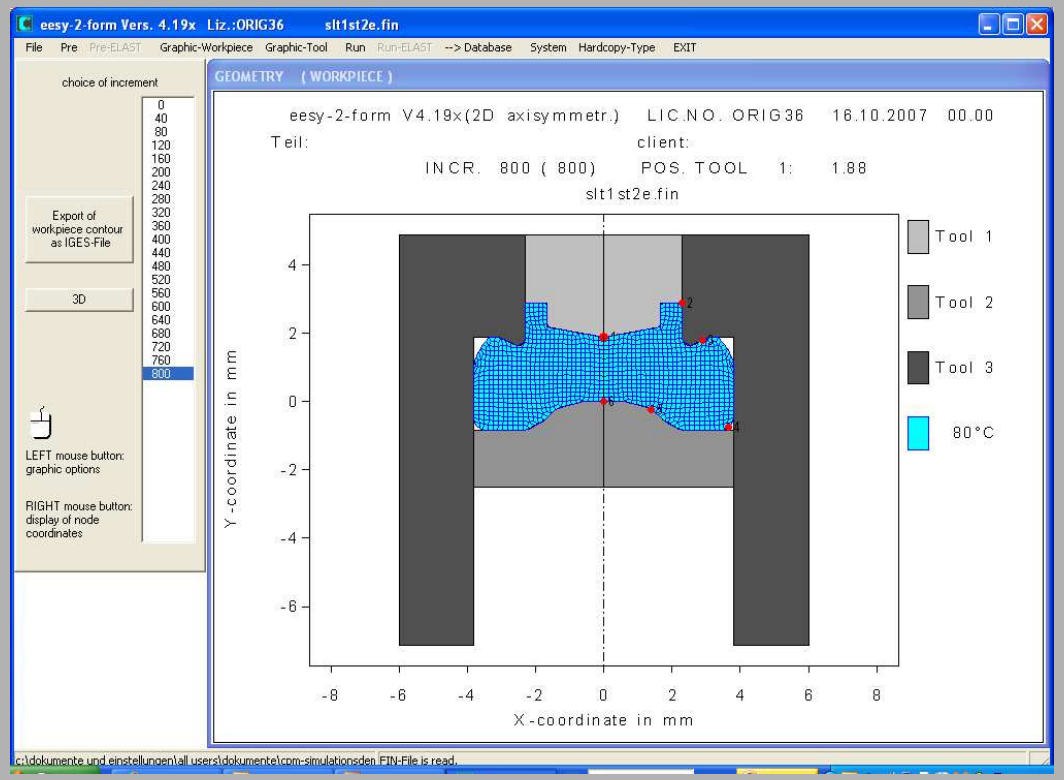
Modern process engineering –solving difficult tasks

XXVII SENAFOR, XI CONFERENCIA INTERNATIONAL DE FORJAMENTO, Bento Goncalves, RS, Brazil

Forming station with spring loaded die

Layout of the spring loaded die system for a complex operation

Final position



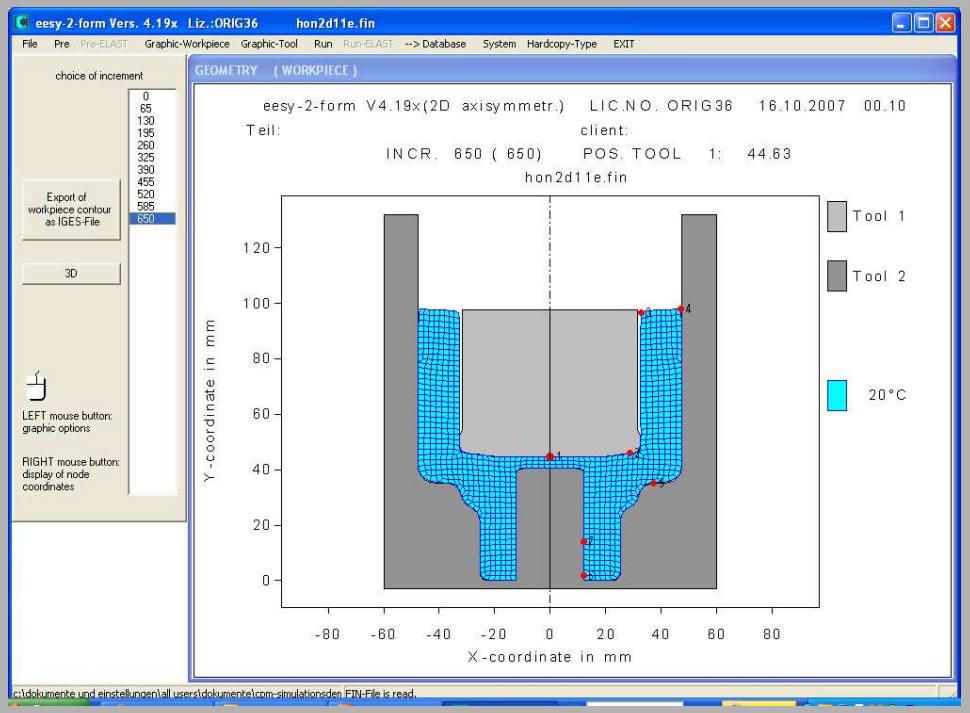
18th of October 2007

Modern process engineering –solving difficult tasks

XXVII SENAFOR, XI CONFERENCIA INTERNATIONAL DE FORJAMENTO, Bento Goncalves, RS, Brazil

Difficult tool design for a combined forward and backward extrusion

Extream deformations during extrusion with tight tolerances



18th of October 2007

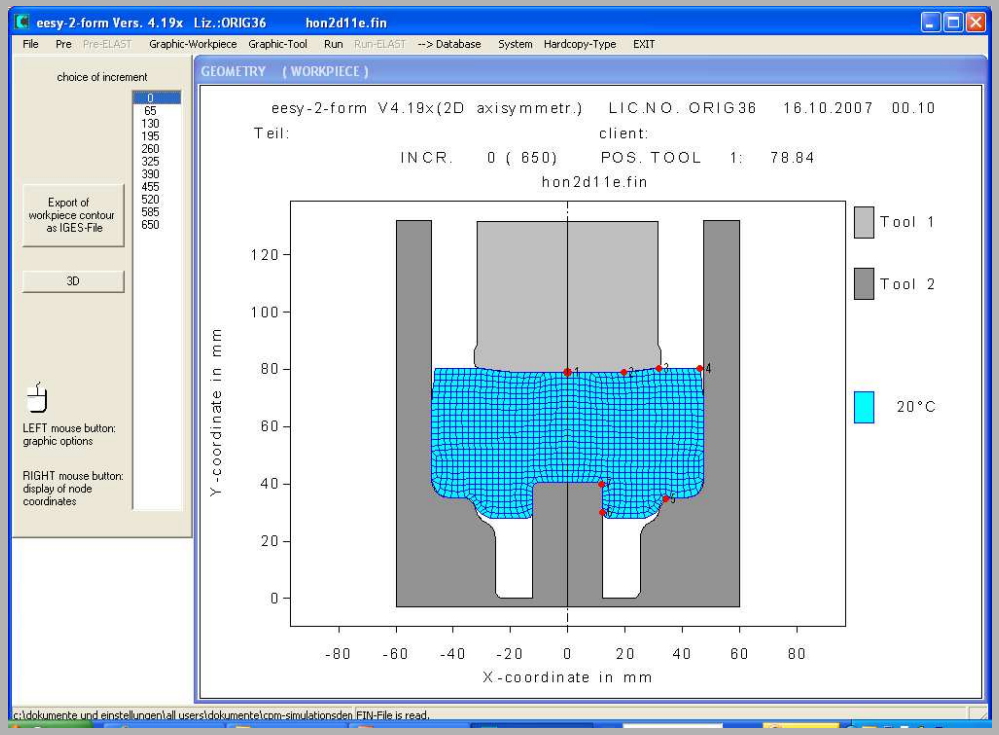
Modern process engineering –solving difficult tasks

XXVII SENAFOR, XI CONFERENCIA INTERNATIONAL DE FORJAMENTO, Bento Goncalves, RS, Brazil

Difficult tool design for a combined forward and backward extrusion

Extream deformations during extrusion with tight tolerances

Initial position



18th of October 2007

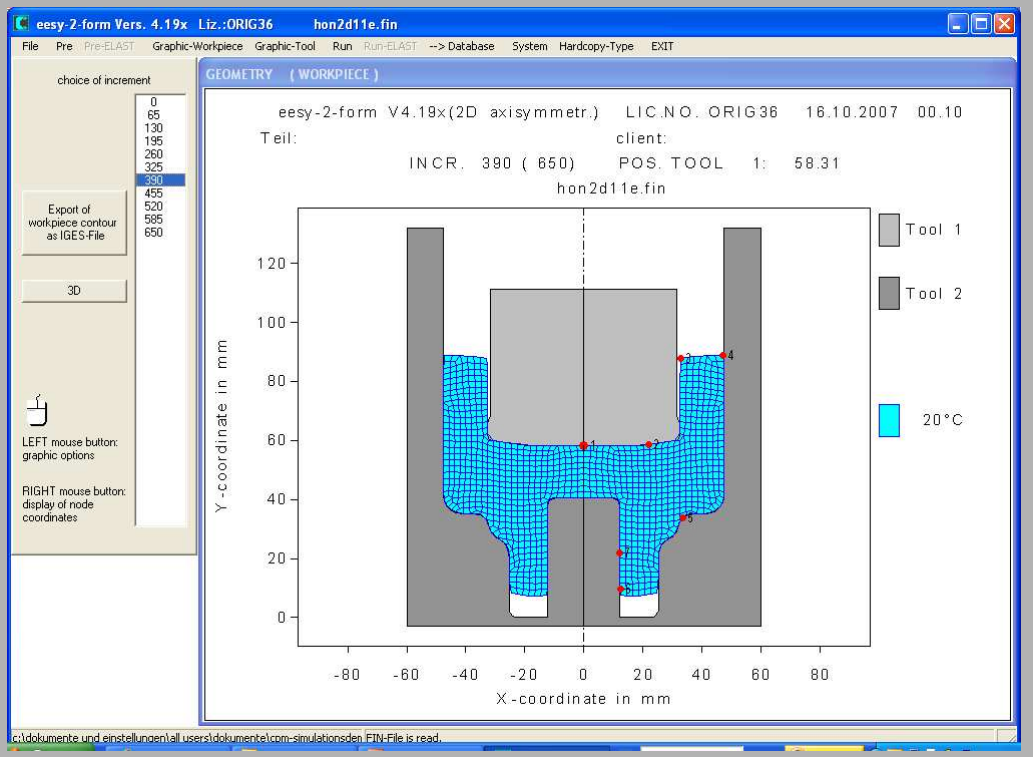
Modern process engineering –solving difficult tasks

XXVII SENAFOR, XI CONFERENCIA INTERNATIONAL DE FORJAMENTO, Bento Goncalves, RS, Brazil

Difficult tool design for a combined forward and backward extrusion

Extream deformations during extrusion with tight tolerances

intermediate position



18th of October 2007

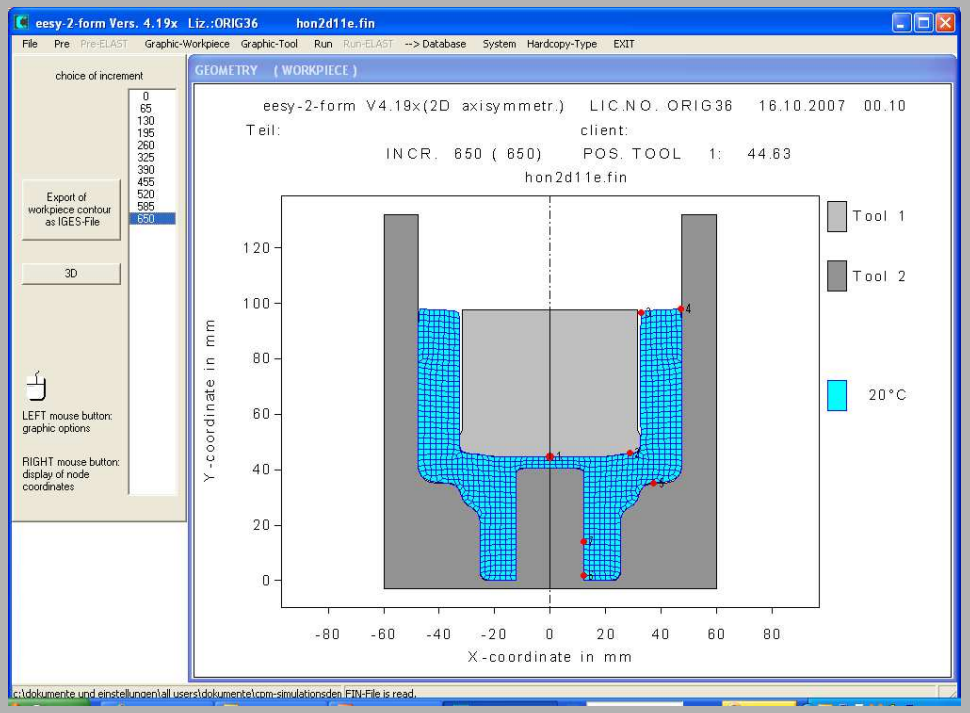
Modern process engineering –solving difficult tasks

XXVII SENAFOR, XI CONFERENCIA INTERNATIONAL DE FORJAMENTO, Bento Goncalves, RS, Brazil

Difficult tool design for a combined forward and backward extrusion

Extream deformations during extrusion with tight tolerances

Final position

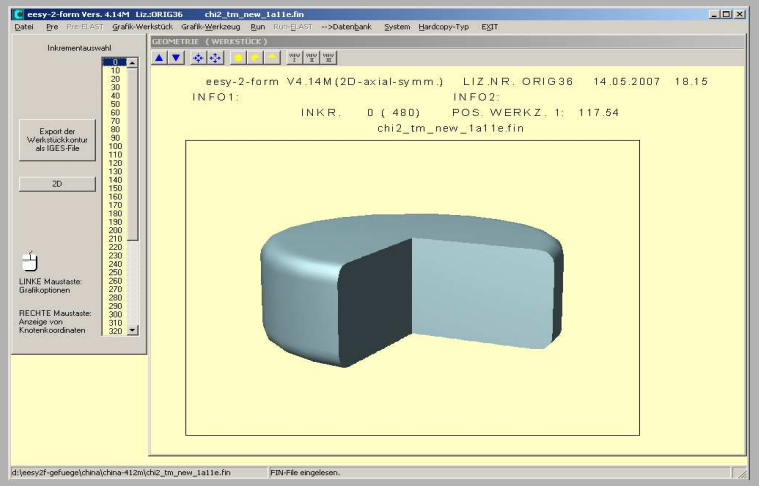


18th of October 2007

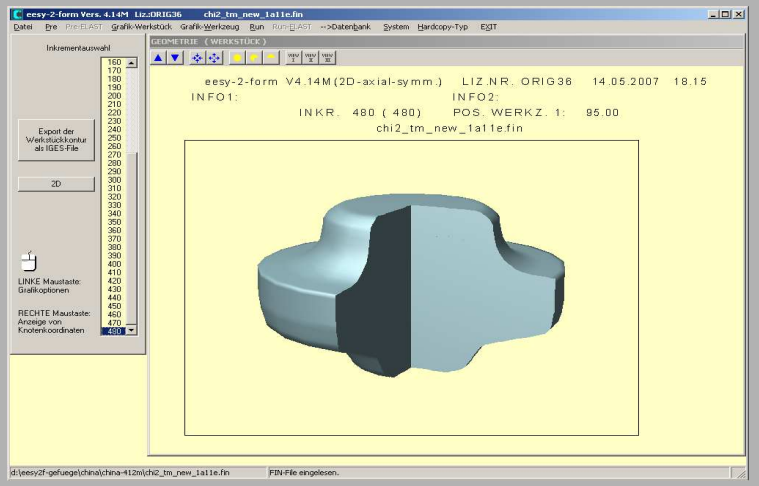
Modern process engineering –solving difficult tasks

XXVII SENAFOR, XI CONFERENCIA INTERNATIONAL DE FORJAMENTO, Bento Goncalves, RS, Brazil

Microstructure prediction in forging



Initial blank



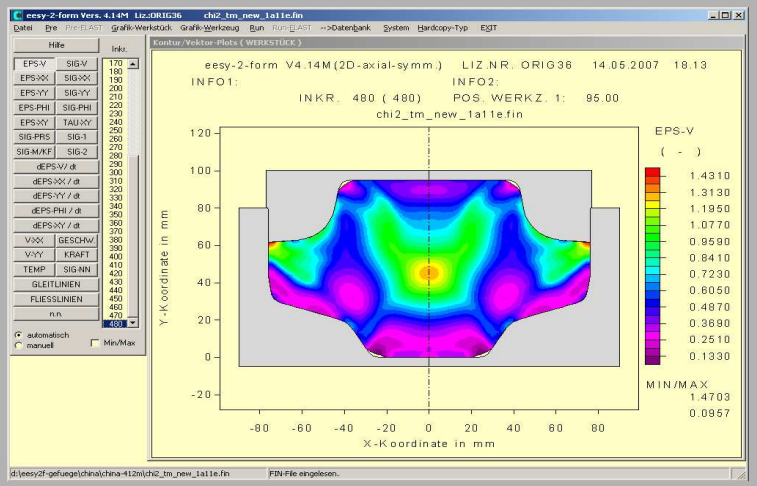
Final shape

18th of October 2007

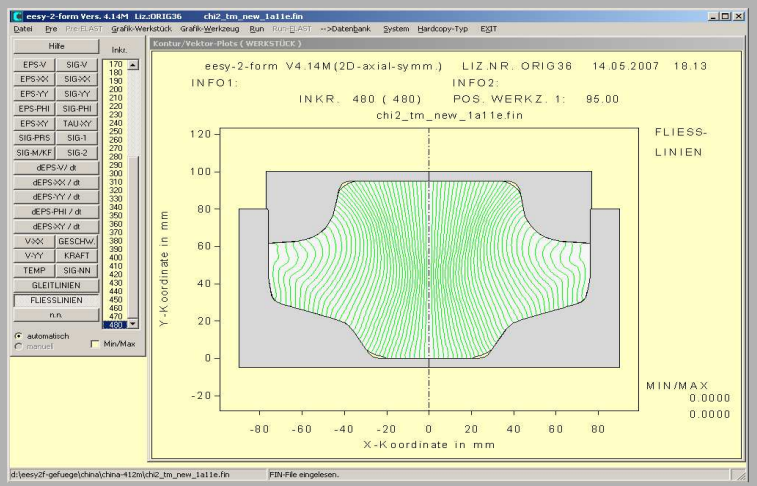
Modern process engineering –solving difficult tasks

XXVII SENAFOR, XI CONFERENCIA INTERNATIONAL DE FORJAMENTO, Bento Goncalves, RS, Brazil

Microstructure prediction in forging



Distribution of strain



Fibre distribution

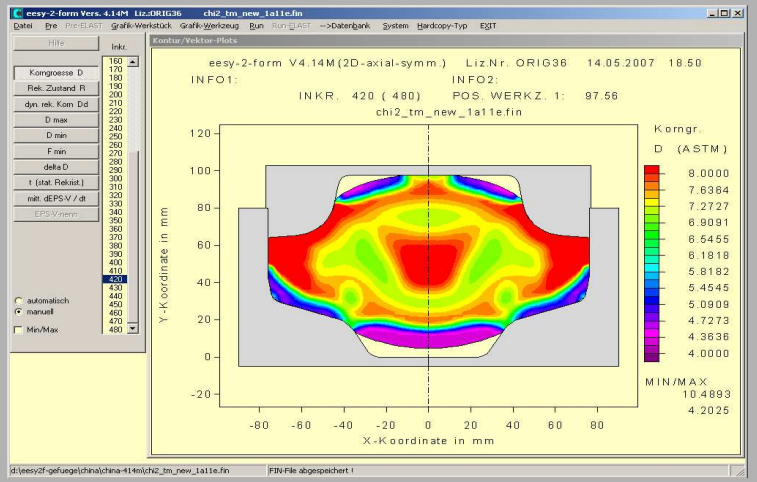
18th of October 2007

Modern process engineering –solving difficult tasks

XXVII SENAFOR, XI CONFERENCIA INTERNATIONAL DE FORJAMENTO, Bento Goncalves, RS, Brazil

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

18th of October 2007

Modern process engineering –solving difficult tasks

XXVII SENAFOR, XI CONFERENCIA INTERNATIONAL DE FORJAMENTO, Bento Goncalves, RS, Brazil

Conclusion

18th of October 2007

Modern process engineering –solving difficult tasks

XXVII SENAFOR, XI CONFERENCIA INTERNATIONAL DE FORJAMENTO, Bento Goncalves, RS, Brazil

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.

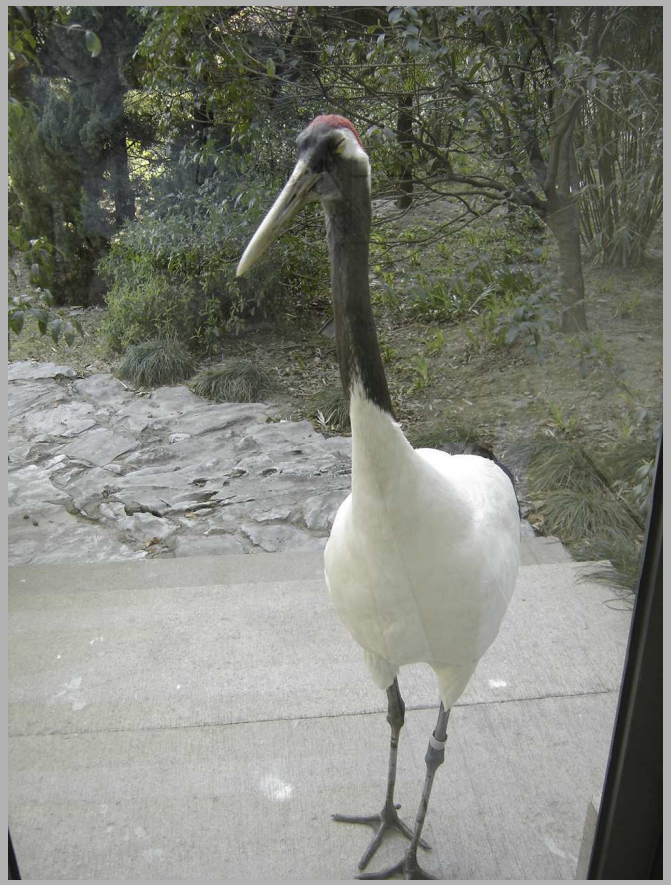
Simulation is generally established as a design tool.

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

18th of October 2007

Modern process engineering –solving difficult tasks

XXVII SENAFOR, XI CONFERENCIA INTERNATIONAL DE FORJAMENTO, Bento Goncalves, RS, Brazil



Thank you for your attention !

Like this bird knocking at my door at a Chineese Hotel in the early morning……

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

18th of October 2007