Engineering Approach to use a Hybrid Simulation System for Process and Tool Design
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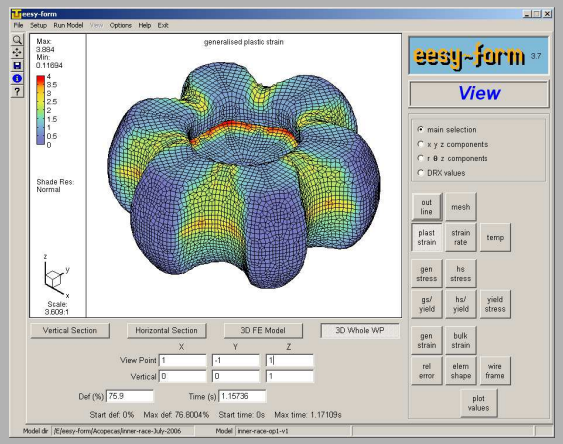
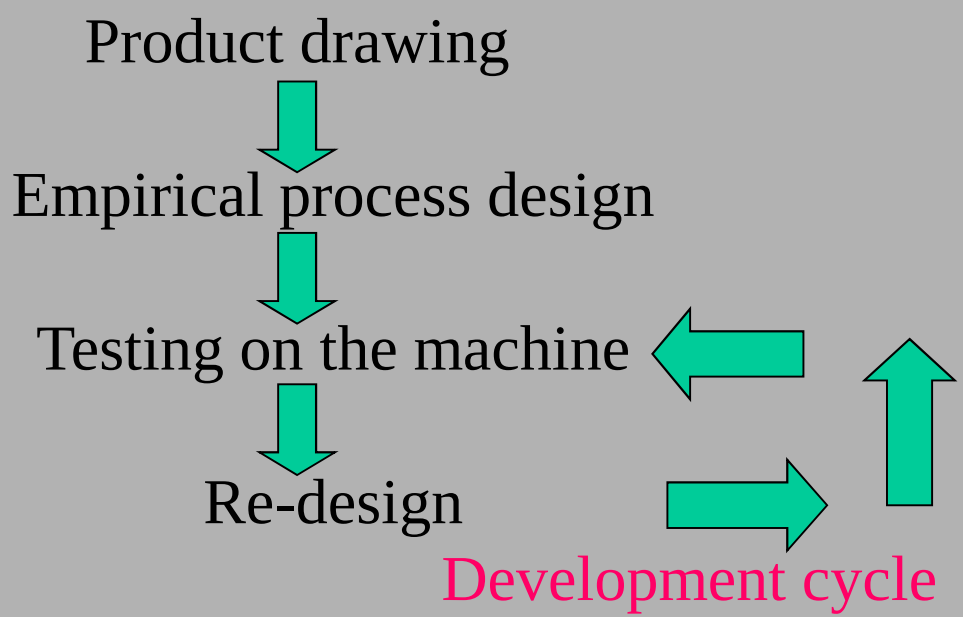
Engineering Approach to use a Hybrid Simulation System for Process and Tool Design

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

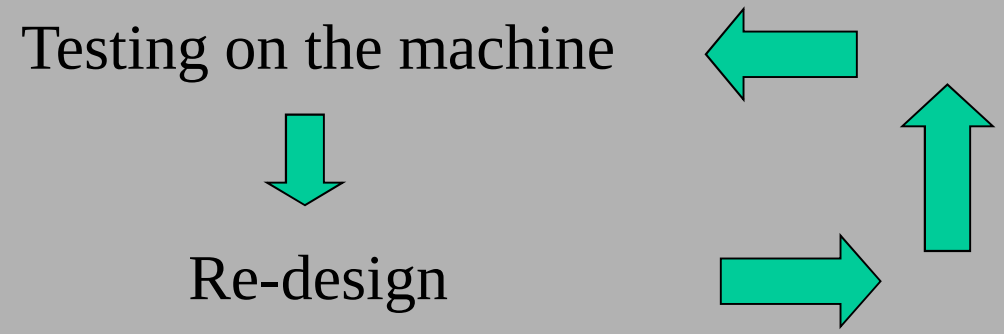


Principle of Process Design Work



Principle of Process Design Work

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



Development cycle

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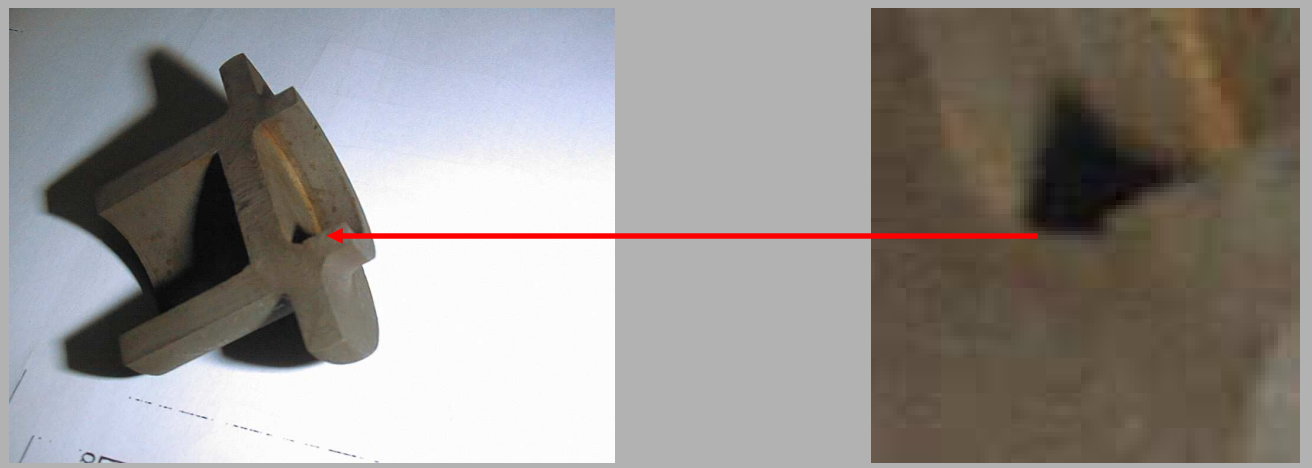
Application of FEM in Process Design

Typical geom. failures in Process Design
Prediction of cracks in a part
Analysis of tool failure

19th of October 2006

Typical geom. failures in Process Design
- Folding -



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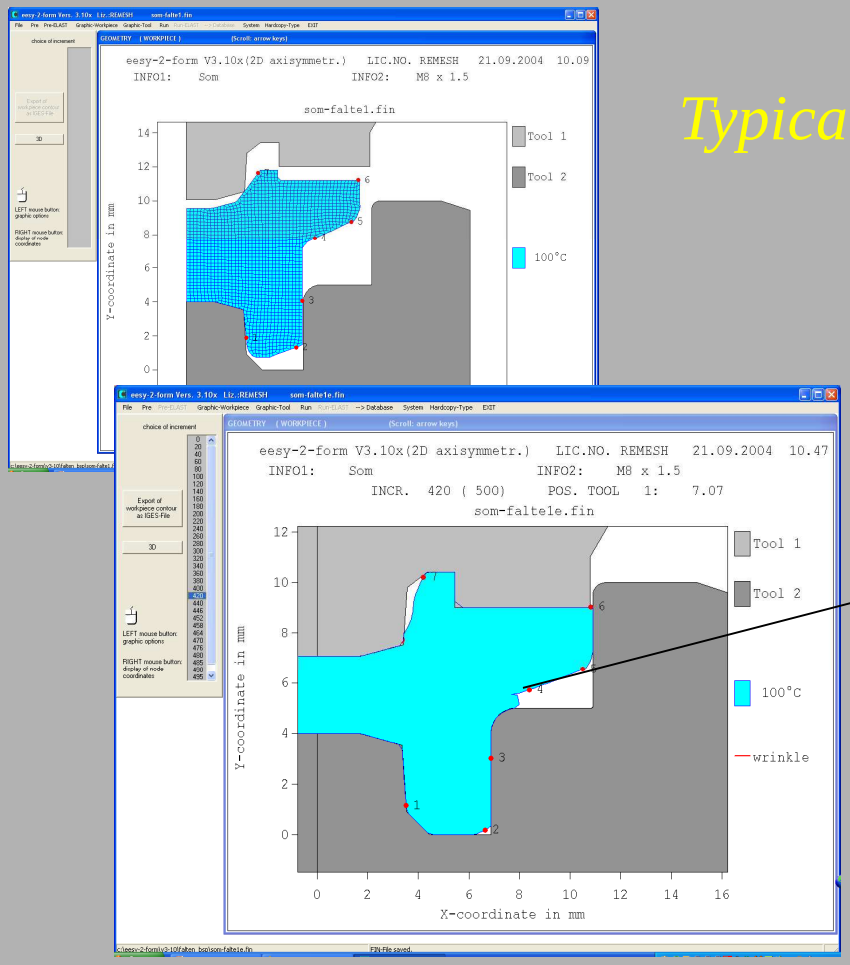

Typical geom. failures in Process Design

Folding at the part Surface

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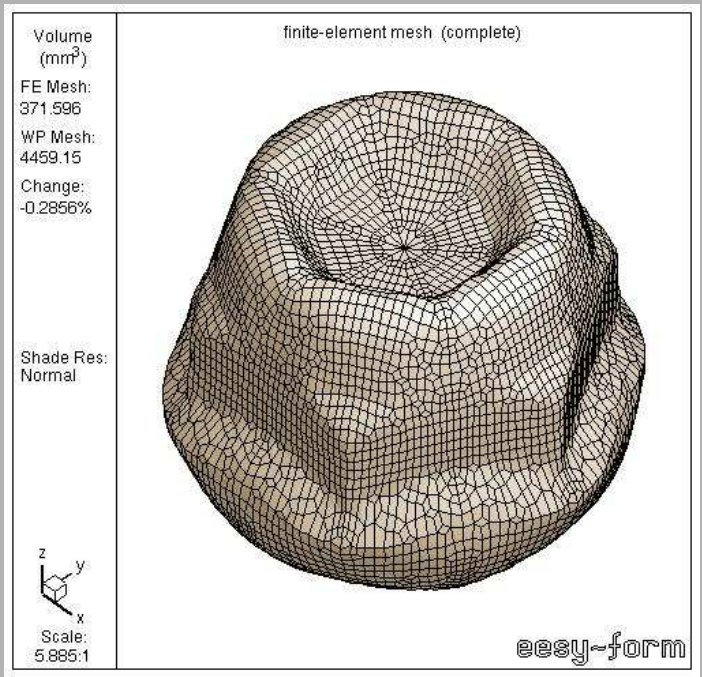
Typical geom. failures in Process Design



Filling

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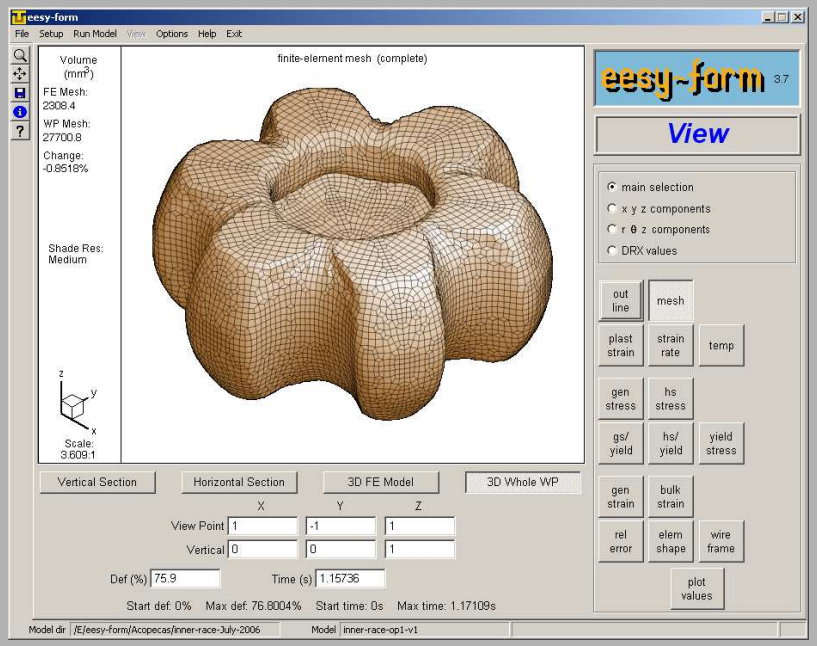
Typical geom. failures in Process Design



Folding / Filling

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Prediction of cracks in a part

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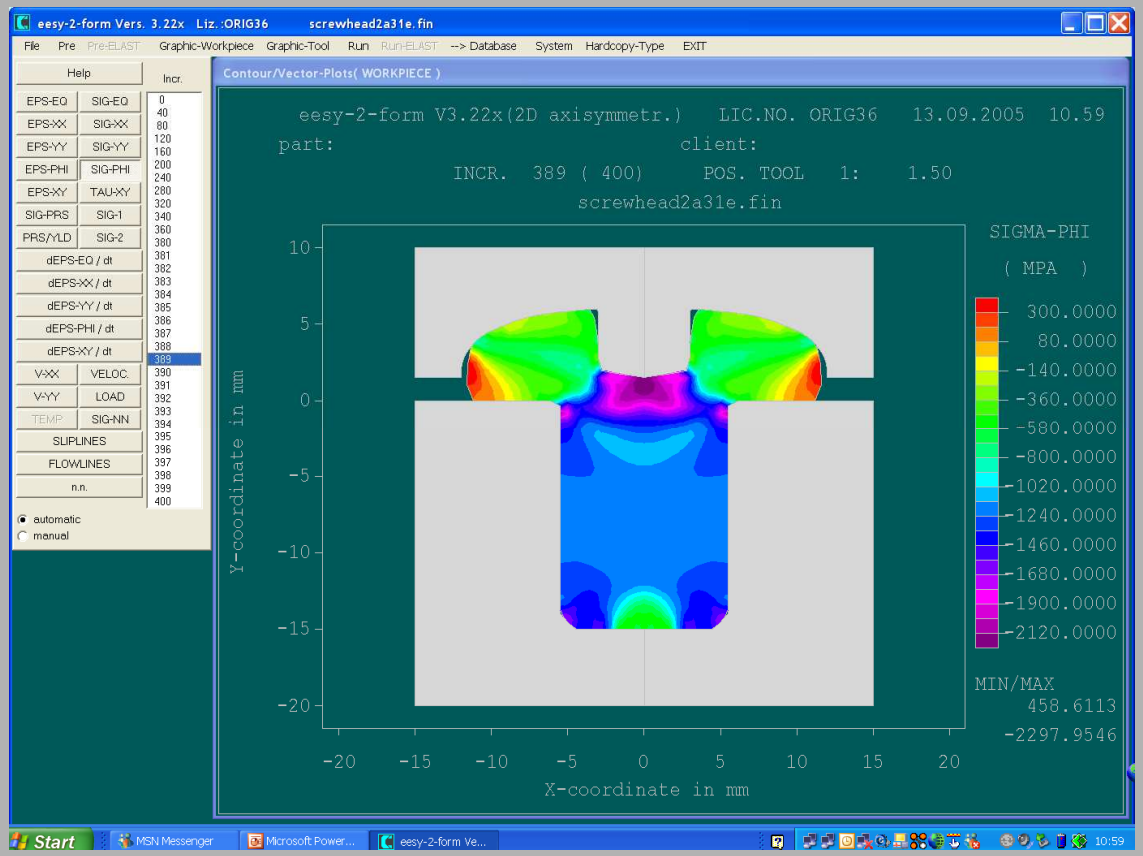

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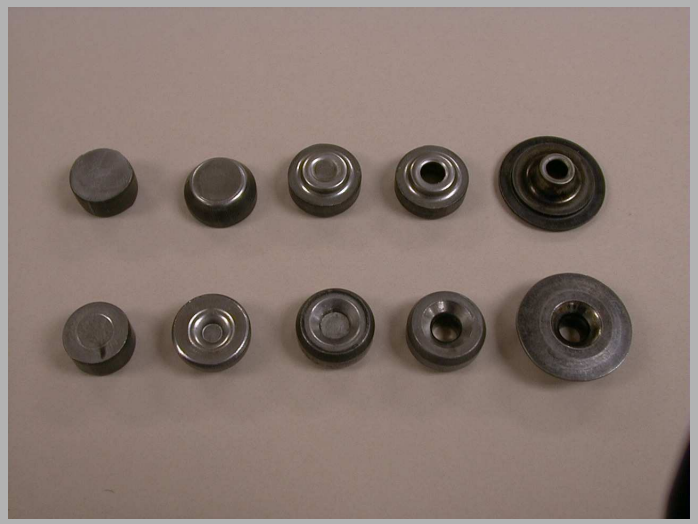
Analysis of tool failure



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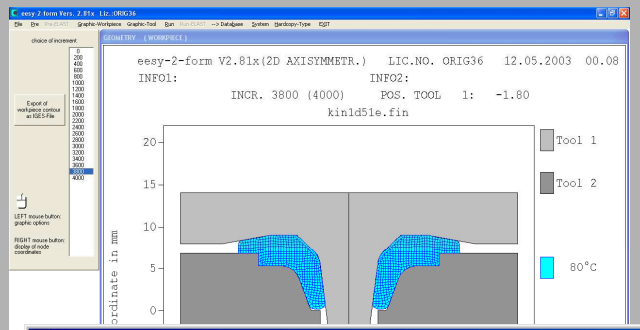
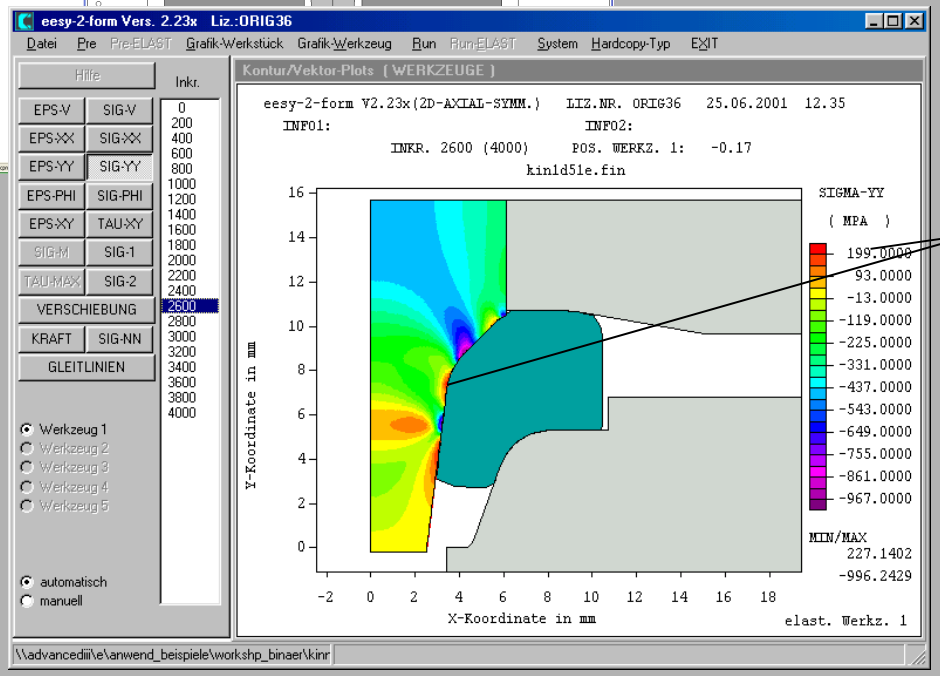
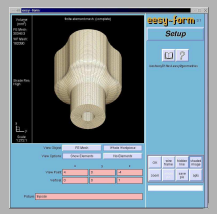




- Avoiding of failures

Failure of a punch

wrong pre-form design



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Analysis of tool failure

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Analysis of tool failure

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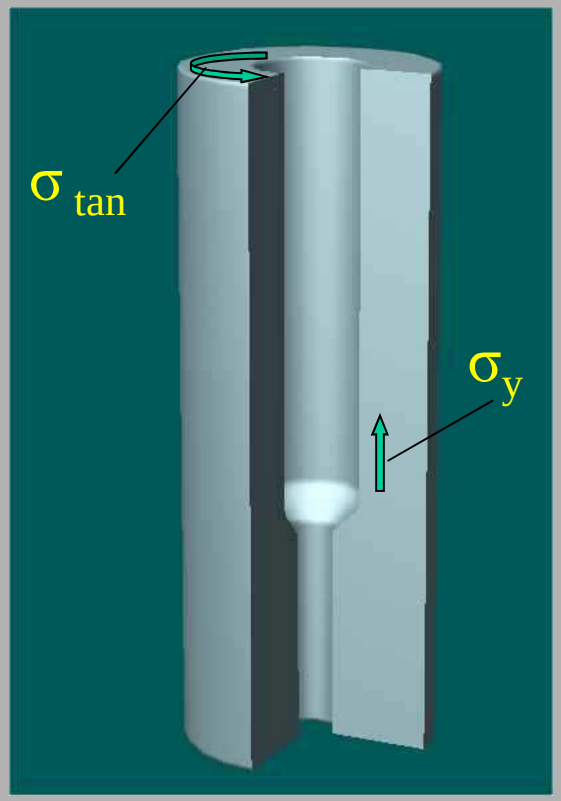
Analysis of tool failure

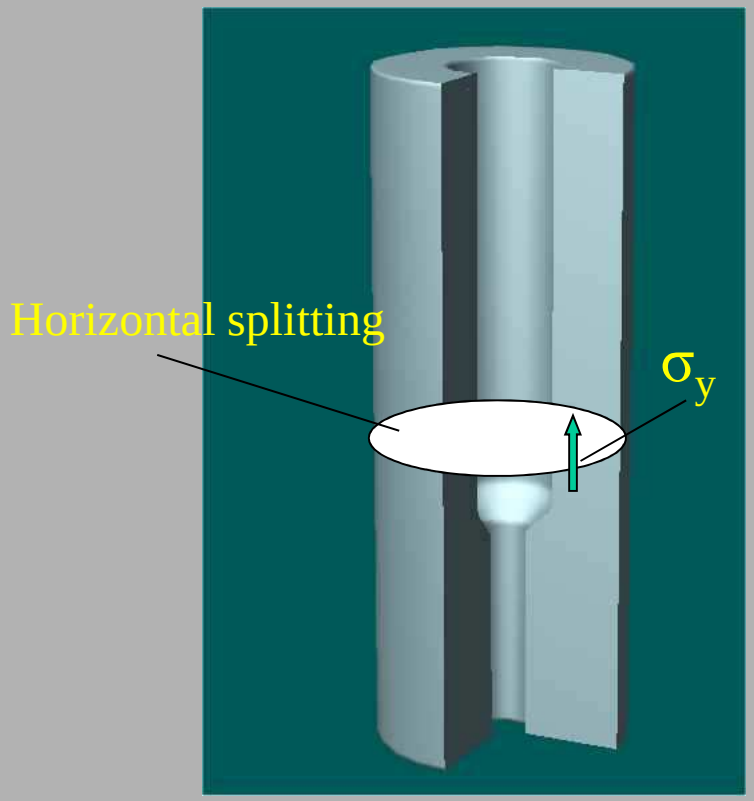
19th of October 2006



Principle of Die Design

σ_{tan}: critical for axial crack

σ_y: critical for horizontal crack



Principle of Die Design

σ_y: critical for horizontal crack

➡ horizontal split of the insert

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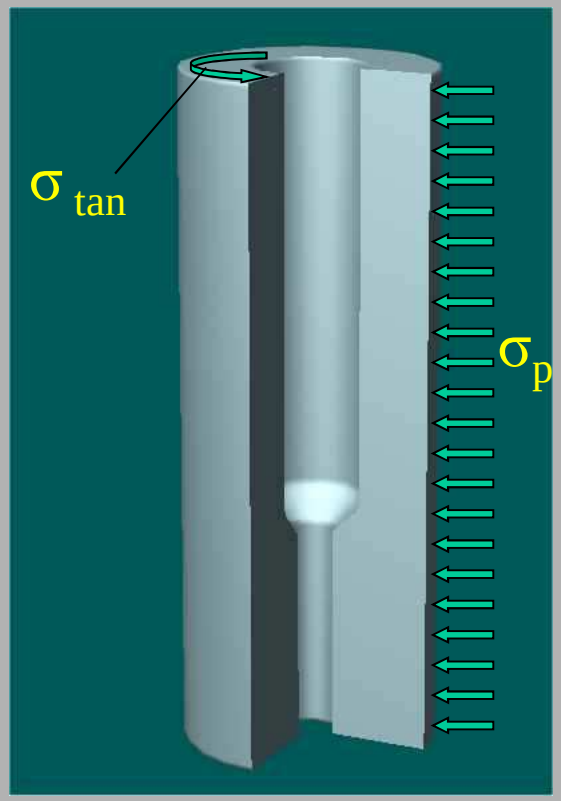

Principle of Die Design

σ_{tan}: critical for axial crack

➡ Pre-stressing of the insert

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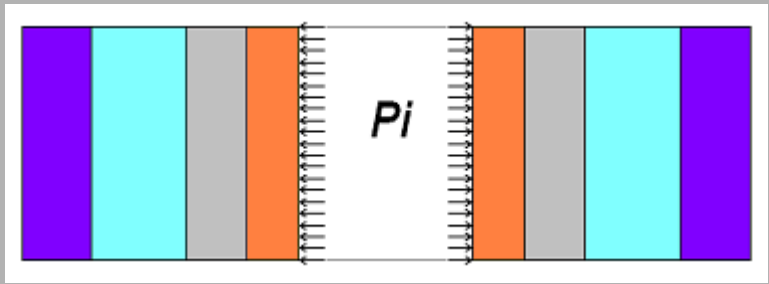
Die Design using a simplified approach

Principle



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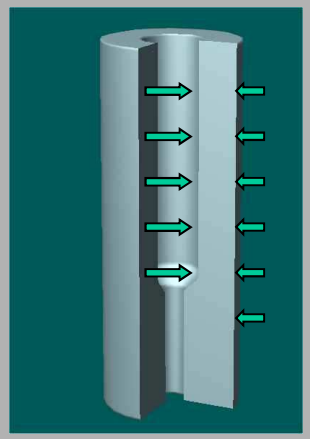
Die Design using a simplified approach

Principle



Simplified Methode

Pre-stress = f (P_i = const.; d_i = const; ...)

P_i – inner pressure, d_i – inner diameter

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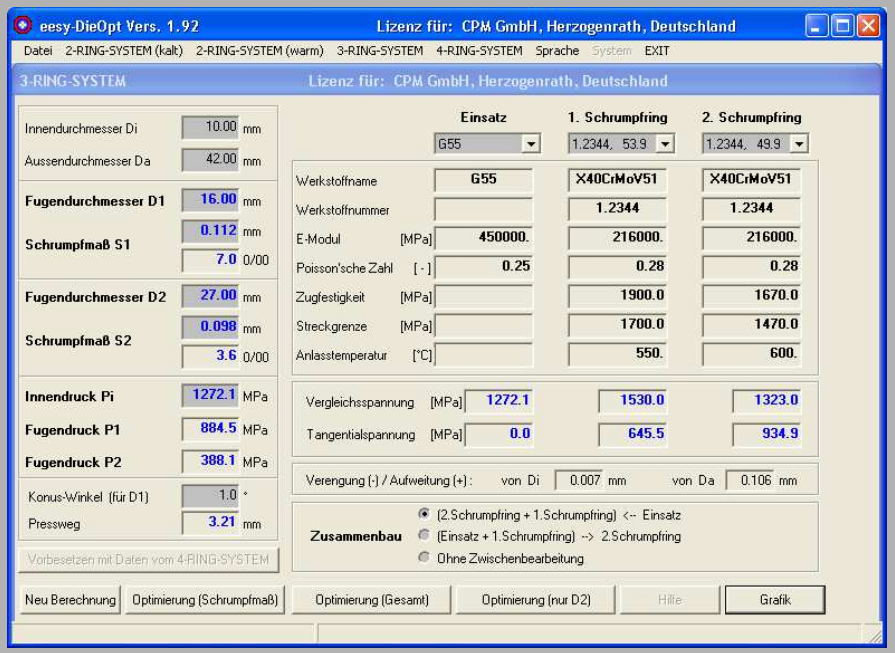
Die Design using a simplified approach

Application



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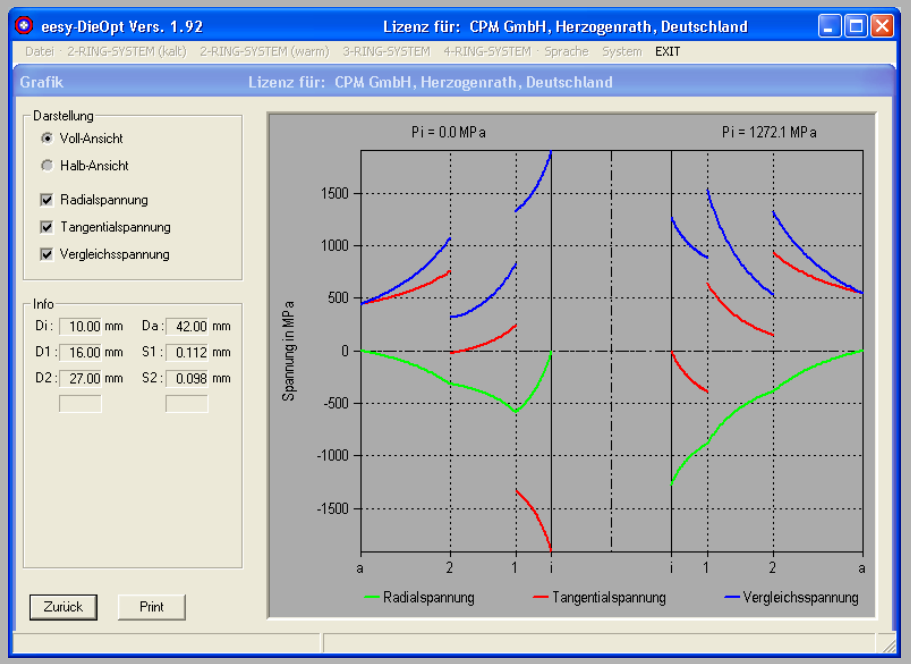
Die Design using a simplified approach

Application



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Using FEM and Die Design Software together

Tool analysis (insert) by FEM

Pre – stressing system layout with analytical methode

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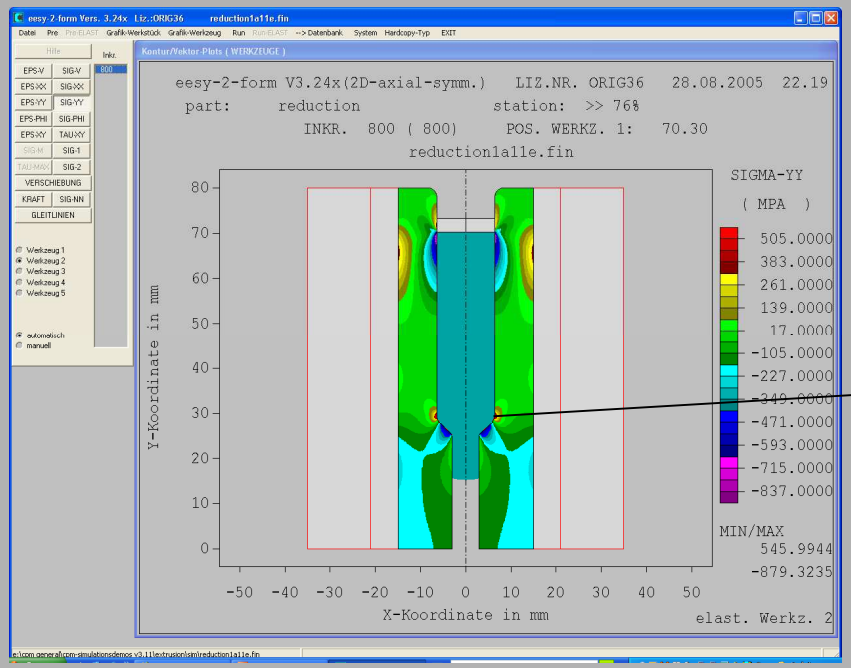
Using FEM and Die Design Software together



- Avoiding of failures (elastic analysis of the insert with FEM)

Splitting of the die due to high axial stresses

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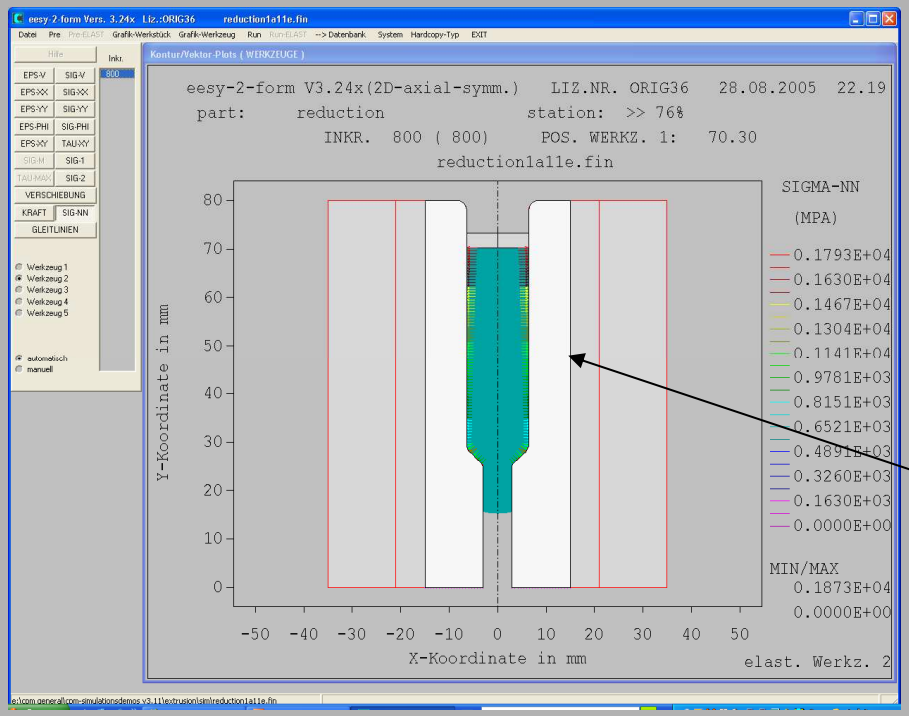

Tool design

Die insert without pre-stressing

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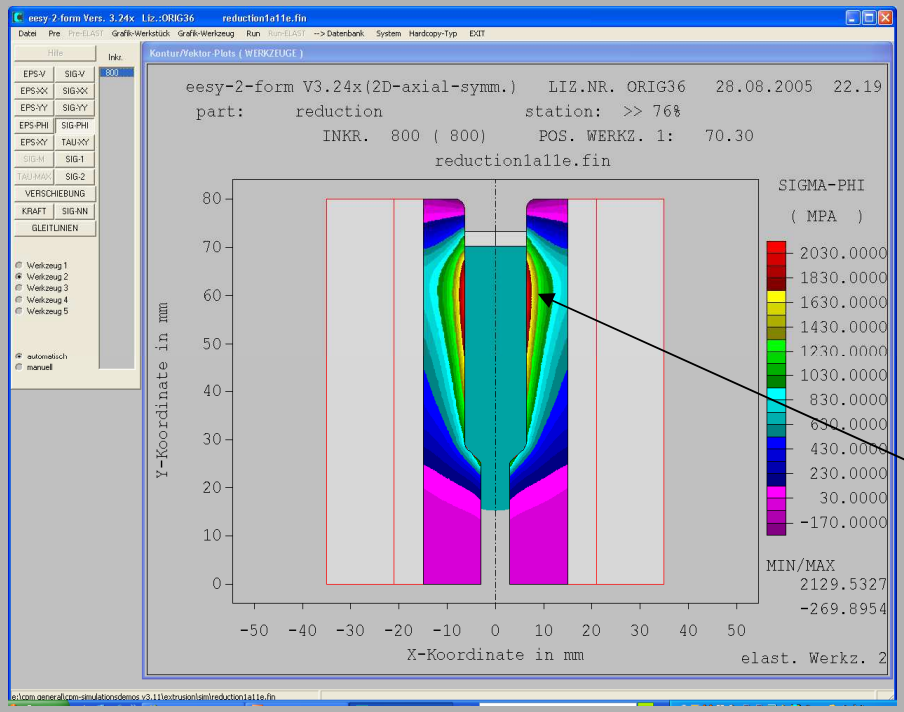
Using FEM and Die Design Software together



Tool design

Positive stress in the die without pre-stressing

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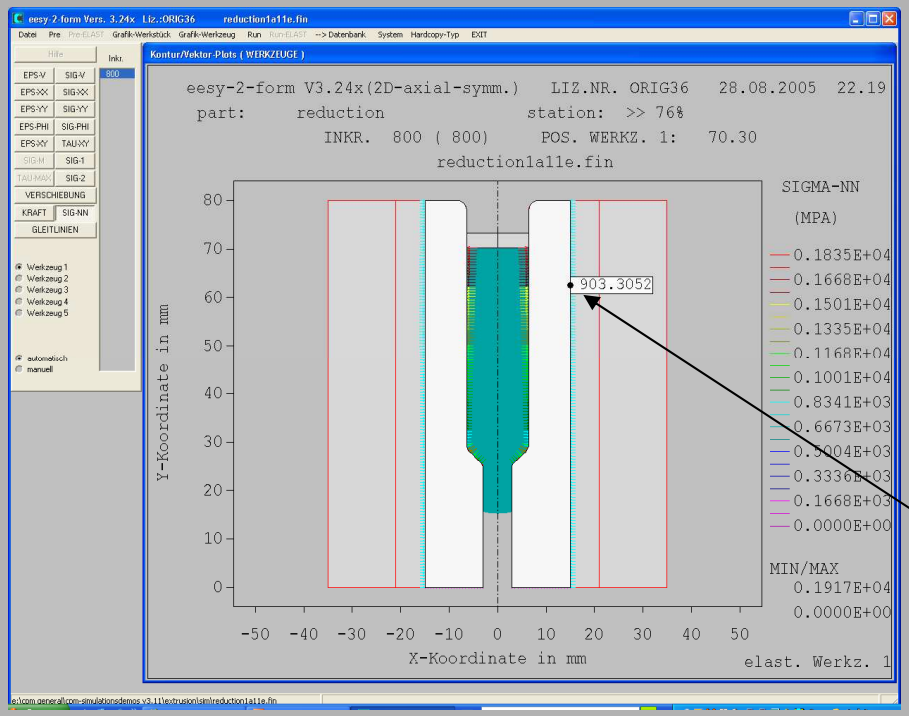
Using FEM and Die Design Software together



Tool design

Die with pre-stressing (900 MPa)

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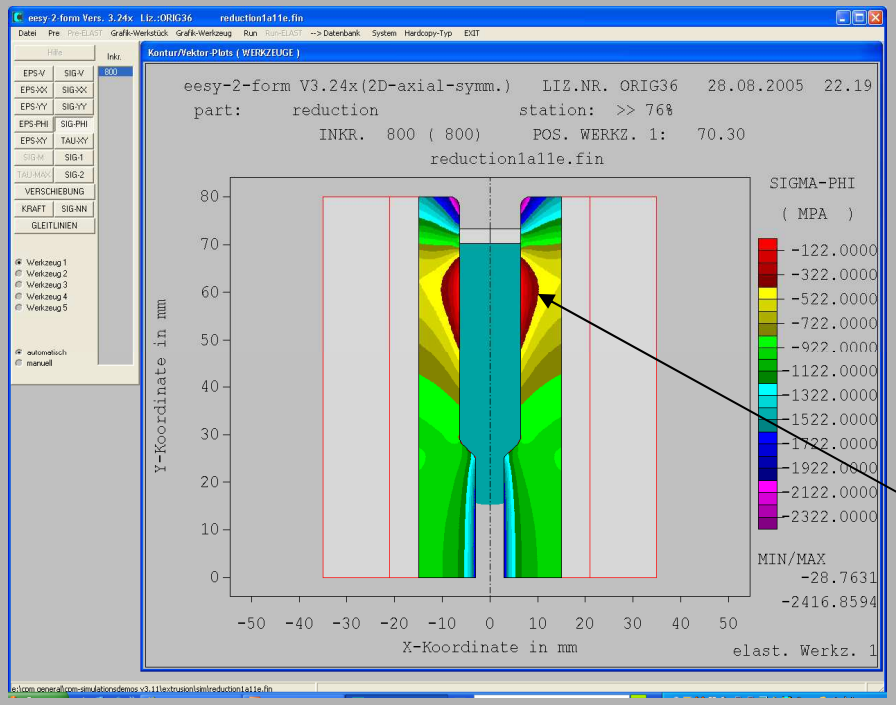
Using FEM and Die Design Software together



Tool design

Pressure in the die with pre-stressing

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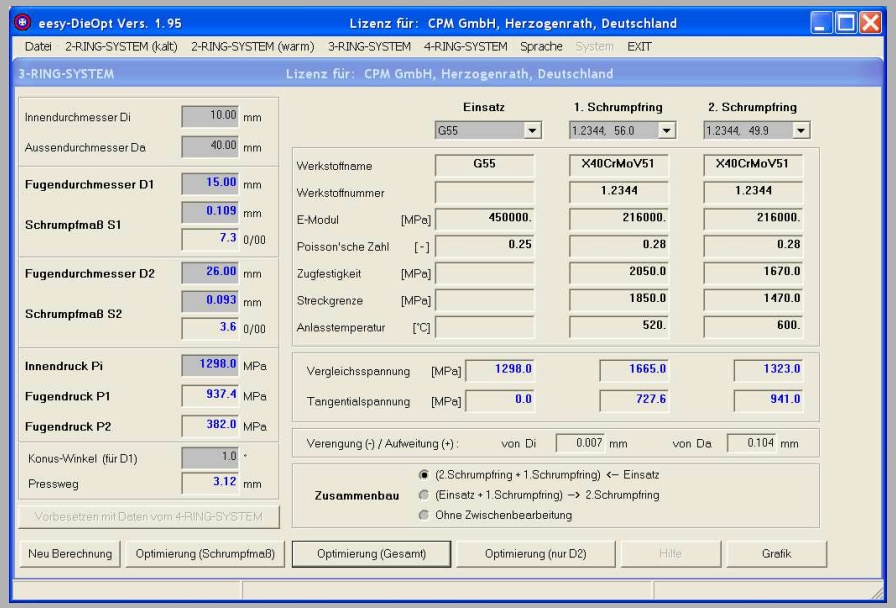
Using FEM and Die Design Software together



Design of a multi-ring pre-stressing-system

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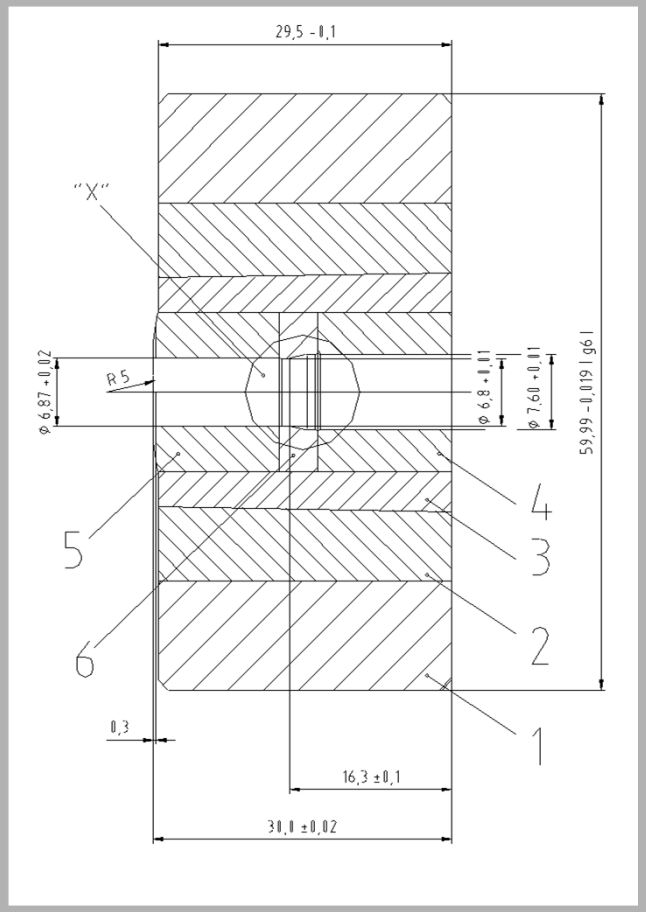
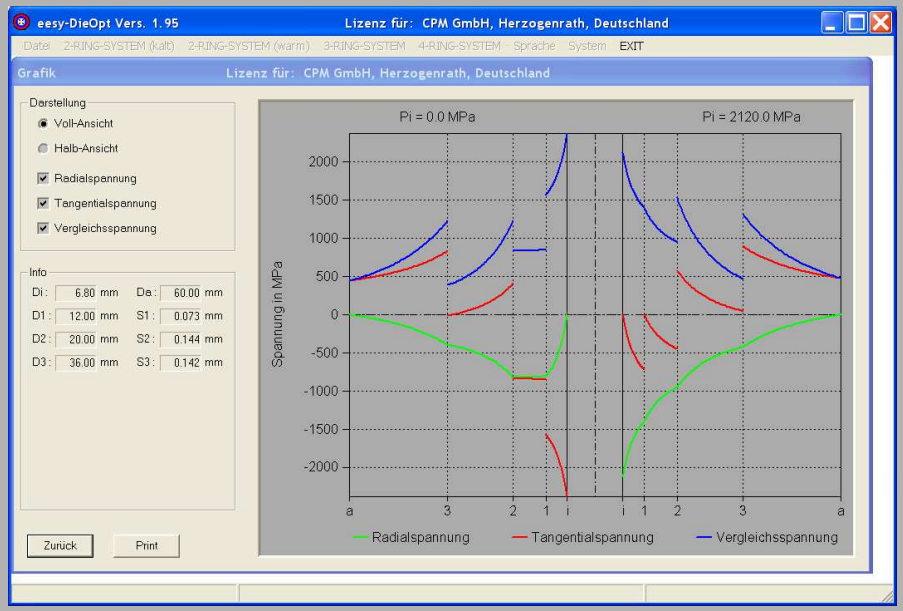
Using FEM and Die Design Software together

- Even complex design could be realized





(c) WALLRAM

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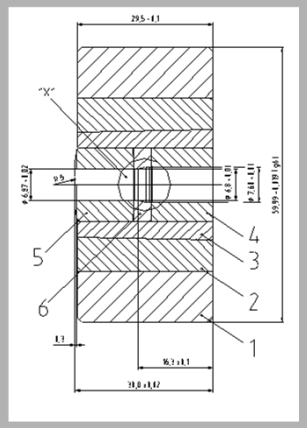
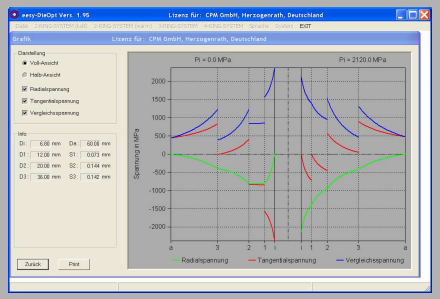
But……..

There are still assumptions in this approach that may lead to big mistakes

One of them is the homogeneous pre-stressing of the insert…….



- Even complex design could be realized



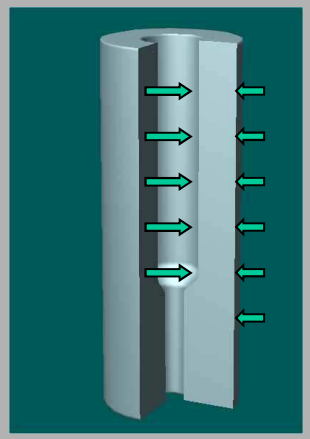
To overcome these problems a new methode is introduced…….

(c) WALLRAM

New Approach - Hybrid System

Using FEM with integrated Die Design Software

Principle



Simplified methode for die design

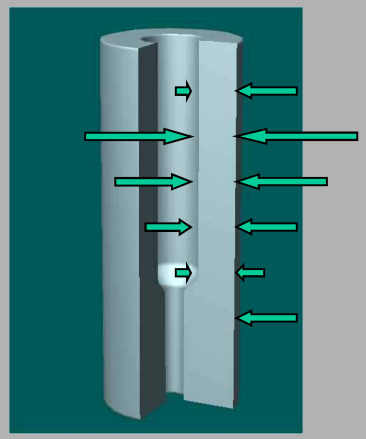
Pre-stress = f (P_i = const.; d_i = const; ...)

P_i – inner pressure, d_i – inner diameter

New Approach - Hybrid System

Using FEM with integrated Die Design Software

Principle



New methode for die design

Pre-stress = f ($P_i(t,y)$; $d_i(y)$; y; ...)

P_i – inner pressure, d_i – inner diameter, t – time (increment), y – axial location

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New Approach - Hybrid System

Using FEM with integrated Die Design Software

Principle

The new methode with integrated die design -

- allows to apply the lamé equation locally in axial direction for the pre-stressing ring and case layout

- is completely integrated in the FEM code which simulates the elastic behaviour in insert, rings and case

- uses a discretisation which is as fine as the FEM mesh in the insert

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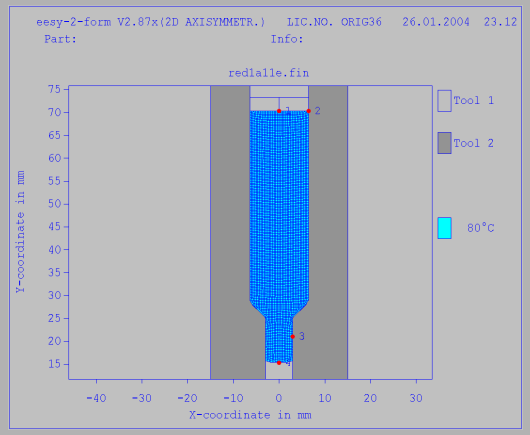
New Approach - Hybrid System

Using FEM with integrated Die Design Software

Example of application



The same example as before will be used to show the advantages of the new methode

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New Approach - Hybrid System

Using FEM with integrated Die Design Software

Procedure

After the FEM analysis of the part an optimal design layout is calculated with the die-design system

The results (diameters, interferences etc) are provided to the FEM code with integrated die-design software

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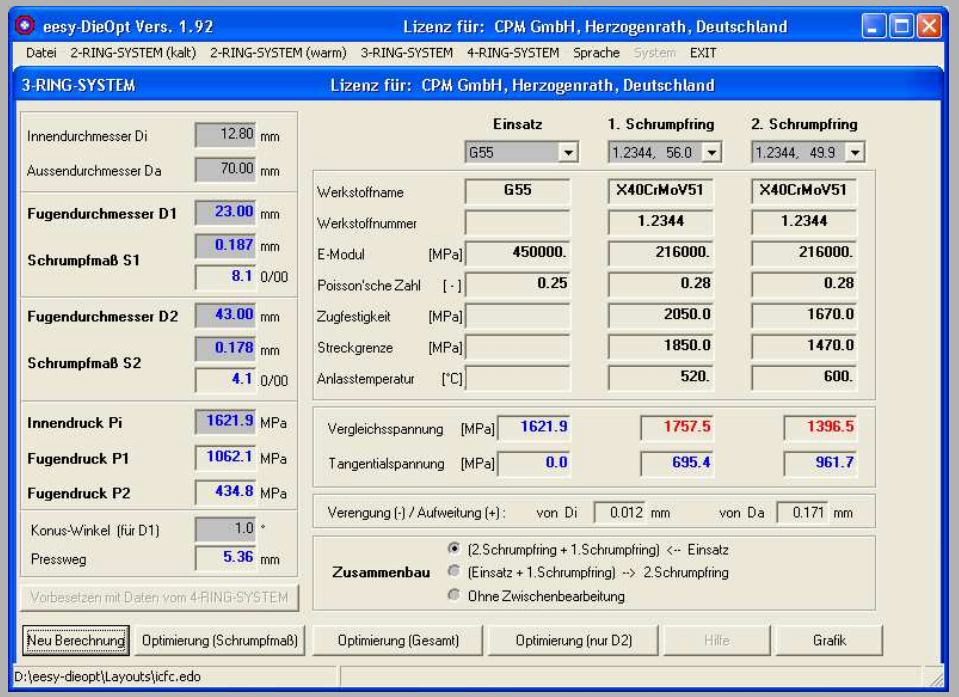
New Approach - Hybrid System

Using FEM with integrated Die Design Software

Calculation of Die Layout



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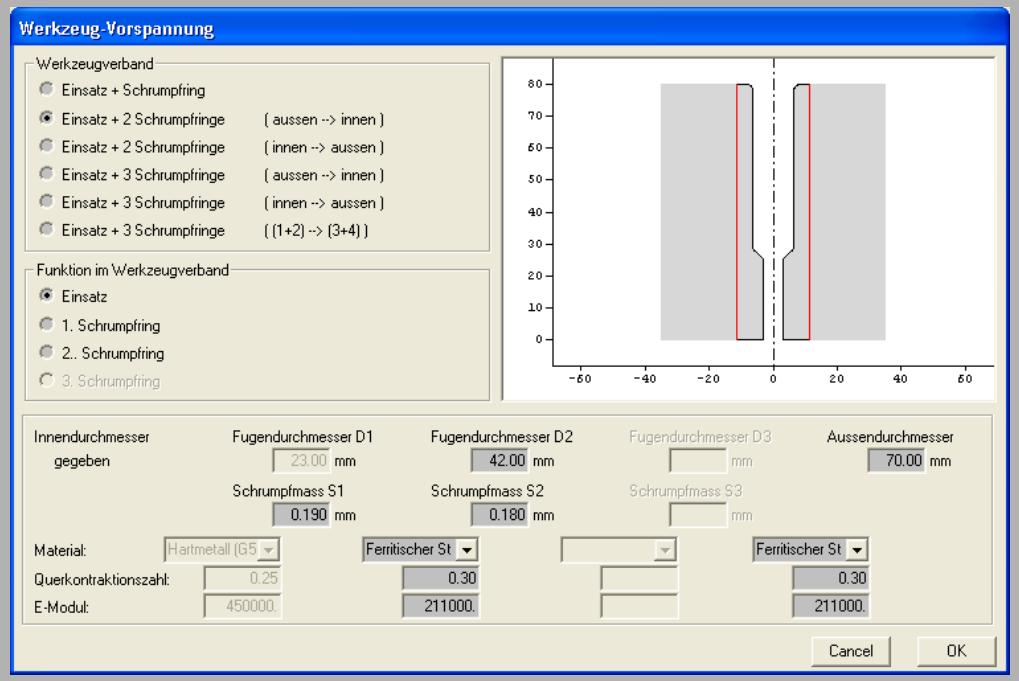
New Approach - Hybrid System

Using FEM with integrated Die Design Software

Transfer of the calculated data into the FEM Code



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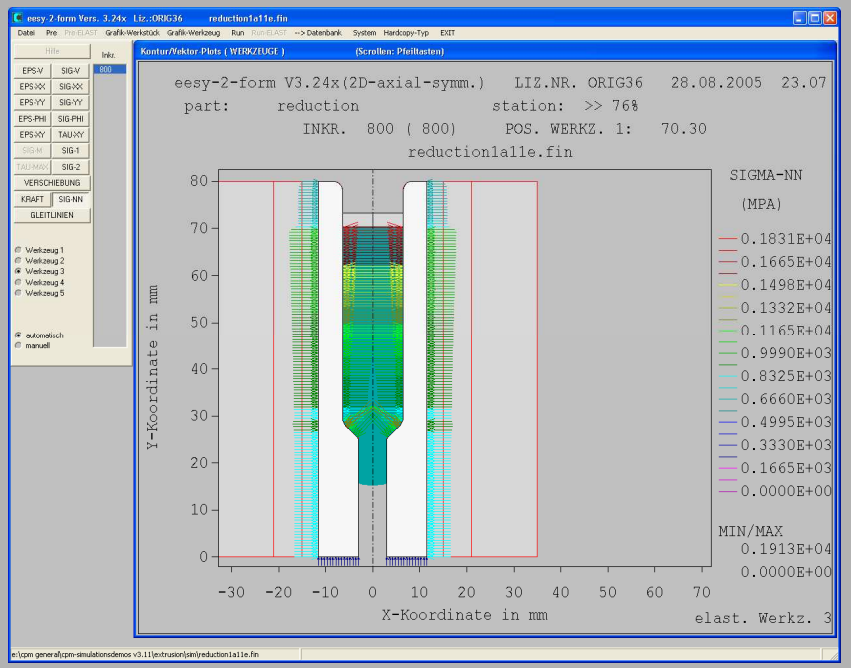
New Approach - Hybrid System

Using FEM with integrated Die Design Software

The pre-stress on the insert shows a distribution due to the non homogeneous pre-stress reaction to the inner load distribution



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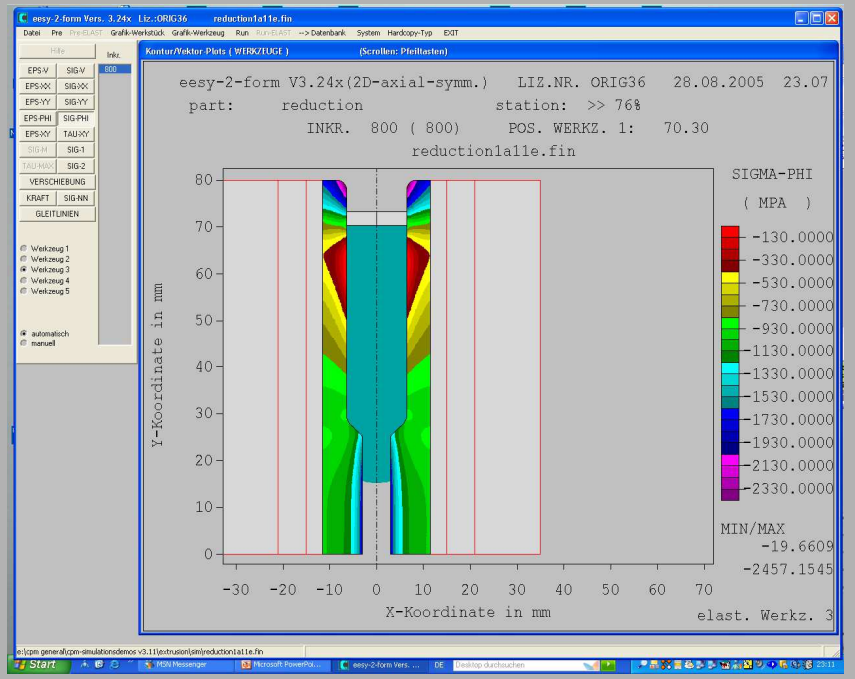
New Approach - Hybrid System

Using FEM with integrated Die Design Software

The stress distribution in the insert is different, too



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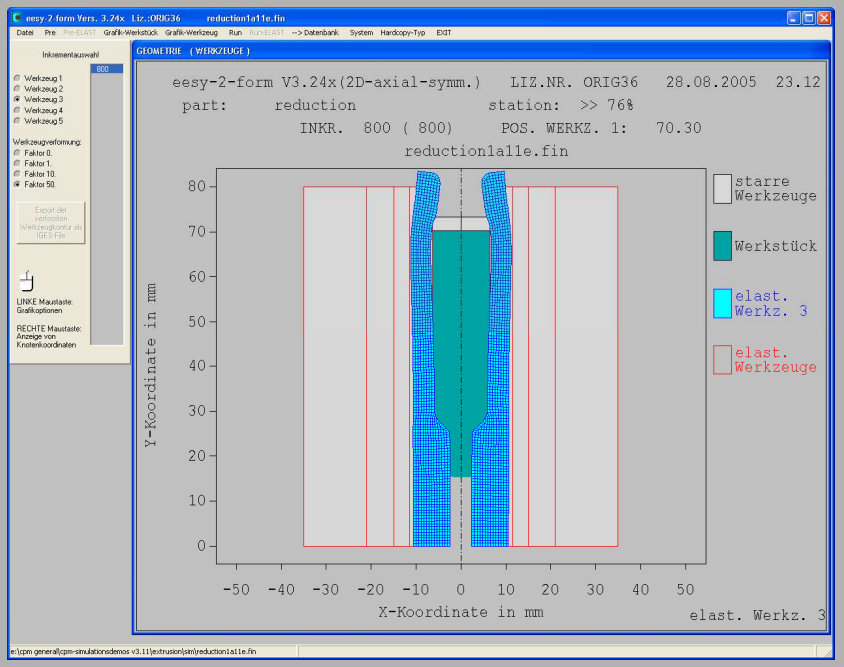
New Approach - Hybrid System

Using FEM with integrated Die Design Software

Magnified destortion
in the insert



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New Approach - Hybrid System

Using FEM with integrated Die Design Software

Conclusions:

The new methode allows for a much more precise study of the stresses in the die assembly

… it is still a simplified approach

… but it helps to solve a lot of practical design tasks in an easy, simple and fast way

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