Engineering Approach to use a Hybrid Simulation System for Process and Tool Design
11th International Cold Forming Congress, 11.09.05-13.09.05, Chester, UK

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

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

13th of September 2005

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Part 0: Process design (General Remarks)

Principle of Process Design Work

Typical obstacles in Process Design

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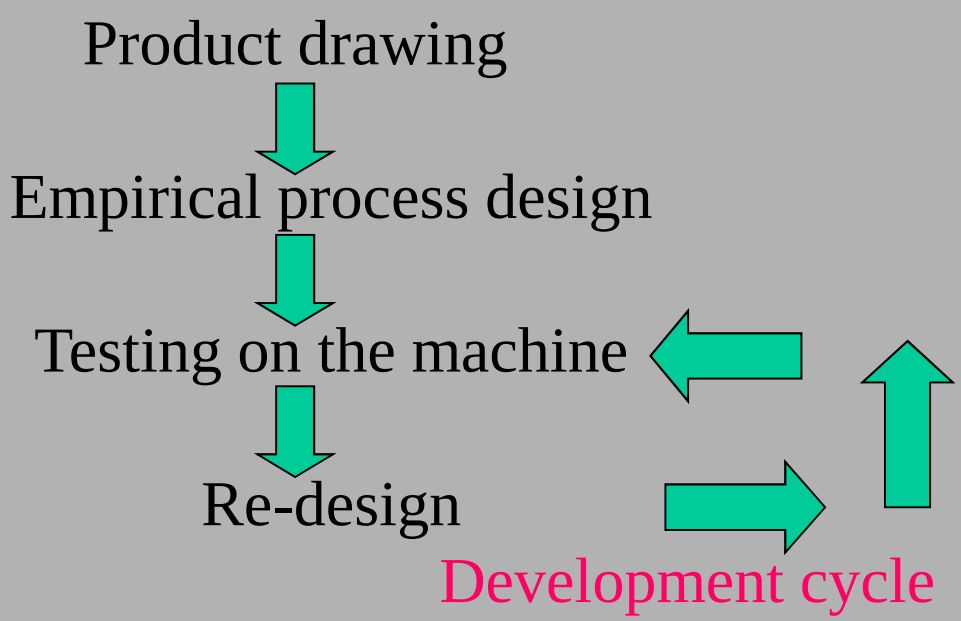
Traditional way of process development



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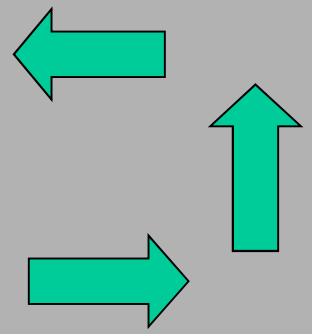
Traditional way of process development

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

Testing on the machine

Re-design



Development cycle

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Part 1: Application of FEM (General Remarks)

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

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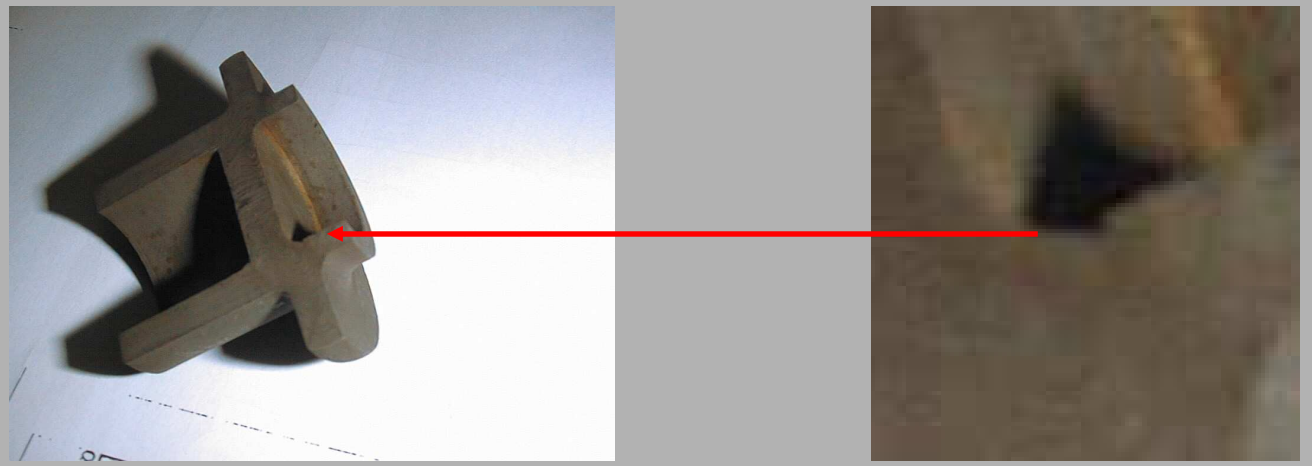

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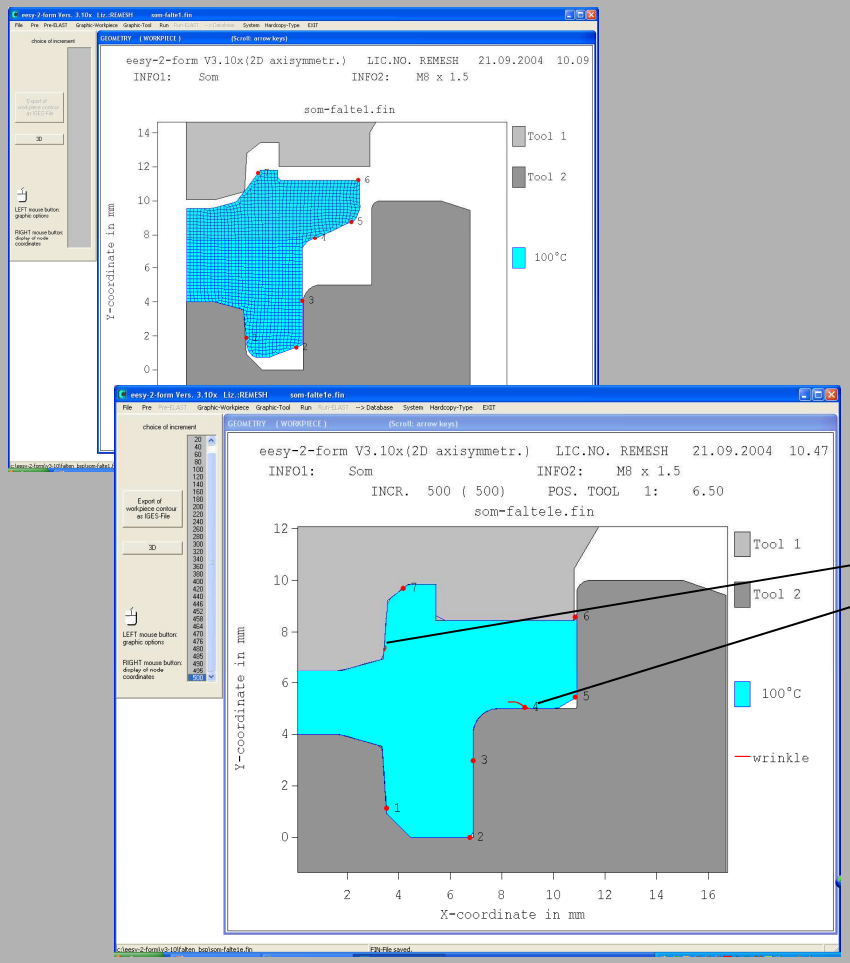

- Avoiding of failures

Folding at the part surface

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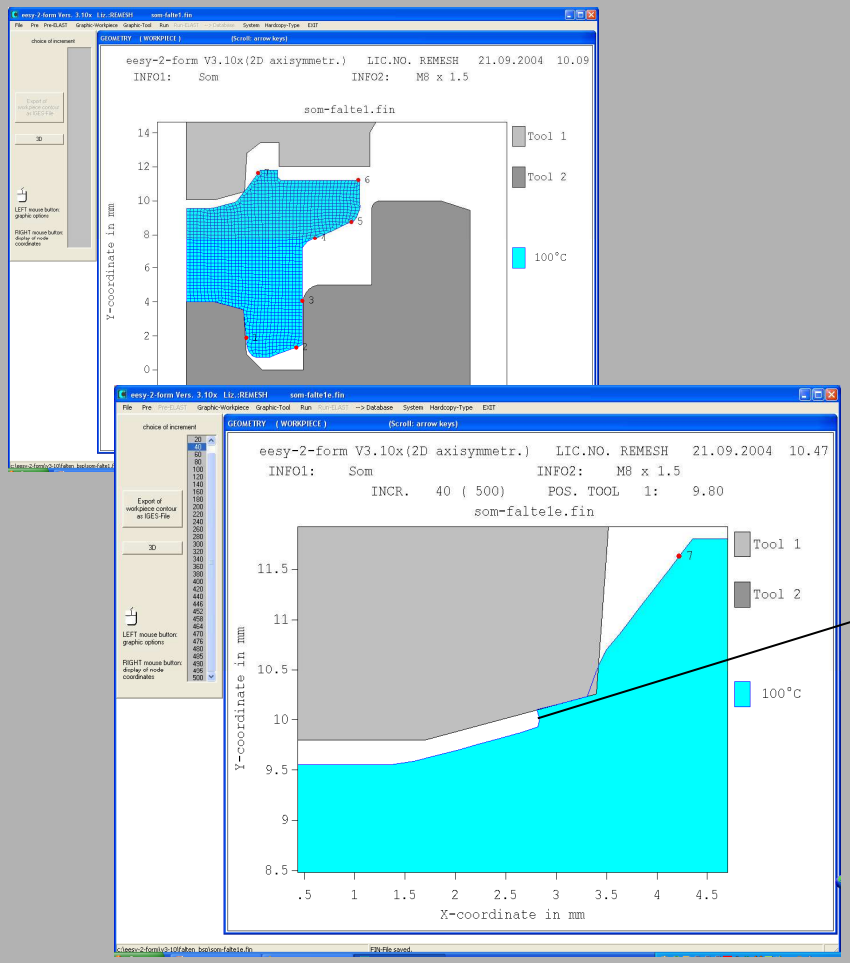

- Avoiding of failures

Folding at the part surface

Generation

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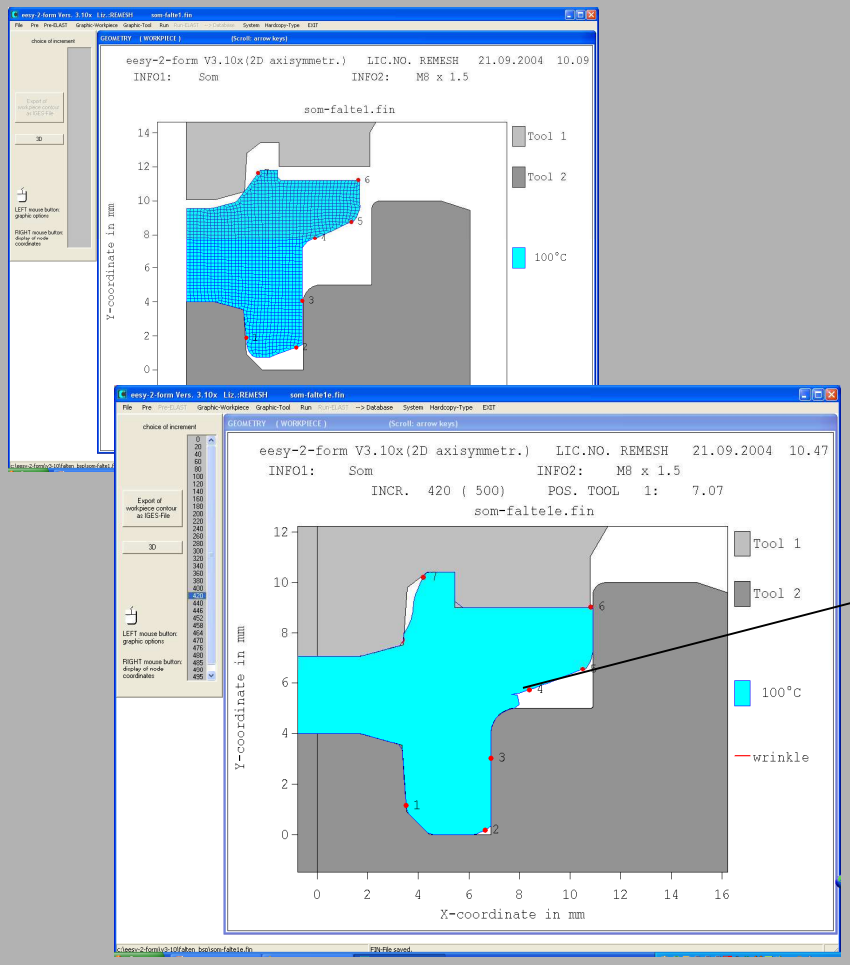

- Avoiding of failures

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Generation

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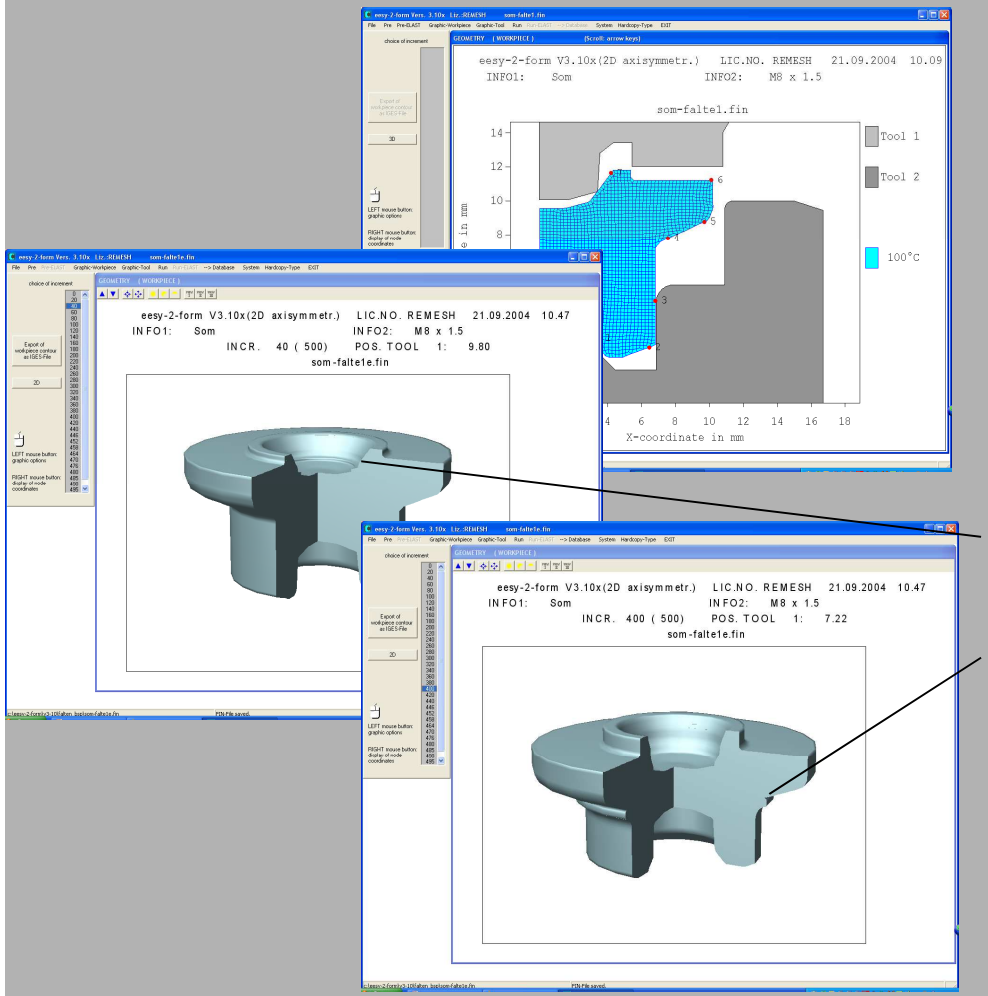

- Avoiding of failures

Folding at the part Surface

Generation

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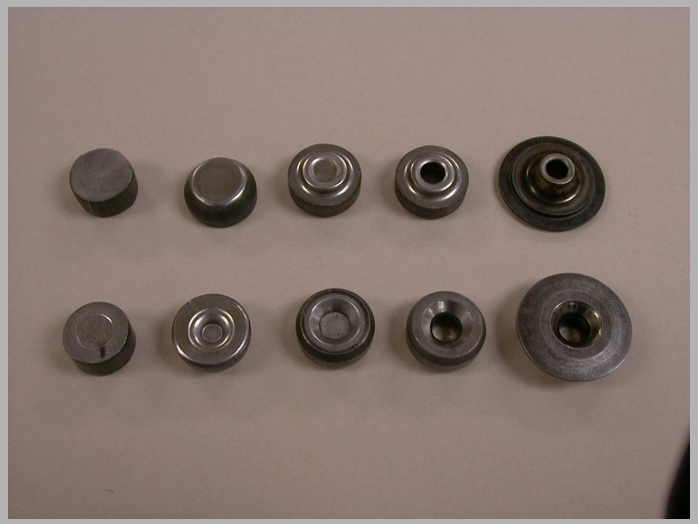

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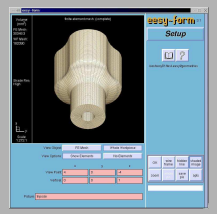
- Avoiding of failures

Failure of a punch

wrong pre-form design



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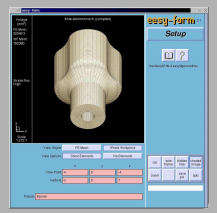
- Avoiding of failures

Failure of a punch

wrong pre-form design



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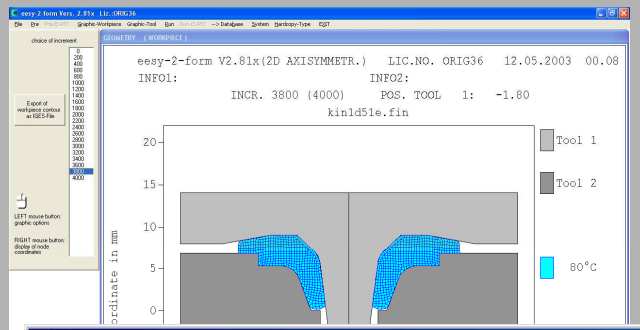

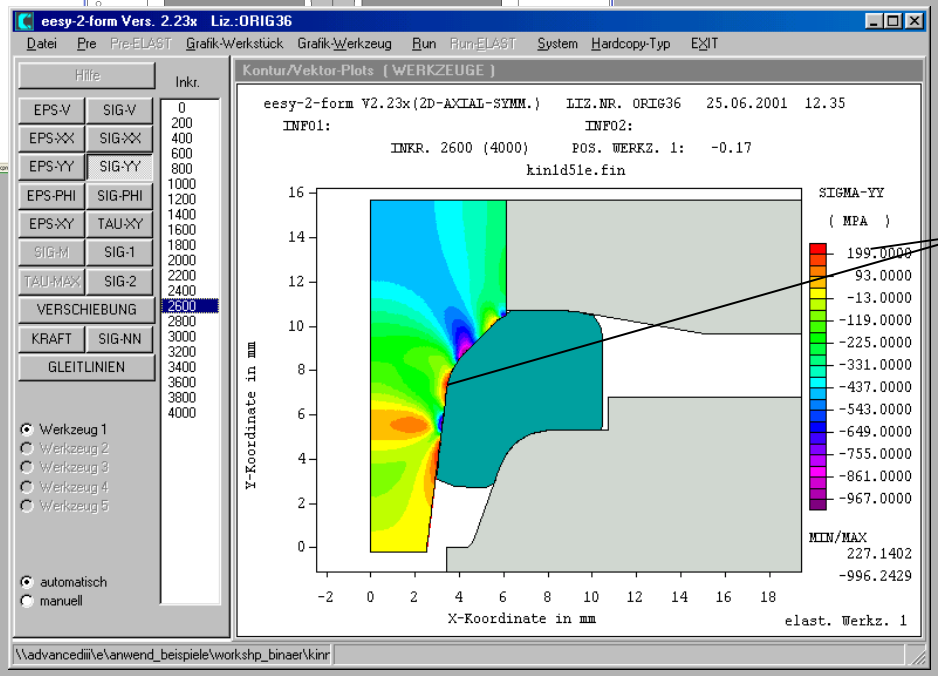

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Failure of a punch

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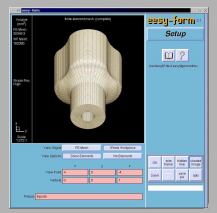

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Part 2: Die Design

Principle of Die Design

Examples of failures

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Part 2: Die Design

Principle of Die Design

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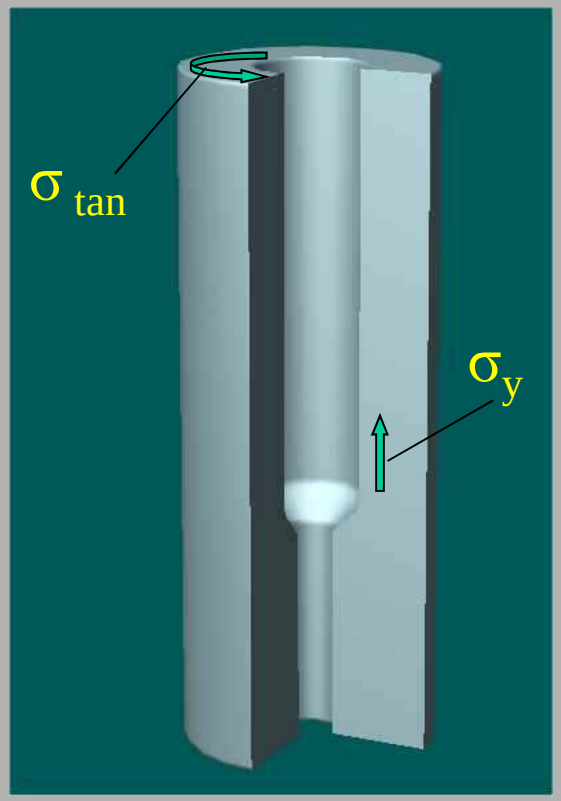
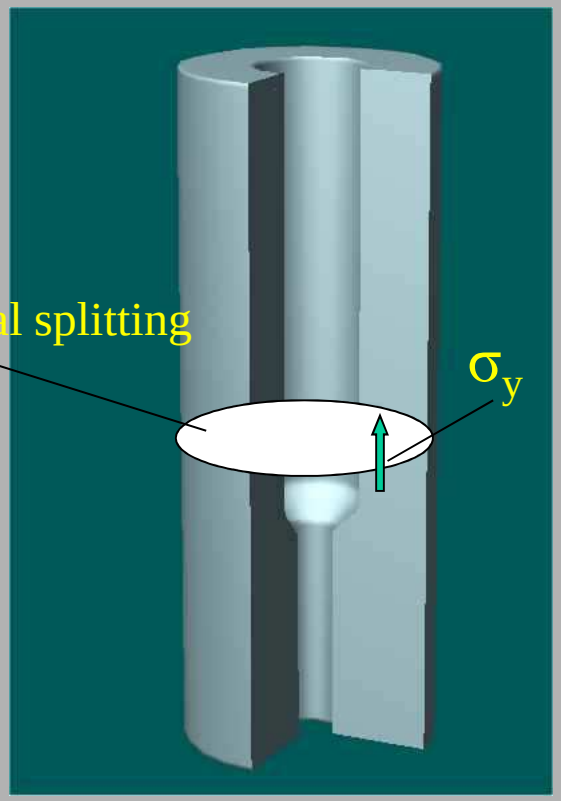


σ_{tan}: critical for axial crack

σ_y: critical for horizontal crack



σ_y: critical for horizontal crack

⇒ horizontal split of the insert

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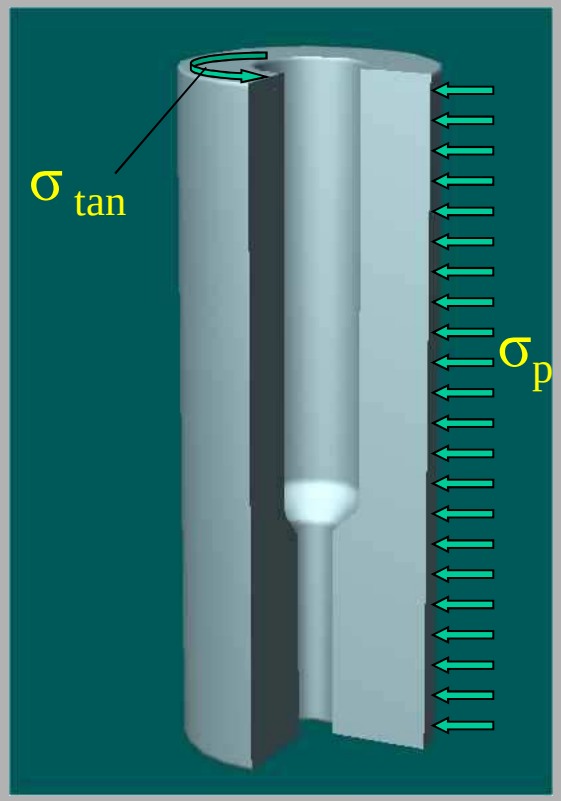

σ_{tan}: critical for axial crack

➡ Pre-stressing of the insert

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Part 2: Die Design

Examples of failures

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Part 3: Die Design using a simplified approach (lamé equation)

Principle

Application

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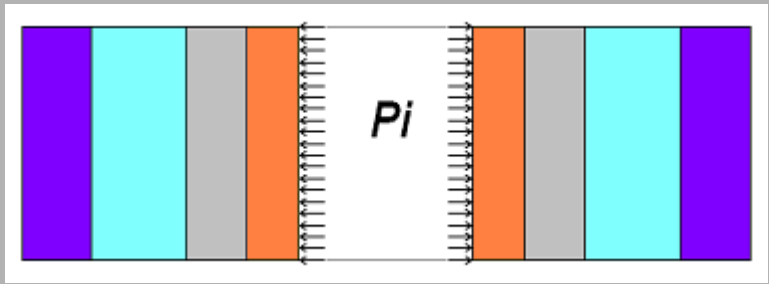
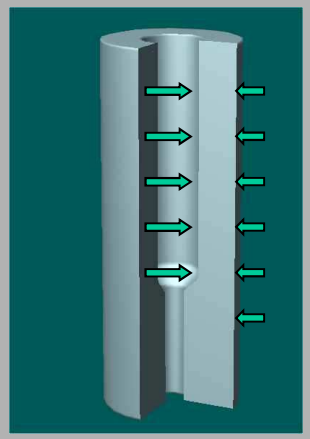
Part 3: Die Design using a simplified approach (lamé equation)

Principle



Part 3: Die Design using a simplified approach (lamé equation)

Principle



Simplified Methode

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

P_i – inner pressure, d_i – inner diameter

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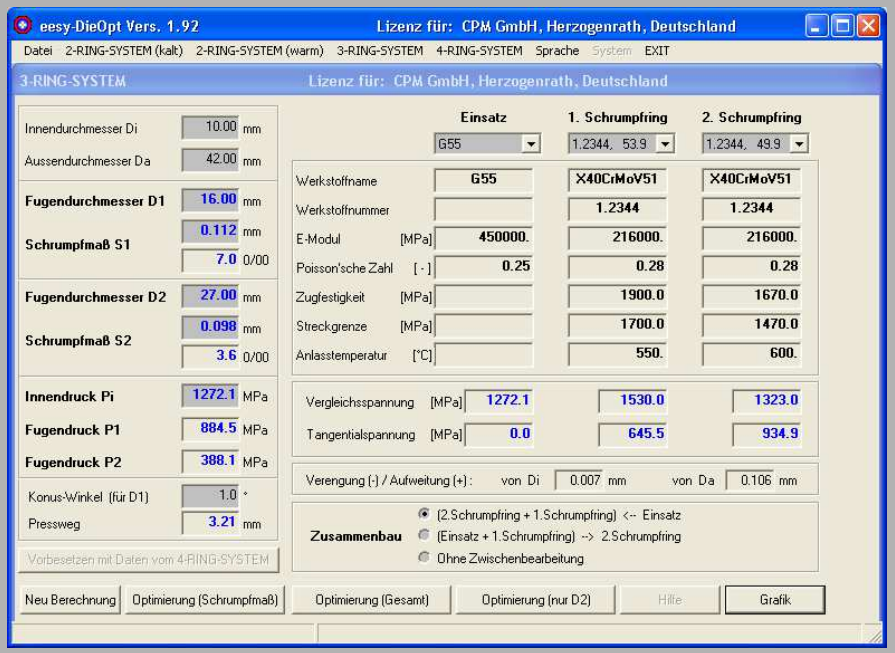
Part 3: Die Design using a simplified approach (lamé equation)

Application



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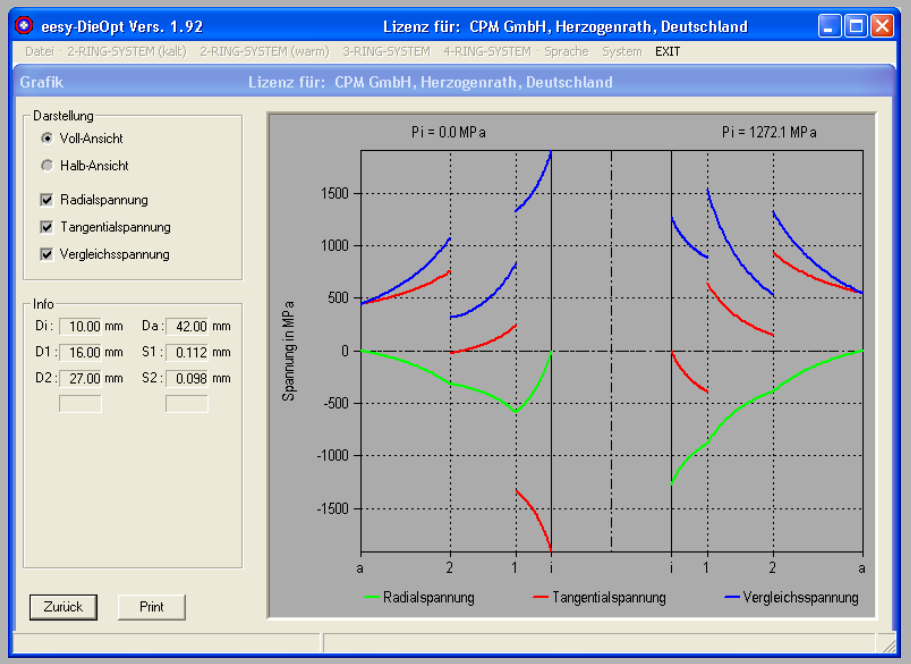

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Part 4: Using FEM and Die Design Software together

Tool analysis (insert) by FEM

Pre – stressing system layout with analytical methode

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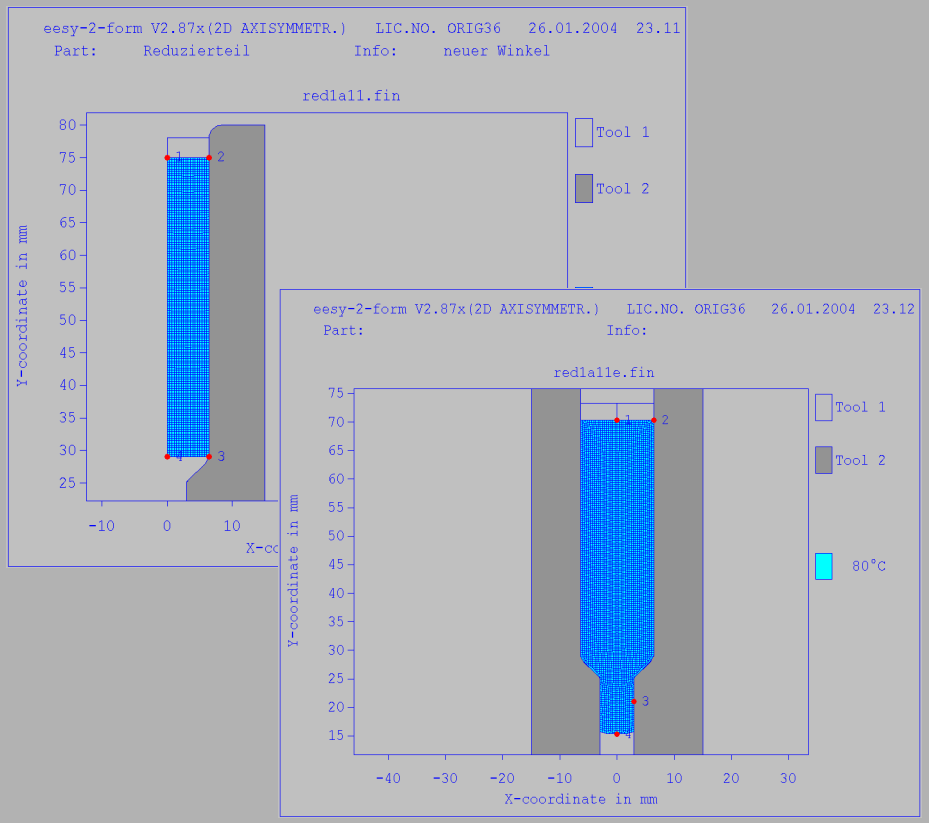

- Design of a cold forming process

Simulation of an extrusion

Material flow

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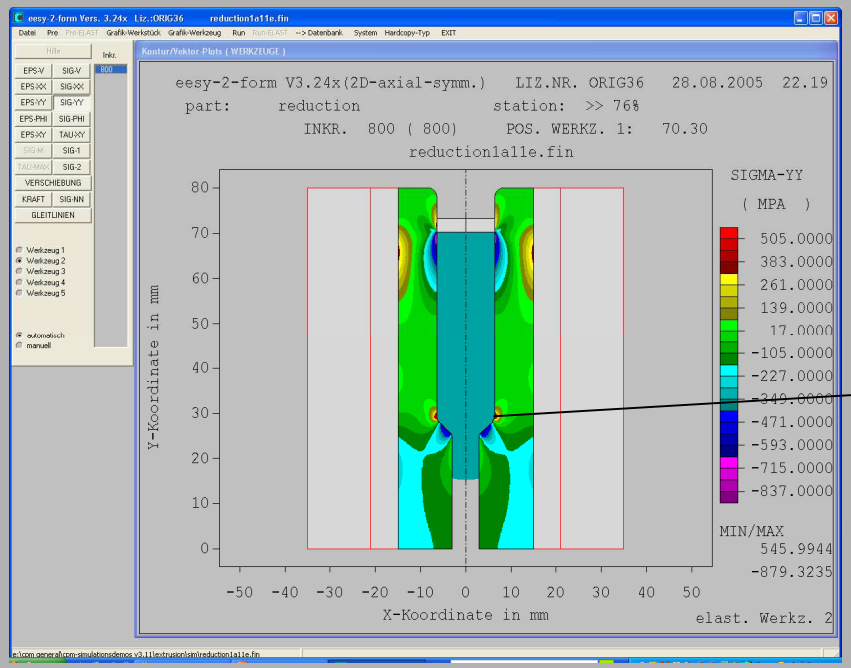

- Avoiding of failures (elastic analysis of the insert with FEM)

Splitting of the die due to high axial stresses

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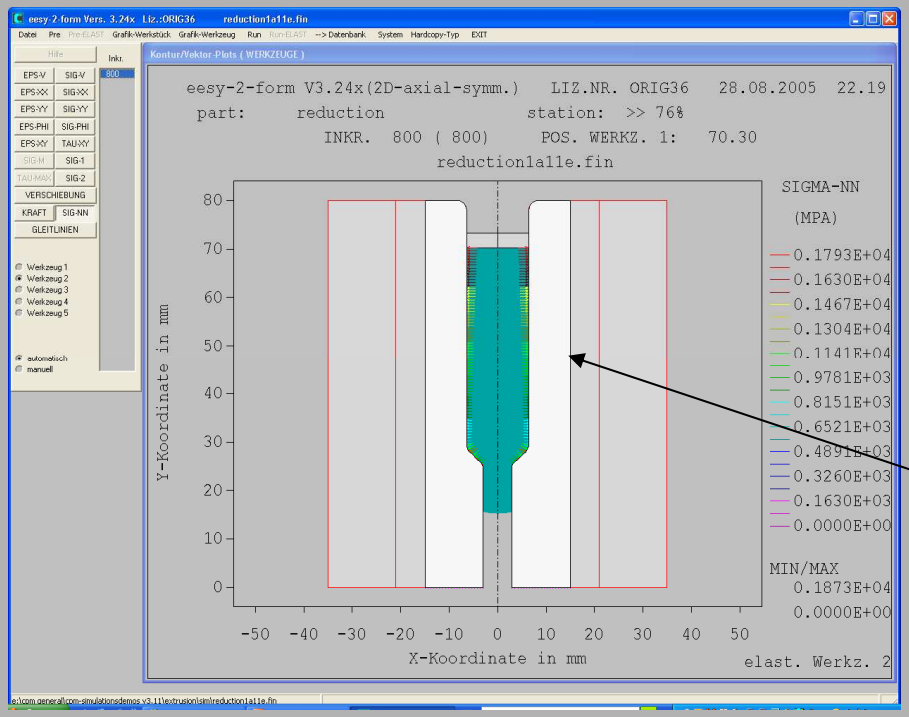

- Design of a cold forming process

Tool design

Die insert without pre-stressing

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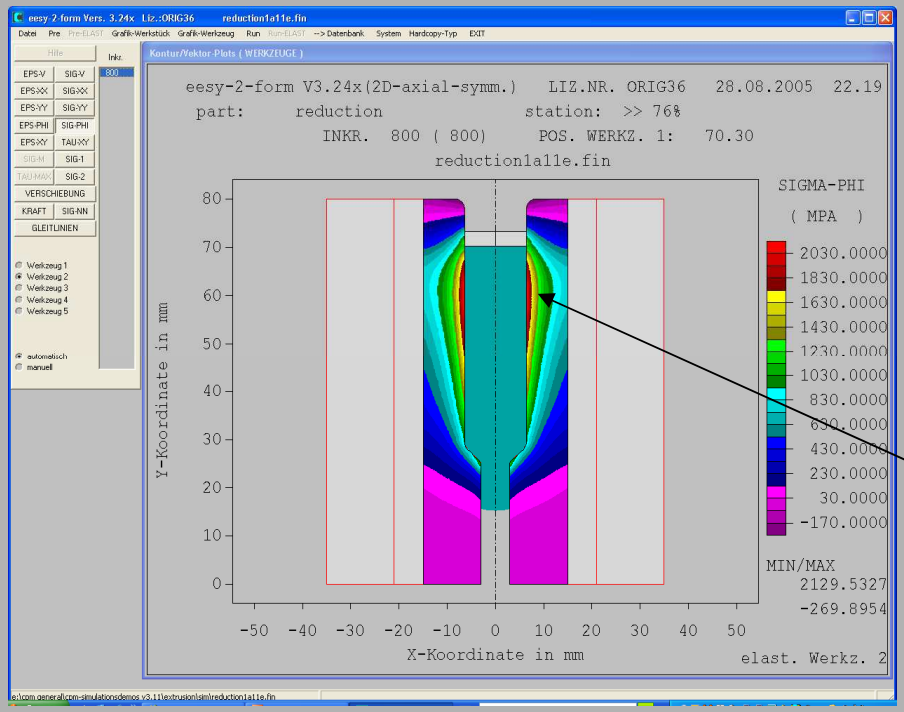

- Design of a cold forming process

Tool design

Positive stress in the die without pre-stressing

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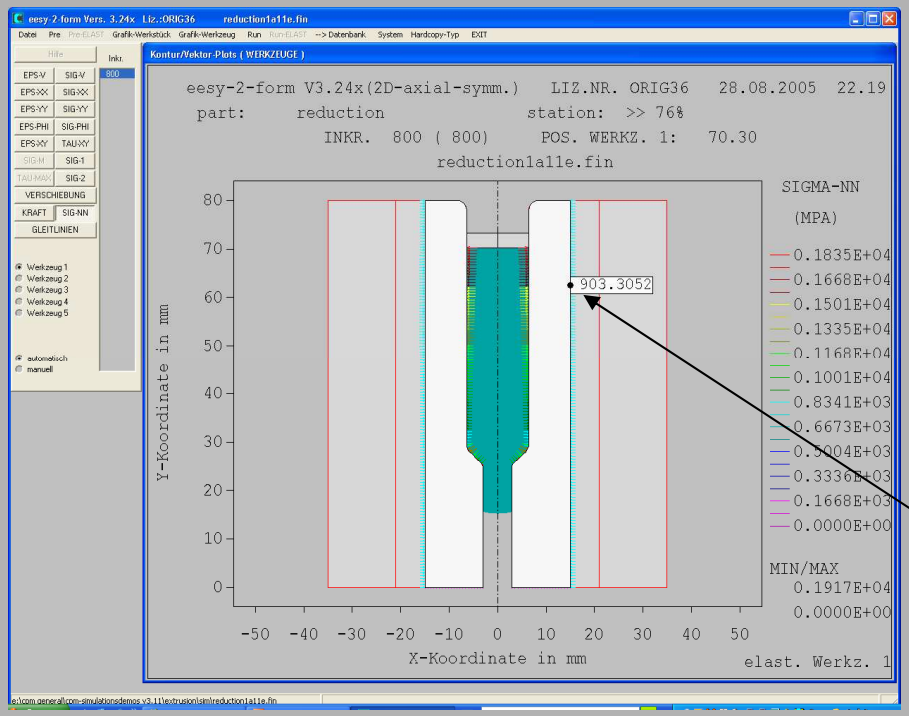

- Design of a cold forming process

Tool design

Die with pre-stressing (900 MPa)

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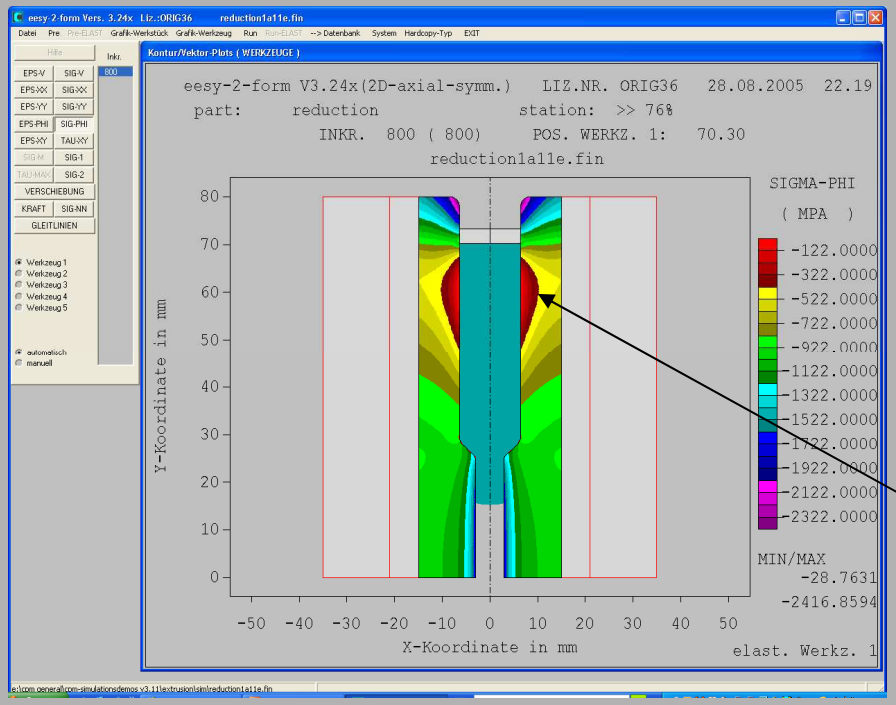

- Design of a cold forming process

Tool design

Pressure in the die with pre-stressing

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Part 4: Using FEM and Die Design Software together

Pre – stressing system layout with analytical methode

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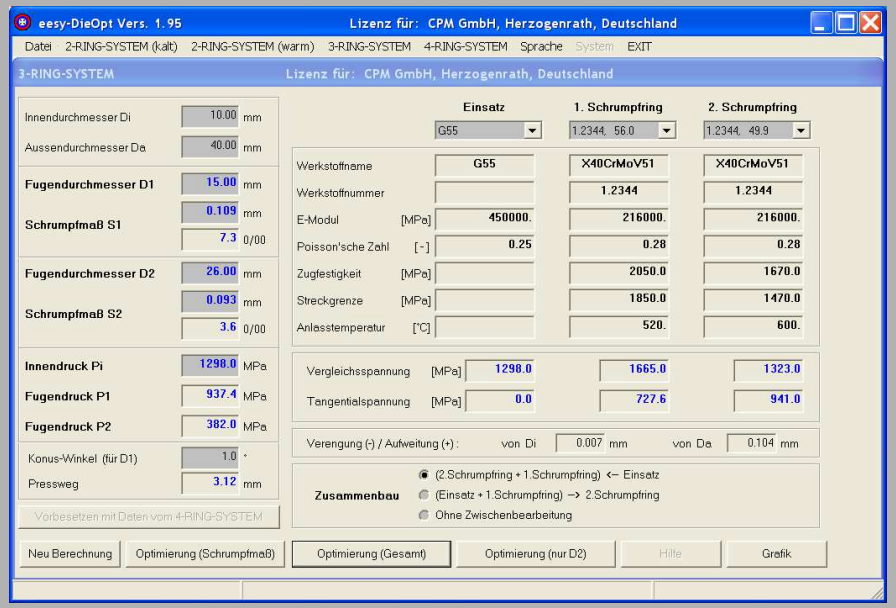

- Design of a cold forming process (Tool design)

Design of a multi-ring pre-stressing-system

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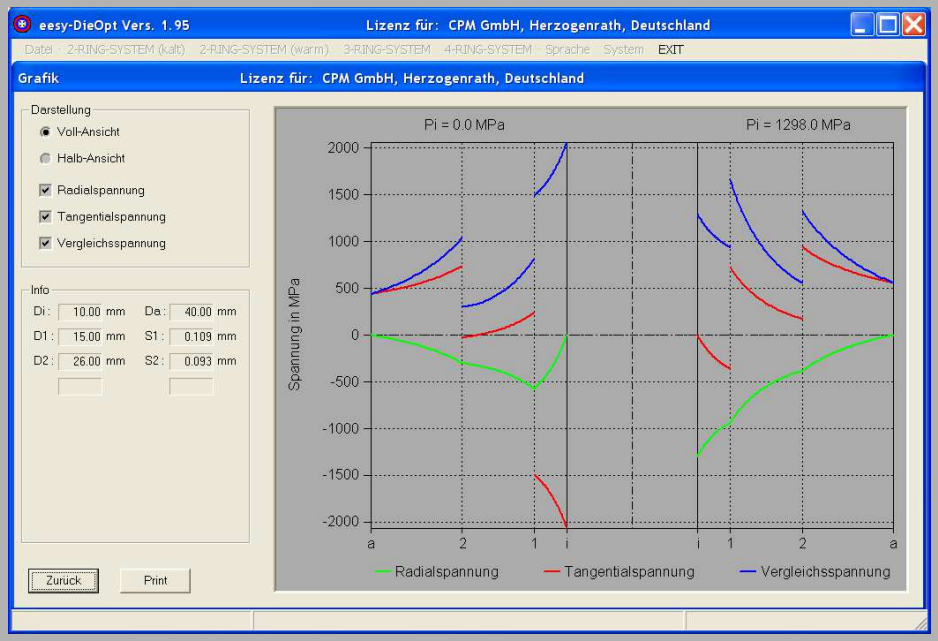

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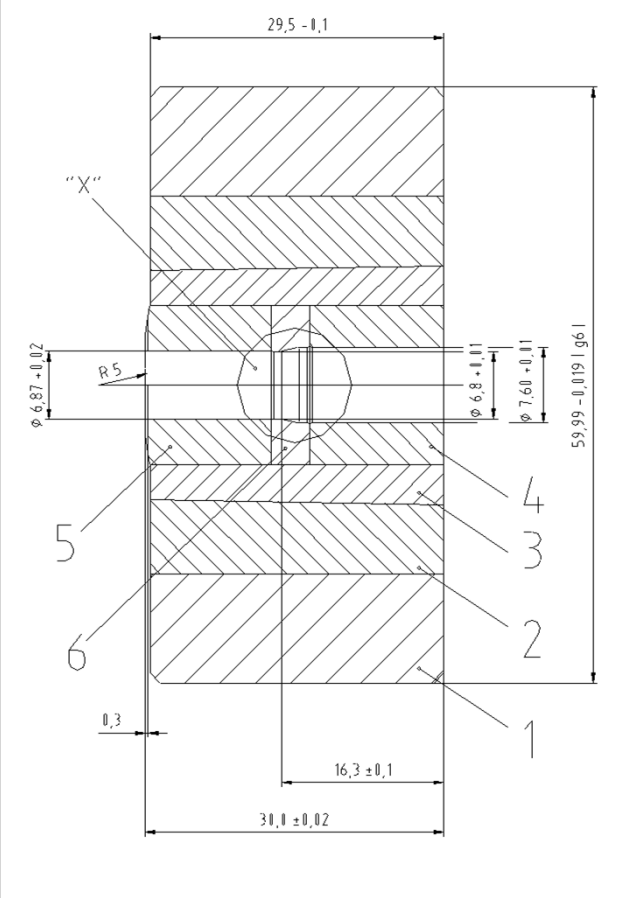
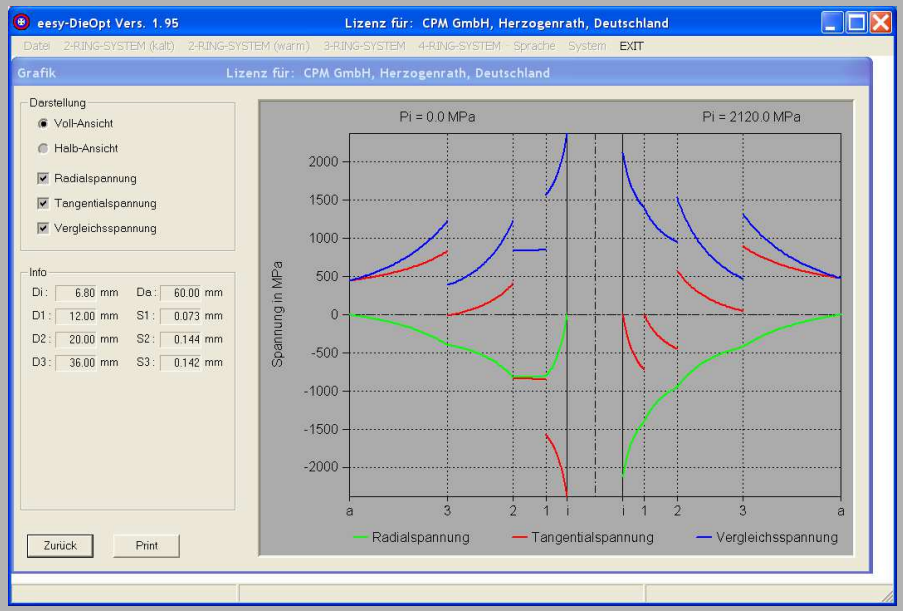


- Even complex design could be realized



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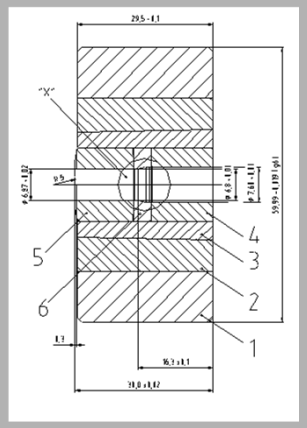
But……..

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

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

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



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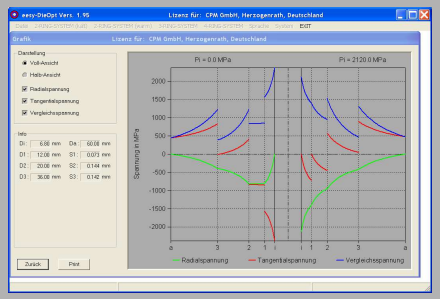

(c) WALLRAM

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Part 5: New Approach - Hybrid System

Using FEM with integrated Die Design Software

Principle

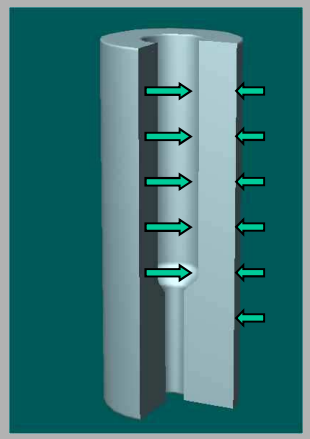
Example of application

13th of September 2005

Part 5: New Approach - Hybrid System

Using FEM with integrated Die Design Software

Principle



Simplified methode for die design

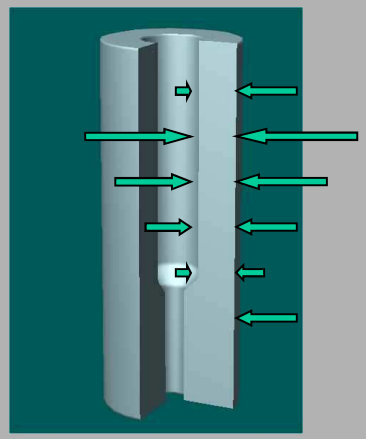
Pre-stress = f (P_i = const.; d_i = const; ...)

P_i – inner pressure, d_i – inner diameter

Part 5: 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

Part 5: 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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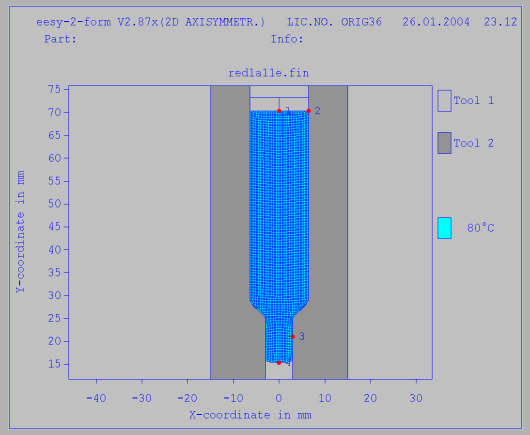
Part 5: New Approach - Hybrid System

Using FEM with integrated Die Design Software

Example of application



The same example as in part 4 will be used to show the advantages of the new methode

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Part 5: New Approach - Hybrid System

Using FEM with integrated Die Design Software

Example of application

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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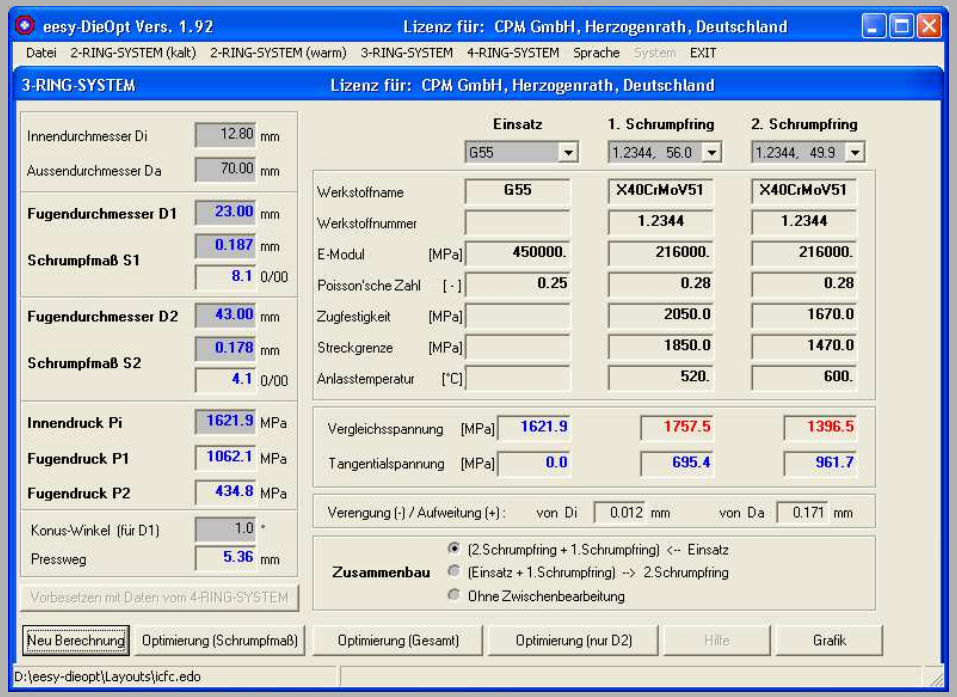
Part 5: New Approach - Hybrid System

Using FEM with integrated Die Design Software

Example of application



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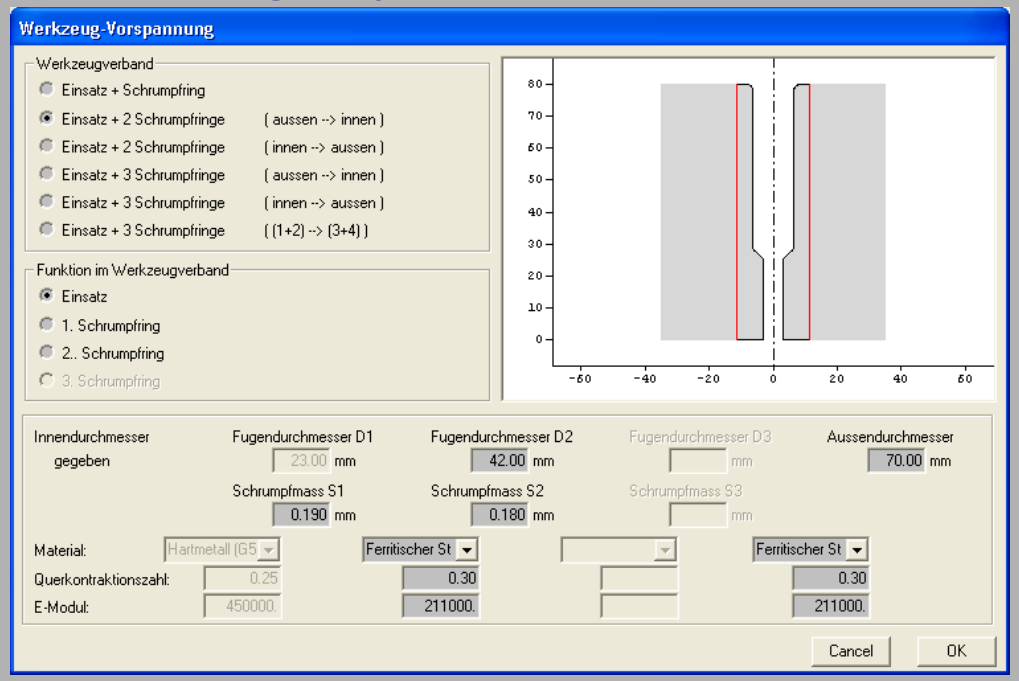
Engineering Approach to use a Hybrid Simulation System for Process and Tool Design

11th International Cold Forming Congress, 11.09.05-13.09.05, Chester, UK

Part 5: New Approach - Hybrid System

Using FEM with integrated Die Design Software

Example of application



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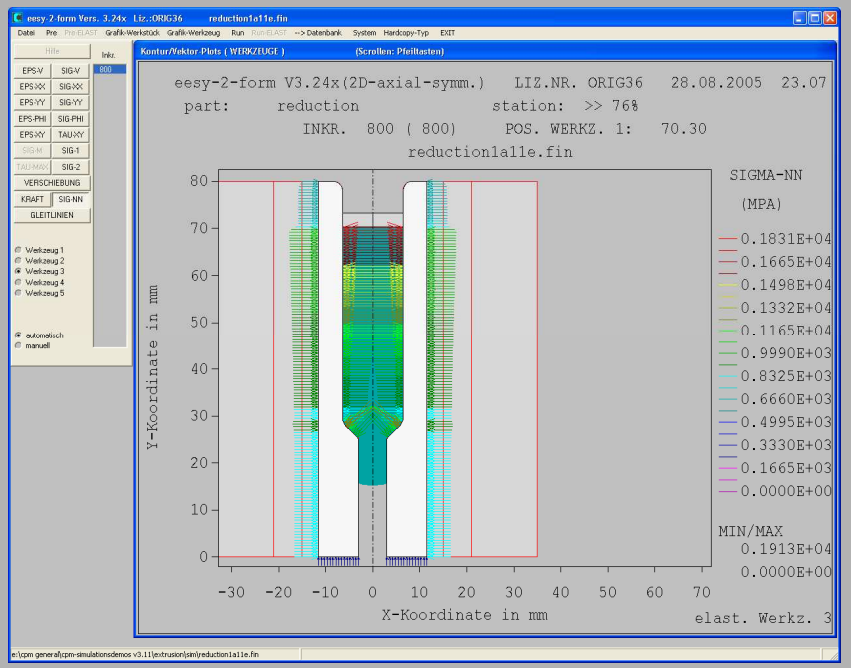
Example of application

The pre-stress on the insert shows a distribution



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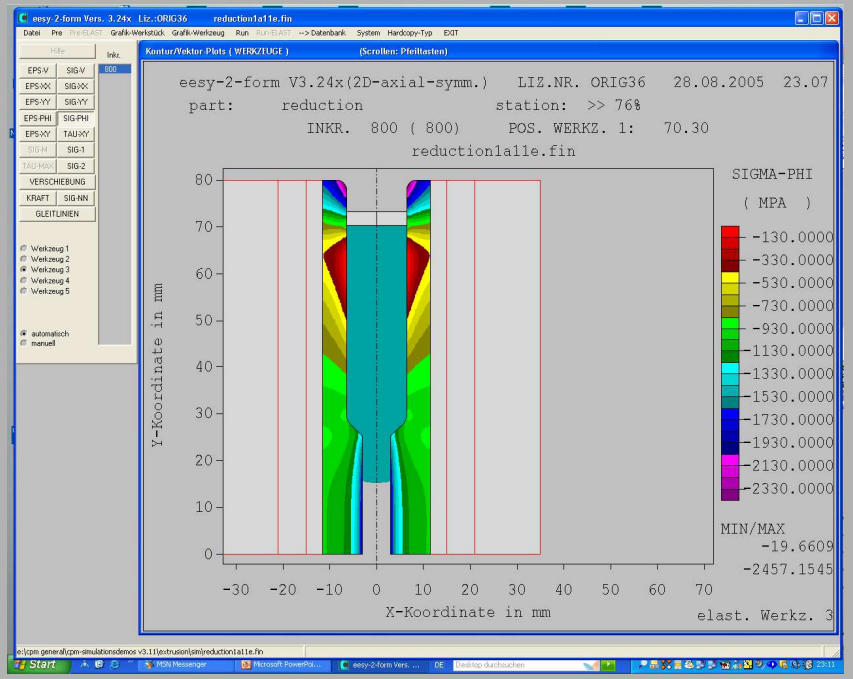
Example of application

The stress distribution in the insert is different, too



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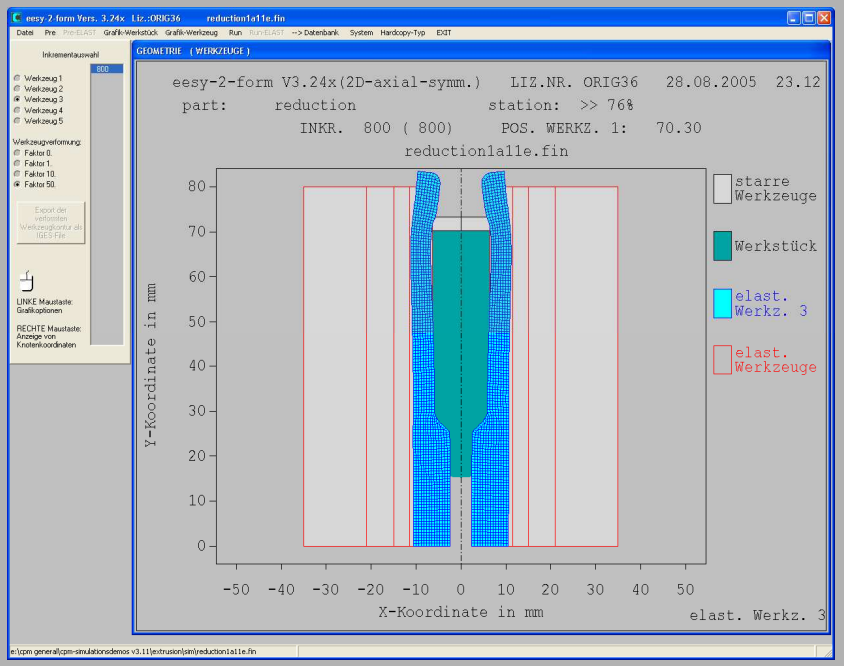
Example of application

Magnified destortion
in the insert



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Part 5: New Approach - Hybrid System

Using FEM with integrated Die Design Software

Example of application

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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