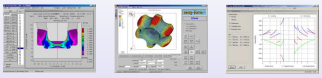

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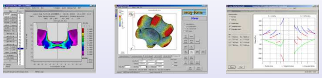
FEA in optimization of progression and tool design in cold forging

Dr. Gerhard H. Arfmann, Dr. Michael Twickler
CPM GmbH, Herzogenrath, Germany



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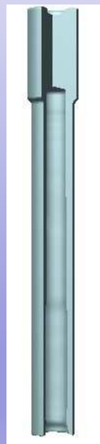
The role of FEA application in progression and tool design in cold forging

Introduction

Examples of highly engineered forged parts

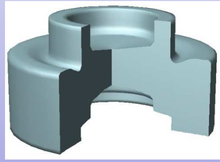
Examples of improved tool design

Conclusions



FEA in optimization of progression and tool design in cold forging

Introduction



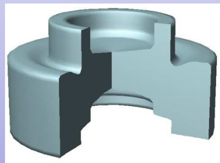
Markets have become more and more demanding

Necessity to reduce production costs to win new orders and necessity of continuous improvement of production to meet decreasing product prices

Flexibility in using the existing equipment is essential instead of big investments in new machinery that is difficult to justify and cannot be implemented quickly.

FEA in optimization of progression and tool design in cold forging

Introduction

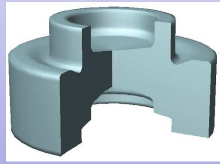


These requirements drive engineers to new efforts.
Creative ideas and innovation is vital.
New ideas to develop more sophisticated processes and tooling are needed.

This presentation will show examples of how innovative engineering can meet these challenges. All examples are real industrial production cases.

FEA in optimization of progression and tool design in cold forging

Introduction



Tasks — How to design the right process to produce a forged part?

How to design the optimum tooling?

Today — Existing knowledge:
"I think" or "I know how"

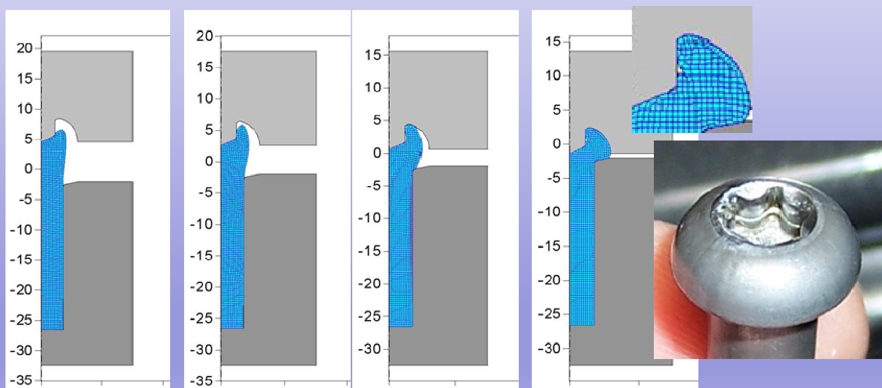
Aim of application of software tools:

I think -> I know how –> I know why

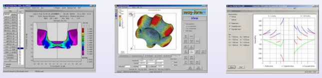
Target — **-> I can generate new know how**

The role of FEA application in progression and tool design in cold forging

Examples of highly engineered forged parts



Production of a bolt **Original progression with folding**



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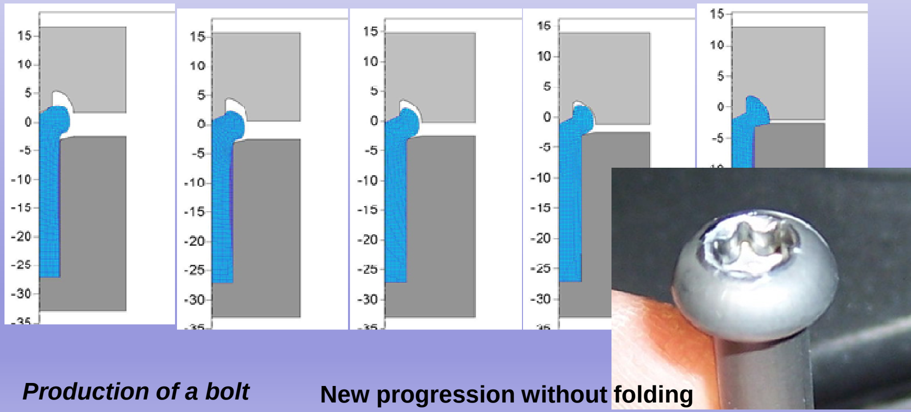
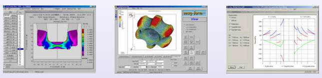
The role of FEA application in progression and tool design in cold forging

Examples of highly engineered forged parts



Production of a bolt

New progression without folding



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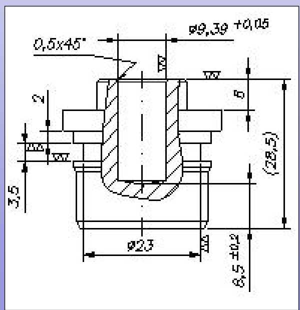
Examples of highly engineered forged parts



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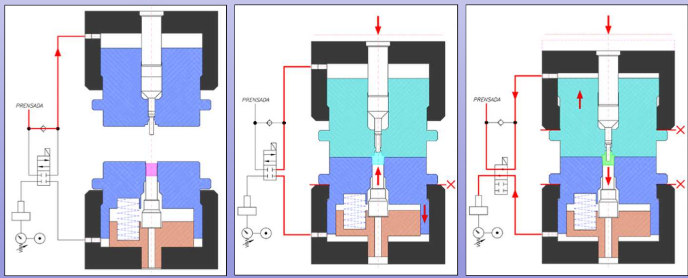
Examples of highly engineered forged parts

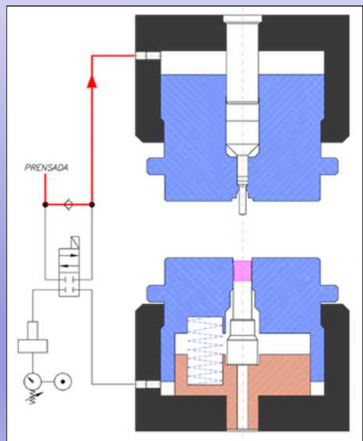


Shock Absorber

Function of the cushion system

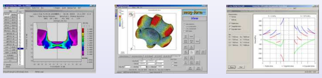
FEA in optimization of progression and tool design in cold forging

Examples of highly engineered forged parts



Shock Absorber

Function of the cushion system

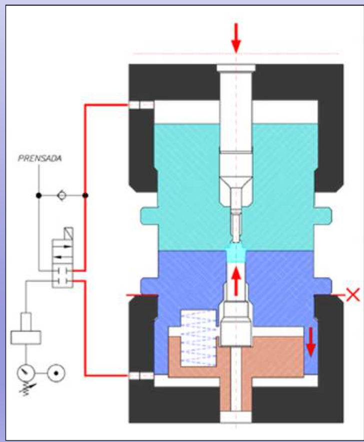


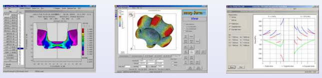
FEA in optimization of progression and tool design in cold forging

Examples of highly engineered forged parts

<u>Shock Absorber</u>

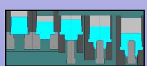
Function of the cushion system





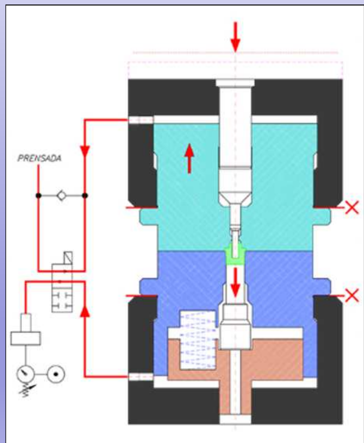
FEA in optimization of progression and tool design in cold forging

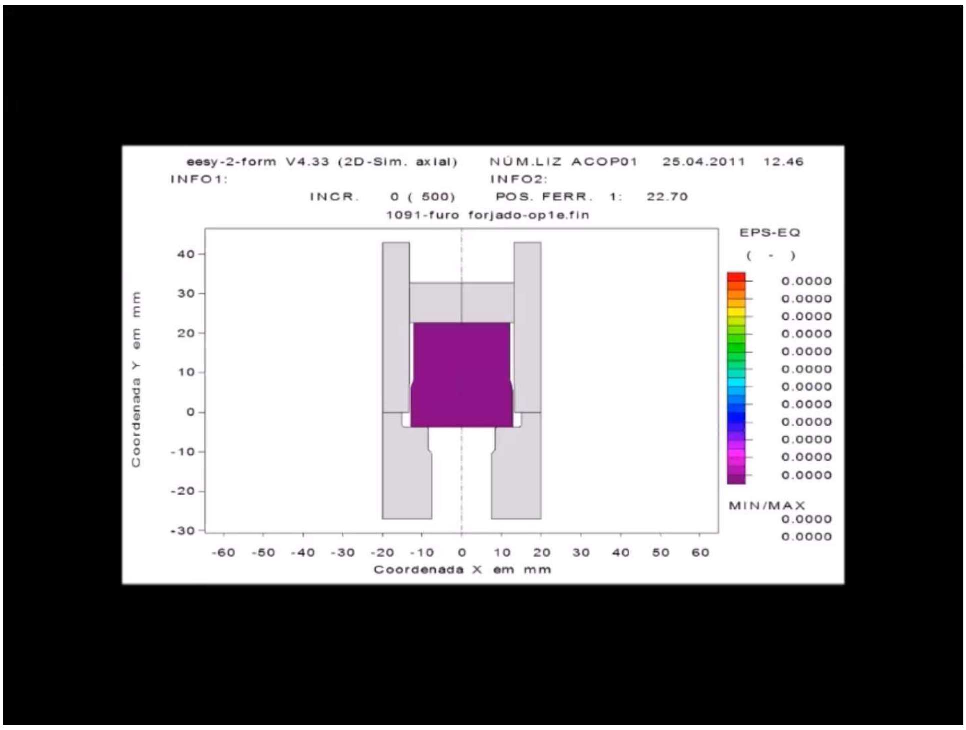
Examples of highly engineered forged parts

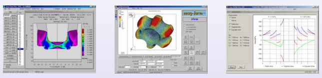


<u>Shock Absorber</u>

Function of the cushion system







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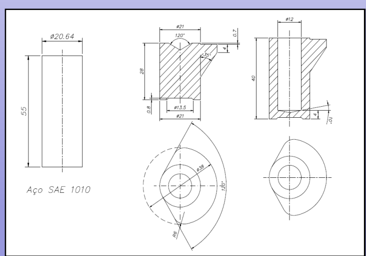
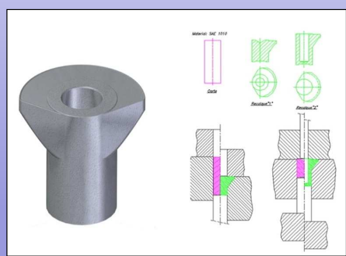
Examples of highly engineered forged parts





Special part produced with cushion system

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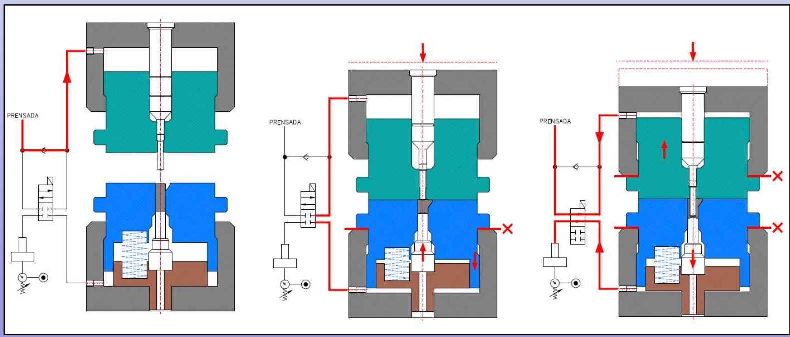
Examples of highly engineered forged parts



Prinziple of the cushion system

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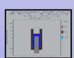
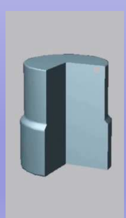
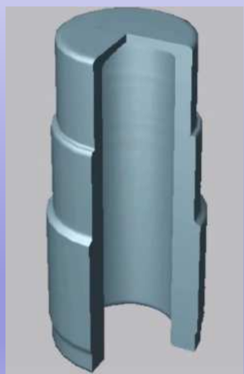
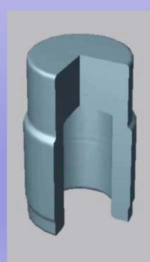
Examples of highly engineered forged parts

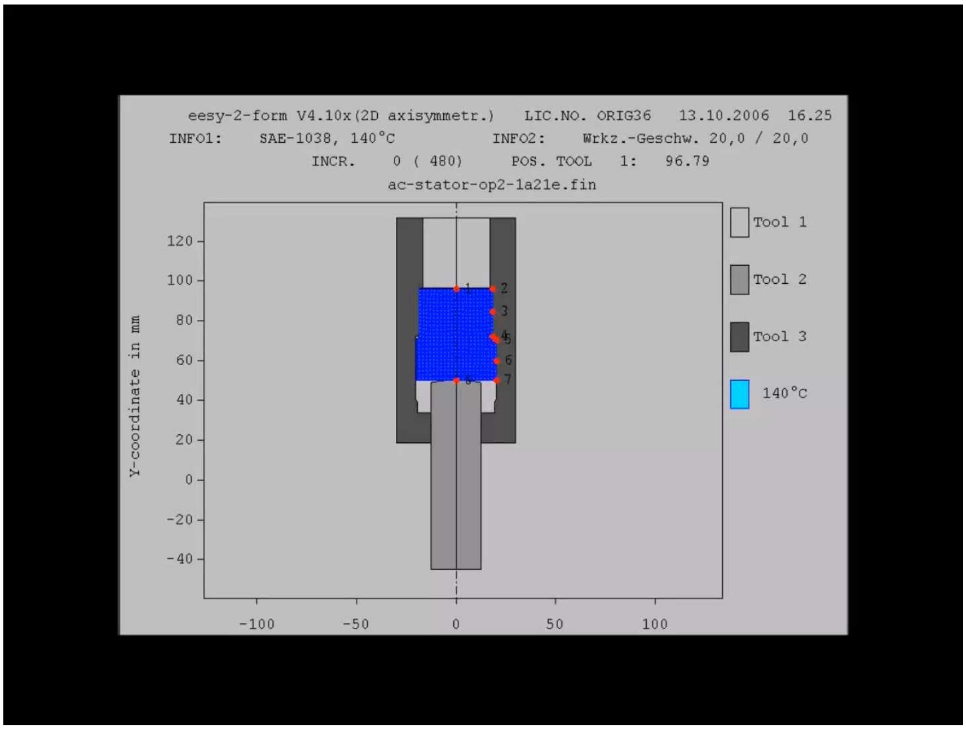
Part with splines

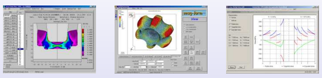












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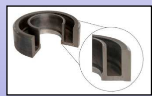
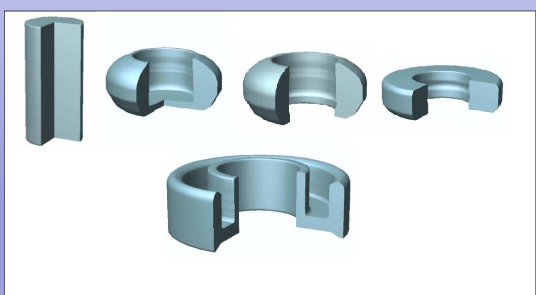
Examples of highly engineered forged parts

<u>Production of a rotor from bar</u>





four stage progression

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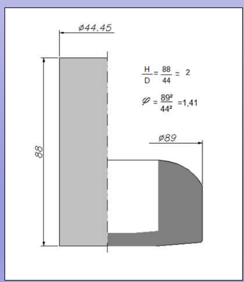
Examples of highly engineered forged parts

Production of a rotor from bar



Production problem in first operation -initial design

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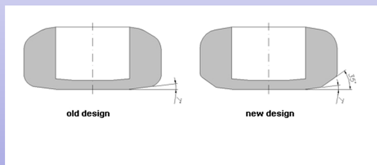
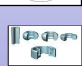
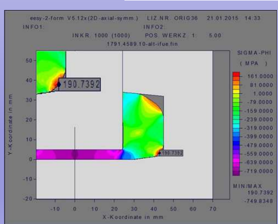
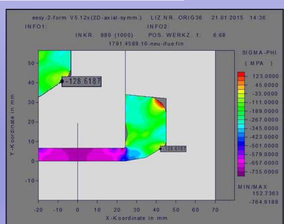
Examples of highly engineered forged parts



Design change first stage

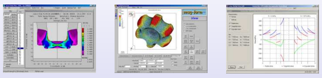






old design **stress analysis** new design

First stage new design



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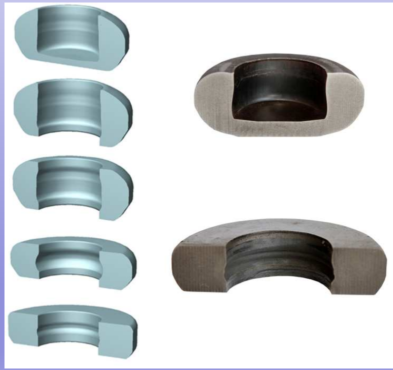
FEA in optimization of progression and tool design in cold forging

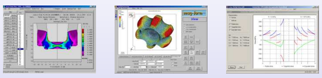
Examples of highly engineered forged parts



Piercing and third stage

Design change
first stage

First stage new design



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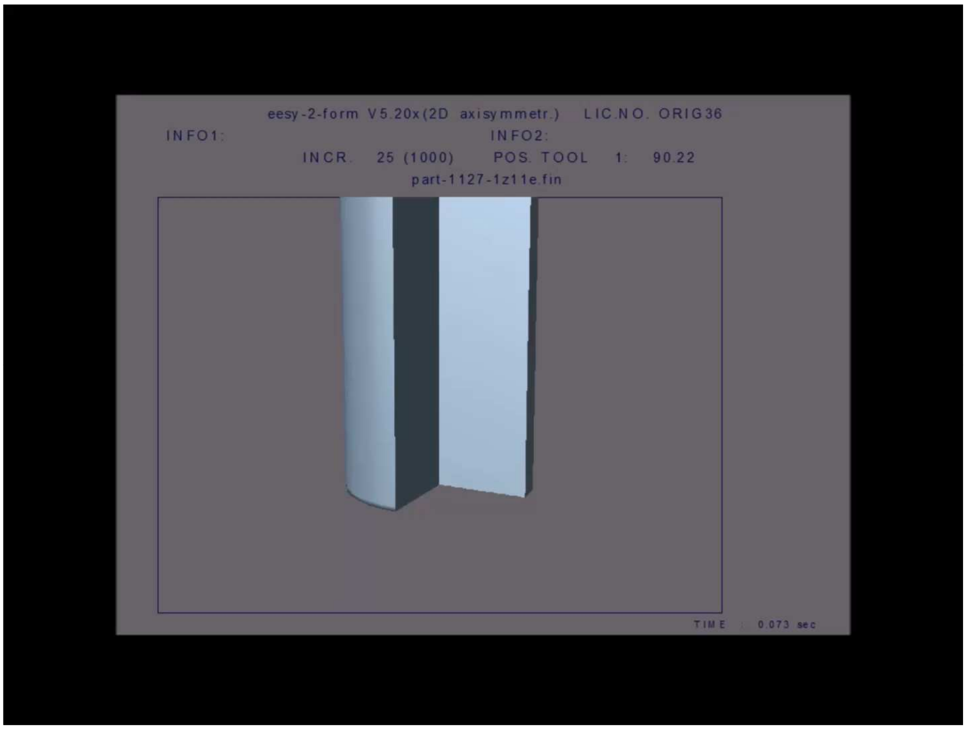
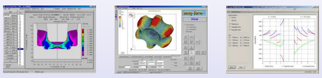
Examples of highly engineered forged parts

Fourth stage

Design change
first stage

First stage new design





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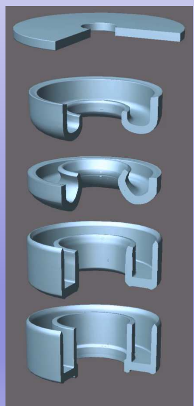
Examples of highly engineered forged parts



Alternative production of the rotor
from sheet metal

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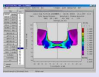
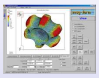
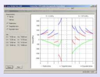

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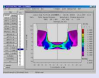
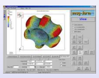
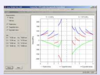
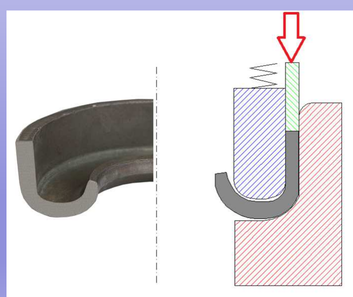
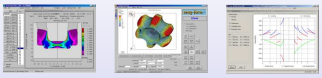
Examples of highly engineered forged parts

FEA in optimization of progression and tool design in cold forging

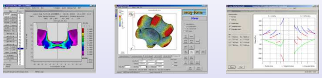
Examples of highly engineered forged parts





FEA in optimization of progression and tool design in cold forging

Examples of highly engineered forged parts



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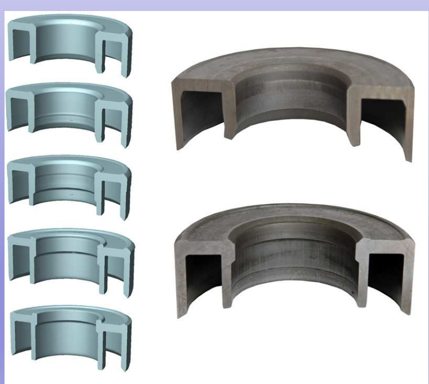

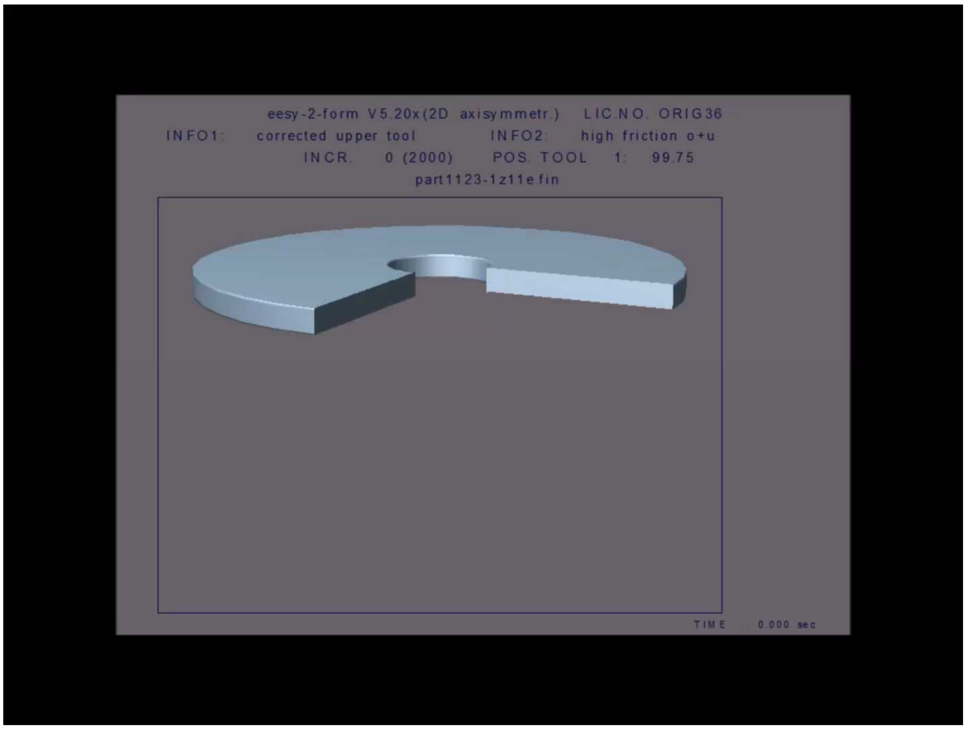

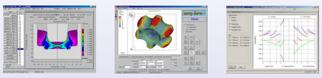

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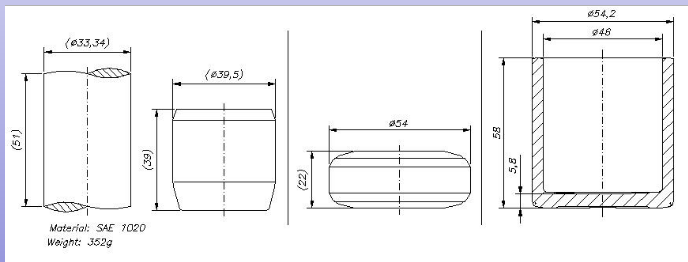

Brake Piston

Conventional production sequence using backward extrusion

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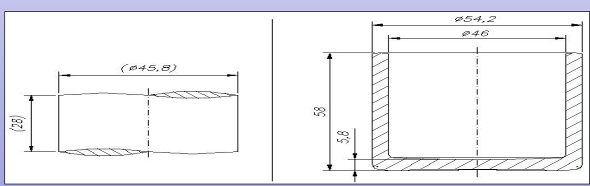
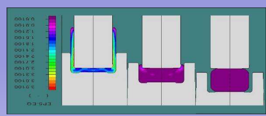
Examples of highly engineered forged parts

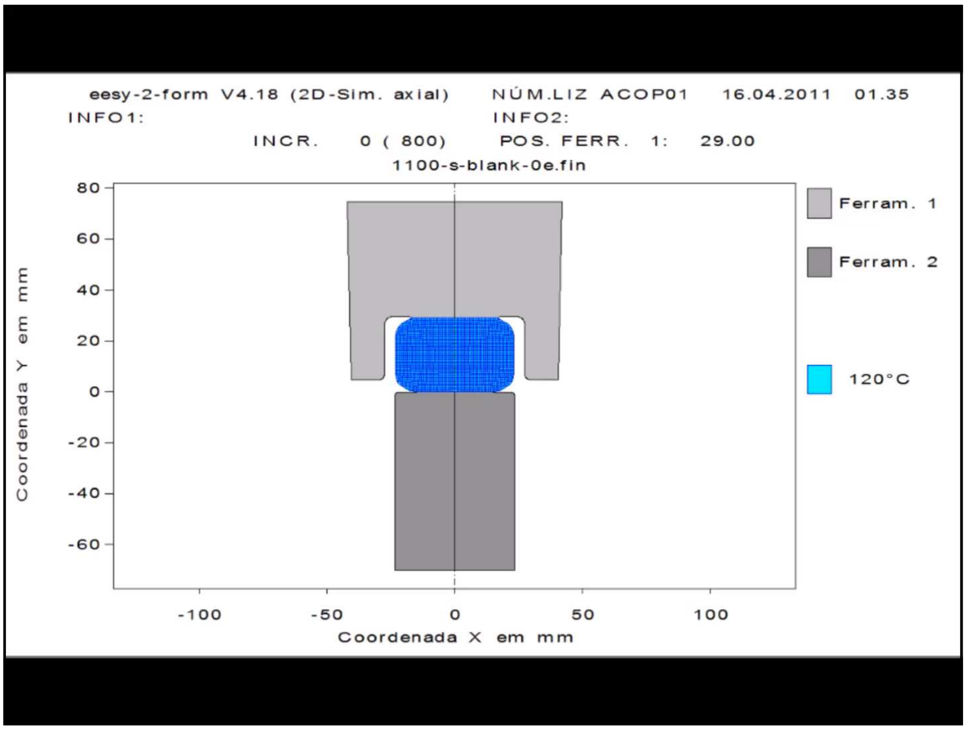


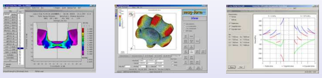
Brake Piston

Conventional backward extrusion

Load ~ 450 to







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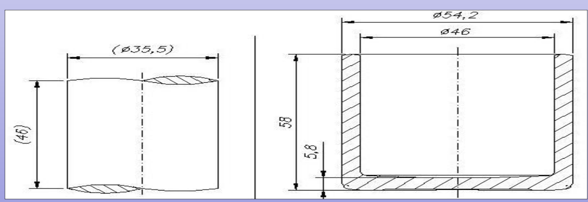
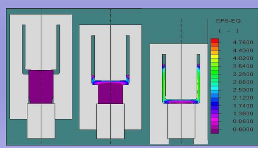
Examples of highly engineered forged parts



Brake Piston

“Osen” process

Load ~ 180 to



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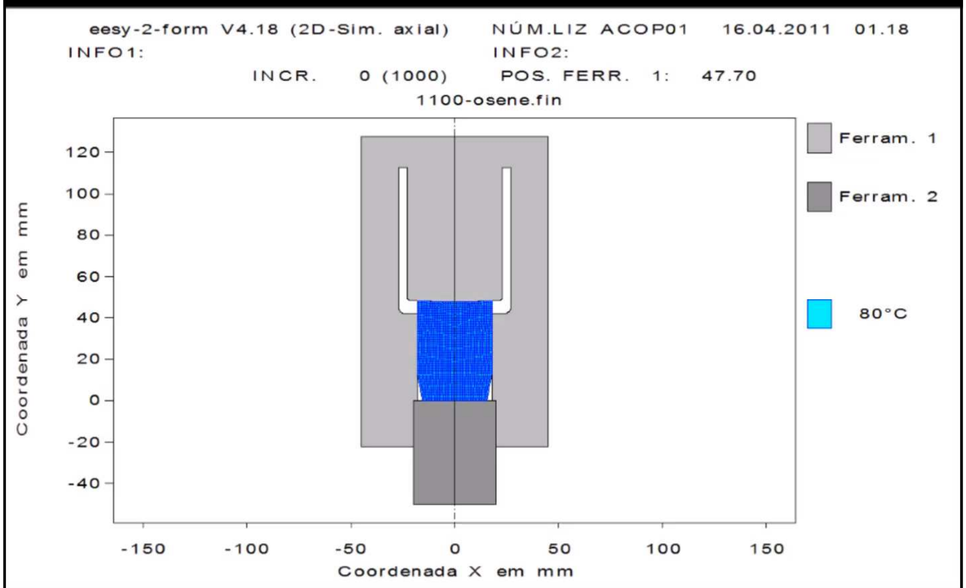

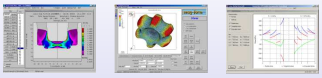

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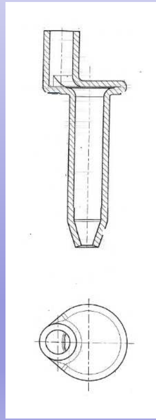
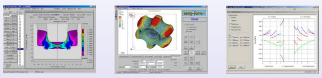
Examples of highly engineered forged parts



Light weight part



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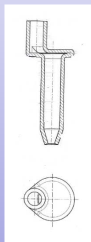
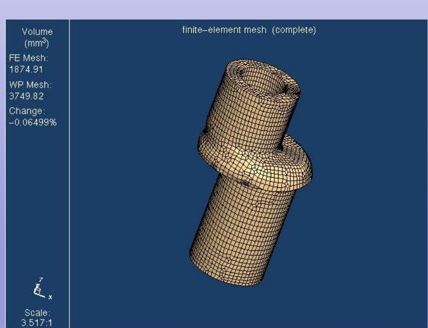
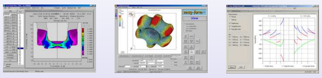
FEA in optimization of progression and tool design in cold forging



Examples of highly engineered forged parts



Light weight part



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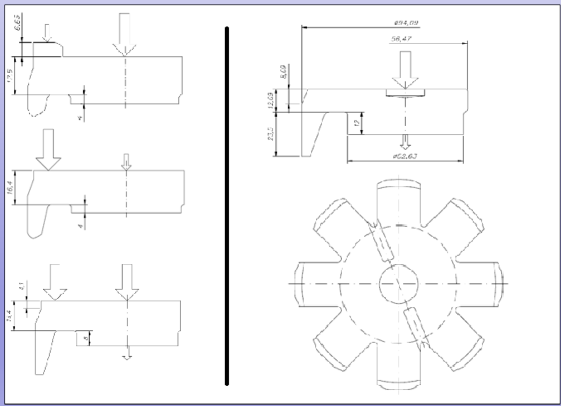
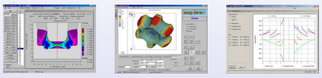
FEA in optimization of progression and tool design in cold forging

Examples of highly engineered forged parts



Claw Pole



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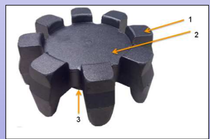
FEA in optimization of progression and tool design in cold forging

Examples of highly engineered forged parts

Claw Pole



Calculation of the relevant contact areas

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FEA in optimization of progression and tool design in cold forging

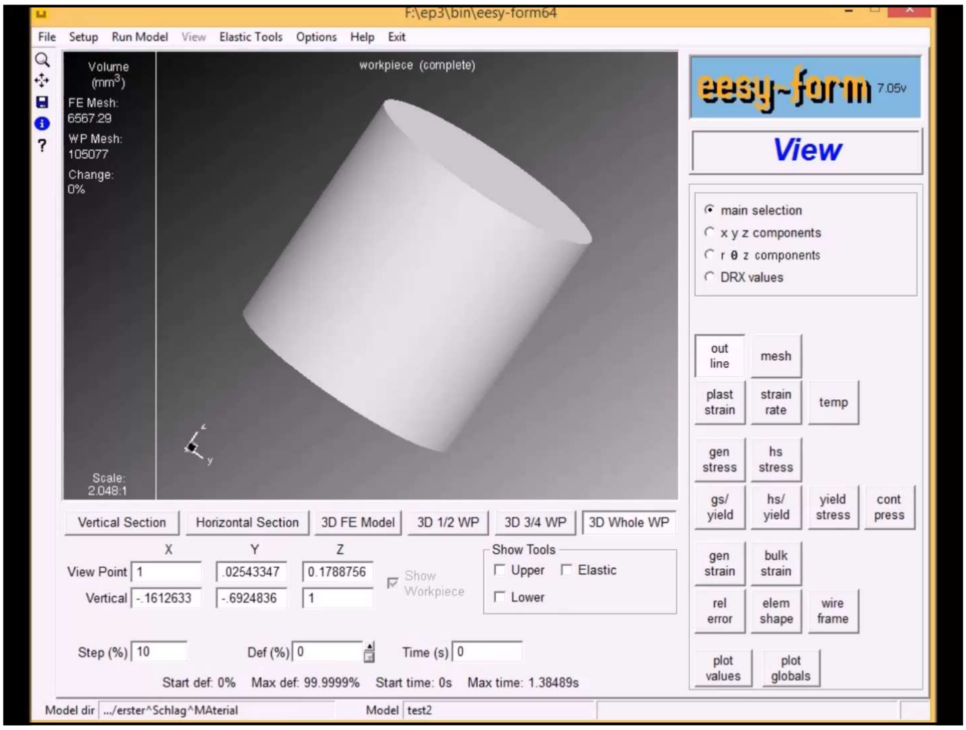
Examples of highly engineered forged parts

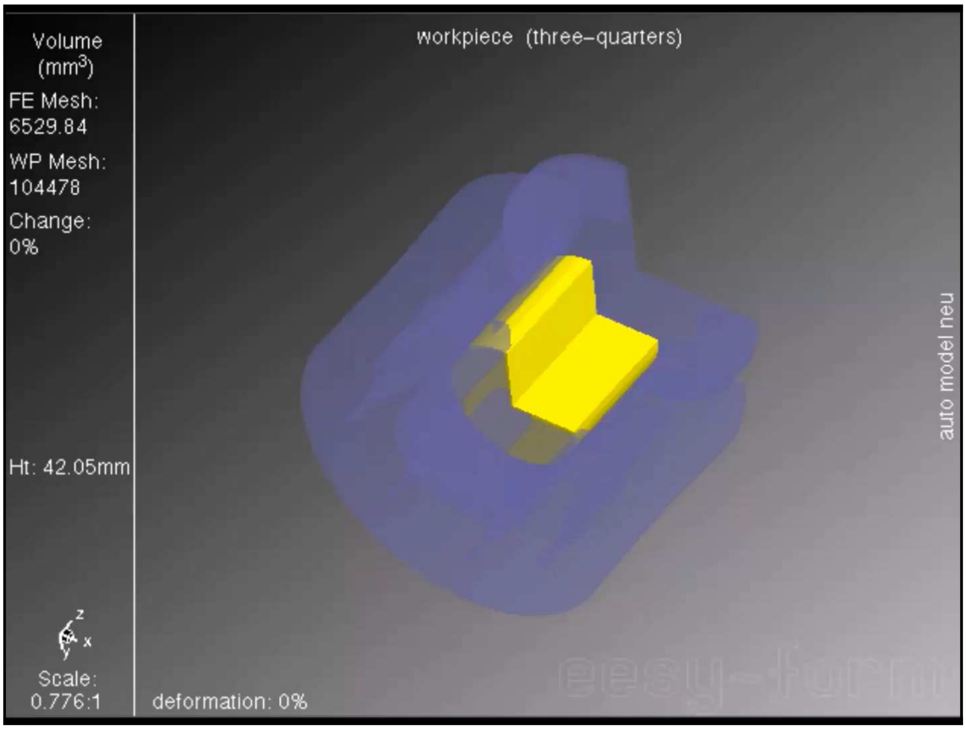
Claw Pole

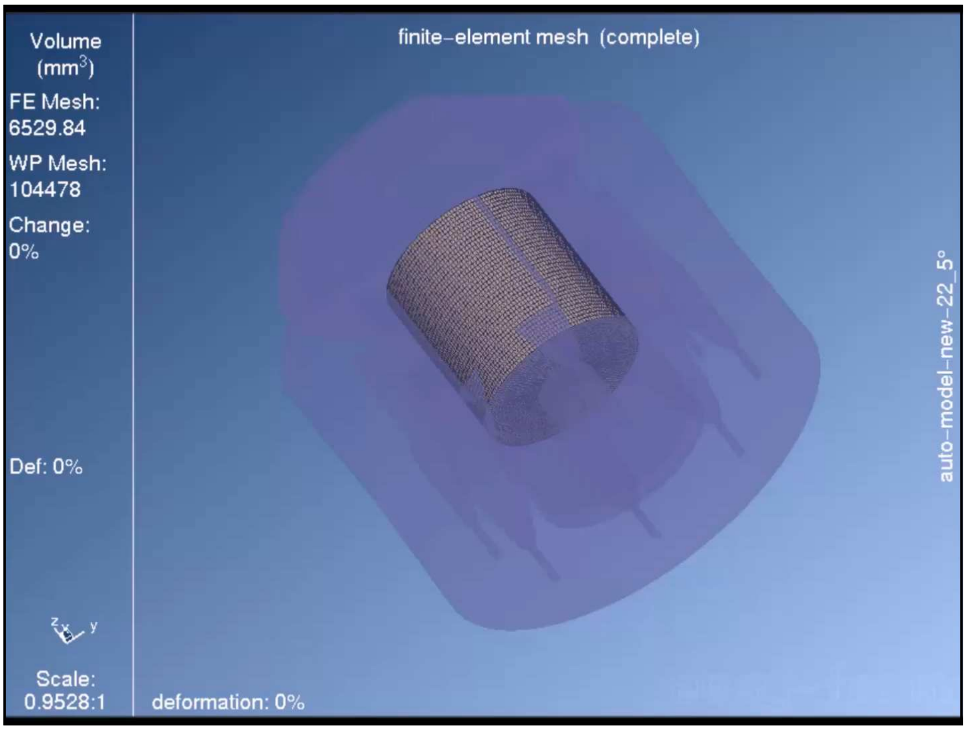
Cut off | 1. Op warm 600°C | 2. Op cold calibration

(c) 2016 Dr. Gerhard H. Arfmann, Dr. Michael Twickler 39

5th GAF Advanced Fastener Technology Development International Forum, 07./09.09.2016, Shanghai, PR China




Volume
(mm³)
FE Mesh:
6529.84
WP Mesh:
104478
Change:
0%
Ht: 42.05mm
Scale:
0.776:1
workpiece (three–quarters)
auto model neu
deformation: 0%


Volume
(mm³)
FE Mesh:
6529.84
WP Mesh:
104478
Change:
0%
Def: 0%
Scale:
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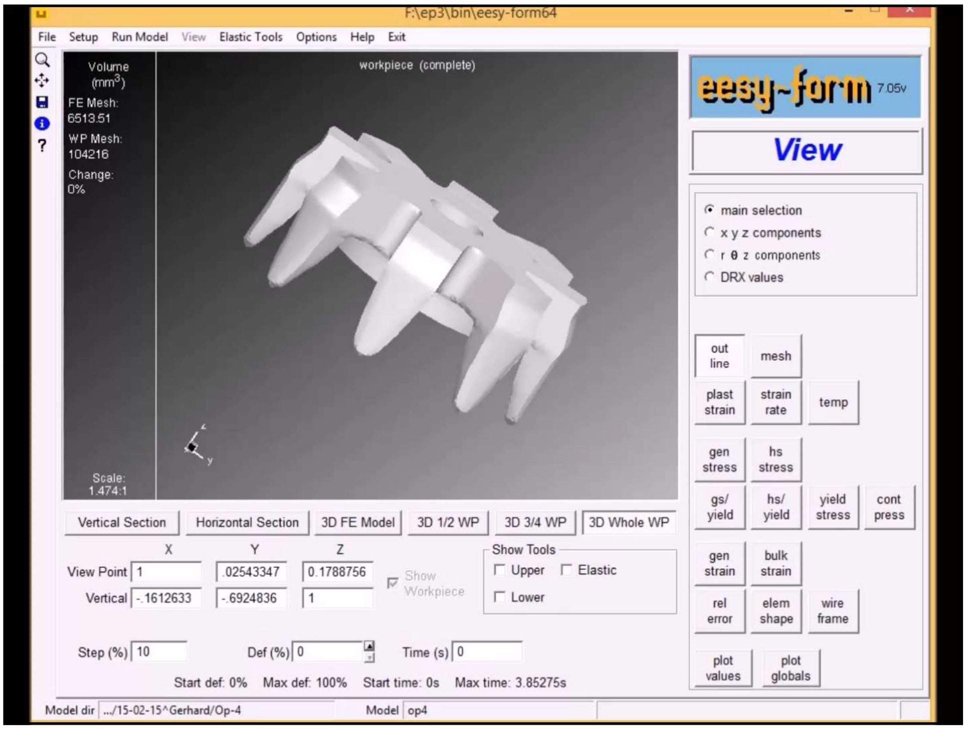
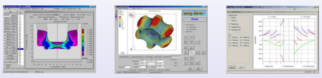
finite–element mesh (complete)
auto-model-new-22_5°
deformation: 0%

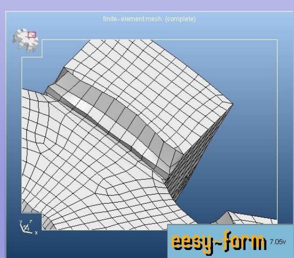




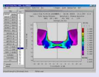
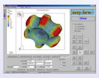
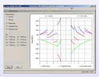
FEA in optimization of progression and tool design in cold forging

Examples of highly engineered forged parts

Claw Pole

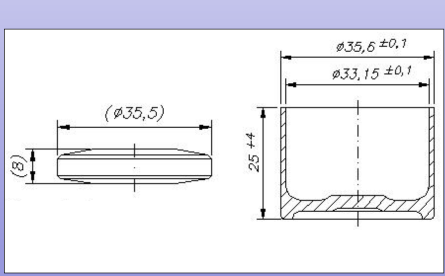


Failure detection during development

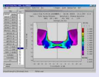
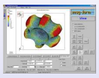
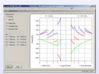




The role of FEA application in progression and tool design in cold forging

Examples of improved tool design



Valve Tappet

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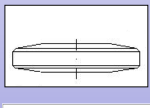
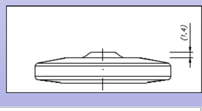
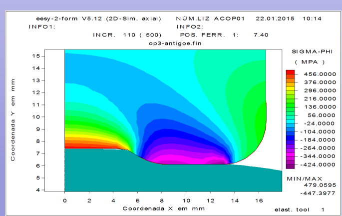
The role of FEA application in progression and tool design in cold forging

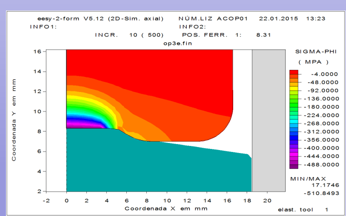
Examples of improved tool design



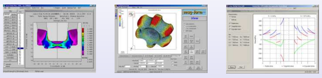
Valve Tappet







Stress analysis old and new preform – tangential stress



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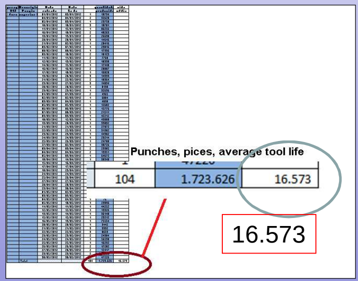
Examples of improved tool design

Valve Tappet

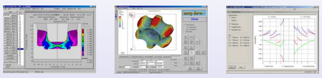


Operação	Descrição	Data	Data		quantidade	vida
012	Punção furo	entrada	Saída		produzida	média
furo	1112	05/01/2013	22/01/2013	1	306862	
		23/01/2013	01/02/2013	1	159514	
		02/02/2013	07/02/2013	1	159009	
		08/02/2013	25/02/2013	1	310984	
		26/02/2013	06/03/2013	1	82310	
		07/03/2013	14/03/2013	1	249464	
		02/04/2013	05/04/2013	1	109904	
		06/04/2013	11/04/2013	1	117252	
		12/04/2013	16/04/2013	1	147344	
		19/04/2013	24/04/2013	1	127711	
		25/04/2013	26/04/2013	1	149130	
		27/04/2013	03/06/2013	1	712489	
		04/06/2013	20/06/2013	1	361138	
		21/06/2013	30/06/2013	1	123517	
	Total			14	3.116.62[illegible]	222.616

222.616

Tool life improvement:
initial: 16573pieces/tool optimized:222616 pieces/tool

New tool cost < 8% of the initial costs



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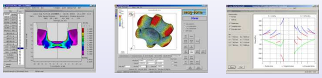
The role of FEA application in progression and tool design in cold forging

Examples of improved tool design

Six Lobe screw



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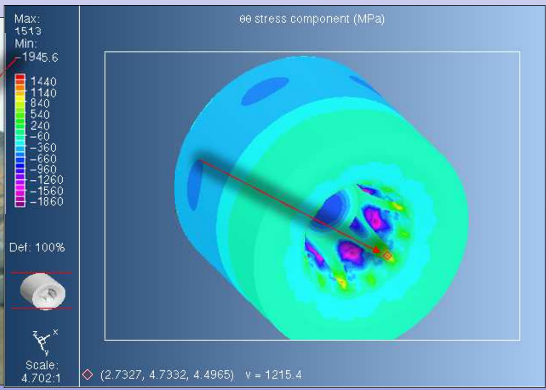
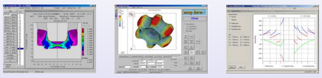


Tool breakage

Stress analysis (tangential stress-positive >1.200MPa



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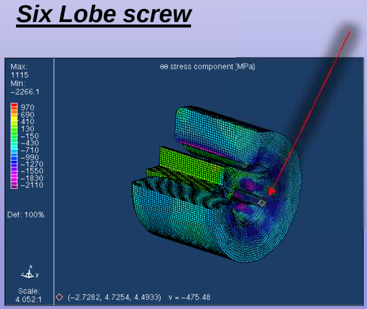

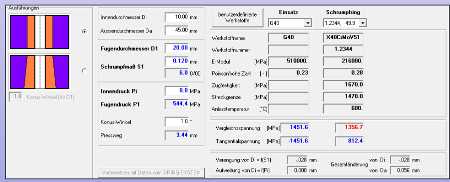

Optimizing tool design to improve the pre-stressing of the insert

400MPa -> 550 MPa

Stress analysis (tangential stress-compressive ~-500MPa)

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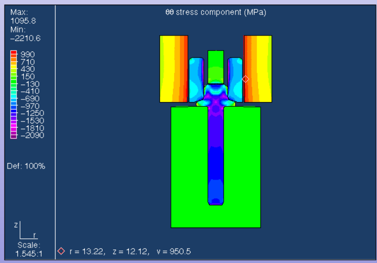

Tool layout overview

Tool actual in production enjoying tool life of more than 2.000.000 pieces

Six Lobe screw

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The role of FEA application in progression and tool design in cold forging

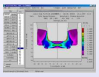
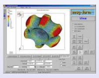
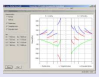
Conclusions

This presentation shows that with
good engineering skills, **new ideas**, **the willingness to try new things** and

the appropriate use of existing good software tools,

the challenges in the market can be met and overcome.

New processes can be designed, tools may be constructed differently,
and the efficiency of forming processes may be improved.
Cold forging has a high potential for future development still.
This presentation is intended to encourage cold forging companies to be forward-thinking and to use available technology intensively.
This will help them to survive in a future of increasing competition,
and the growing technological demands of their clients.

Acknowledgement

The authors would like to thank all their customers contributing to this presentation for their generous support.

Amongst others especially

Mr. Pedro Schmitt of Acopecas, Brazil

has to be mentioned for his continuous contributions.

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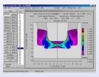
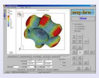
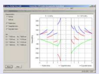
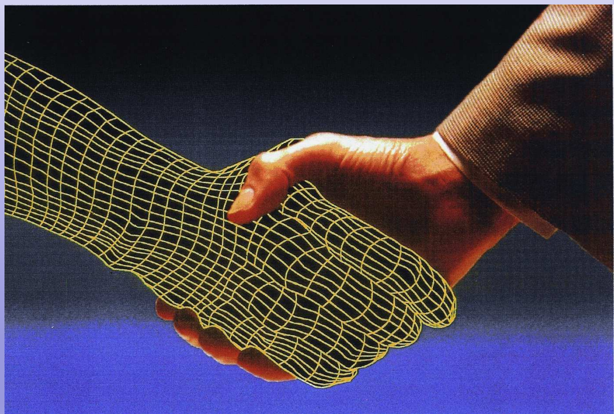




Combine ideas, technology and simulation

I think -> I know how-> I know why -> I may generate new know how



Thank you for your attention