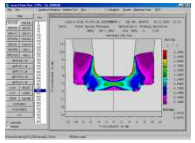
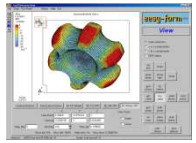
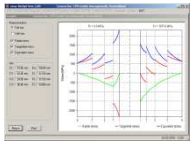
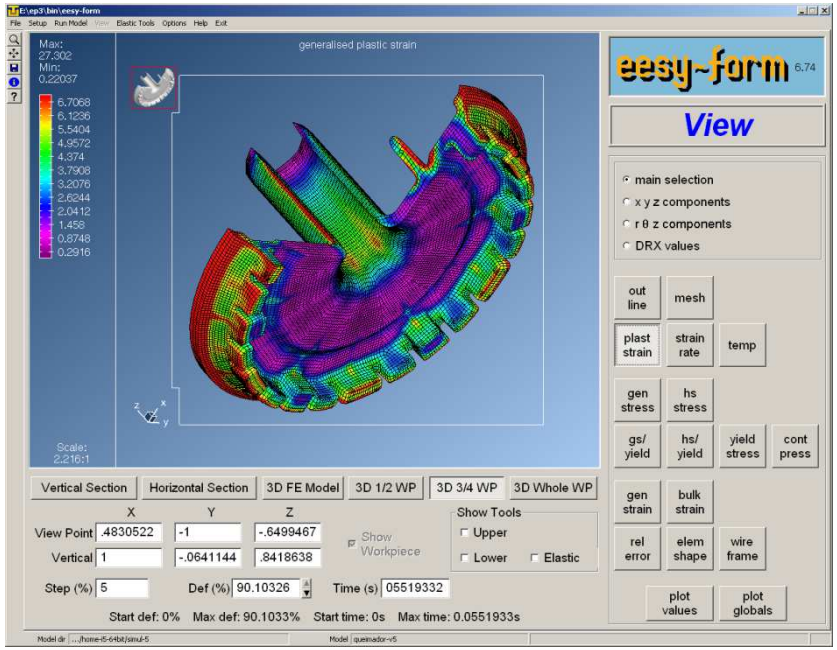




**CPM Gesellschaft für Computeranwendung,
Prozeß- und Materialtechnik**

Application of FEA Simulation in Cold Forging

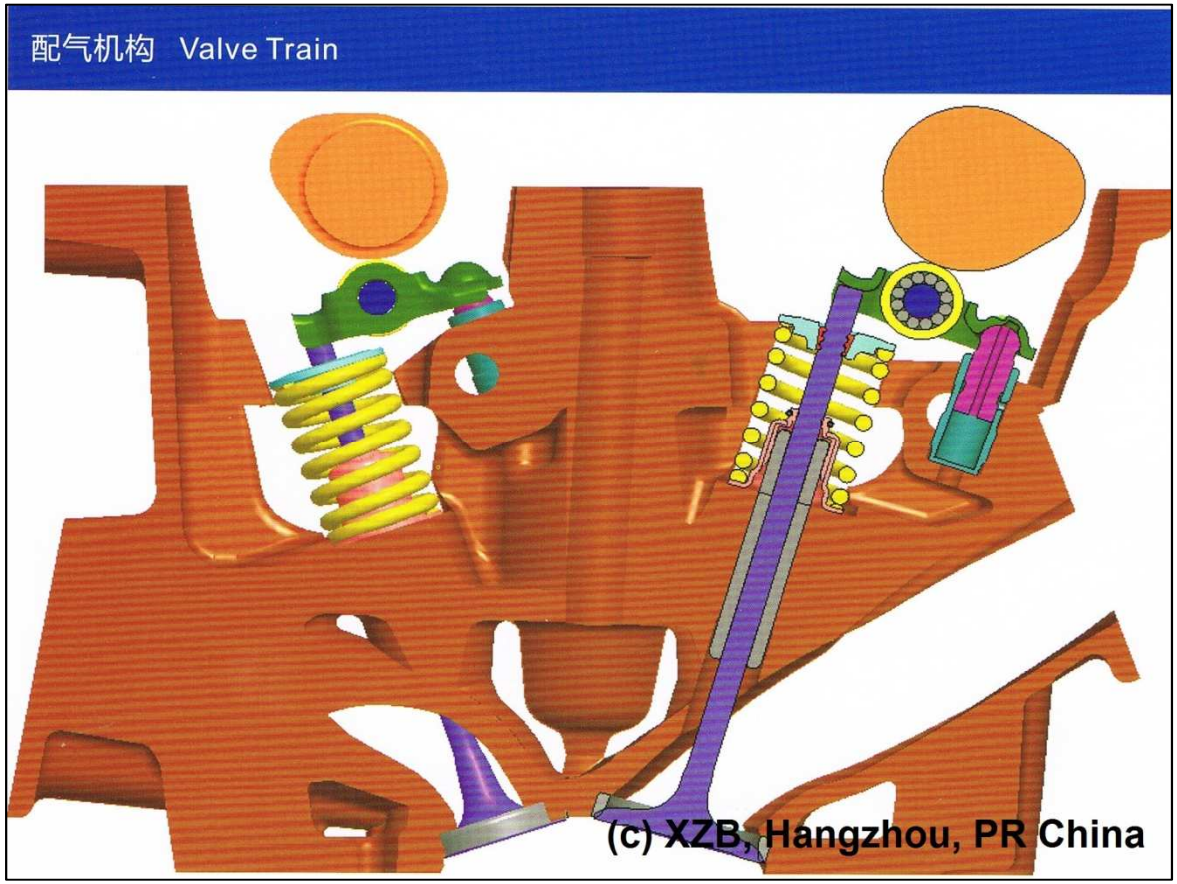


Dr. Gerhard H. Arfmann, Dr. Michael Twickler
CPM GmbH, Herzogenrath, Germany

Application of "*eesy*" Simulation in Cold Forging

Automotive parts made by Forging

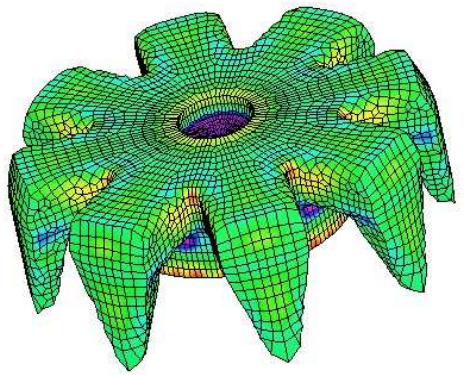
Application of FEA Simulation in Cold Forging



Interesting Automotive parts made by Cold Forging

Application of FEA Simulation in Cold Forging

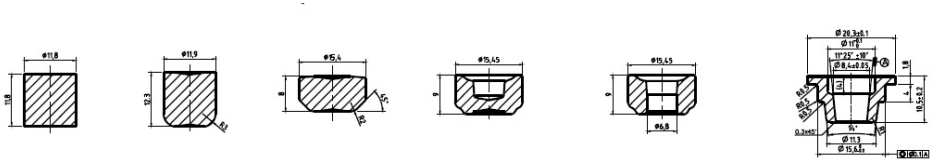
How to design the right process to produce a forged part?



Application of FEA Simulation in Cold Forging

Starting from the product drawing the engineer has to

**design the forming sequence,
chose the machine and
designs the tooling**.



Traditionally he starts his work from **some initial design** and orders **the tooling**.

After arrival of them he starts with **the try out**.

After **some trial and error cycles** the engineer works out the
final process and tool design.

Bild: XZB, Hangzhou, PR China

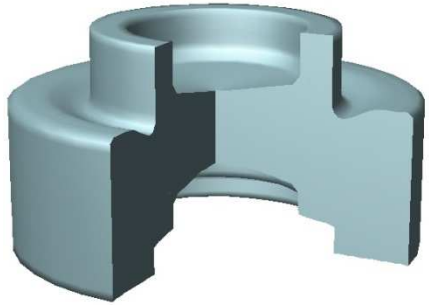
Application of FEA Simulation in Cold Forging

Process Idea

The process idea normally comes from the design engineer.

He may generate it from

- his own knowledge
- experience
- from books
- information from third parties.



Application of FEA Simulation in Cold Forging

Initial Design

Normally the engineer adjusts existing designs to the requirements of the new part.

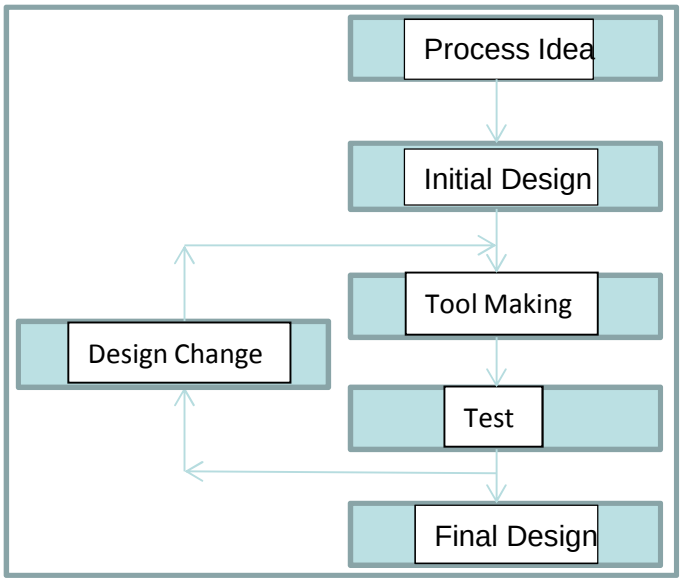
More rarely he develops a new process design form the roots.

Available design packages based on empirical basic technology and/or on stored example progressions may help him as well.

<u>However the engineer has to come up with an initial design layout.</u>

Application of FEA Simulation in Cold Forging

Principle of process design



As published by the author in the 1980`s to explain how future CA techniques may help the engineer

In some cases all the testing is wasted and the product cannot be produced.

Application of FEA Simulation in Cold Forging

The role of Finite Element Analysis (FEA) in Process Design

FEA supports the engineer to generate better designs:

- the engineer models his ideas in FEA
- he finds out whether his process idea will work
- technological information (Stresses, Strain, Flowlines..) enables him to optimize his design
- he can try alternative ideas
- he can study the tool design and can optimize that as well.

Result: The Process is optimized before ordering the tools even.

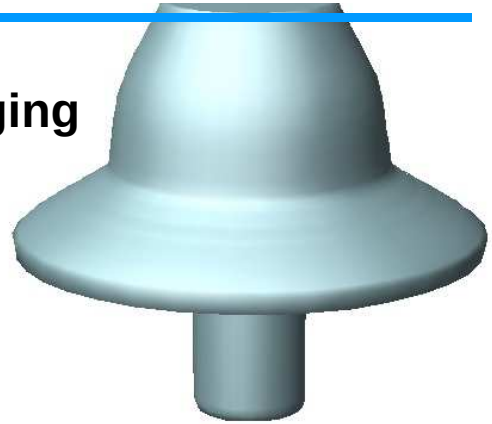
Further: In case of no success the development can be stopped before wasting time on endless trials.

In any case FEA helps to avoid costs.

Application of FEA Simulation in Cold Forging

How good is FEA?

Application of FEA Simulation in Cold Forging



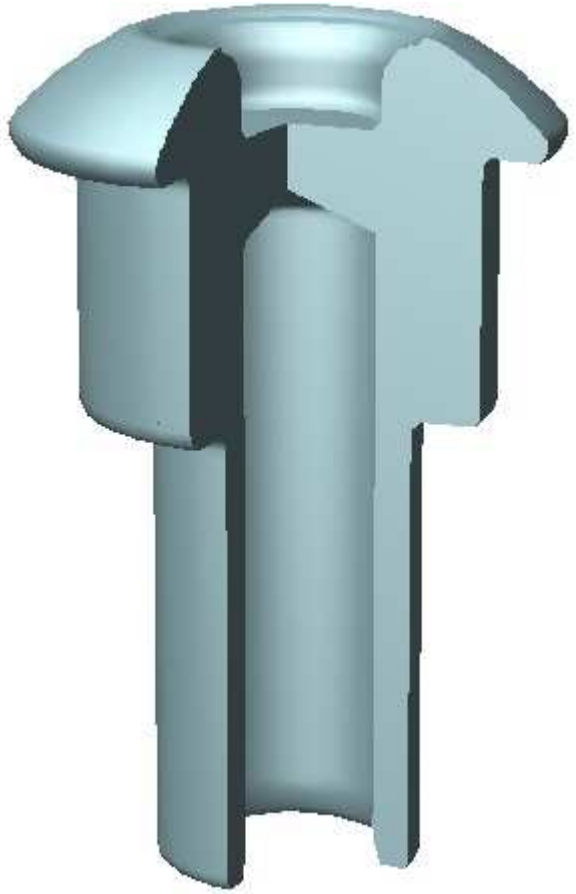
FEA is:

- precise enough to avoid trail and error
- quick enough to accelerate developments significantly (reduce the dev. Time)
- is more precise than the “firm” knowledge of experienced stuff
- helping to close the gaps in knowledge of the stuff
- having the required data (material, friction etc) available and proved
- practically exact even so scientifically not 100% precise
- providing the stuff much more insight in the process than any imagination of an experienced stuff
- best used by experienced stuff and will help to improve their technology
- …….

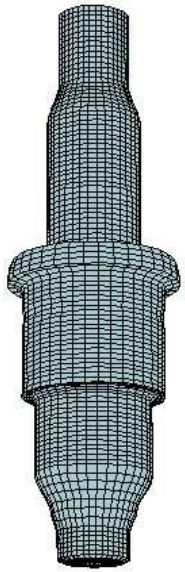
FEA is the ideal tool for the good engineer!

Application of FEA Simulation in Cold Forging

For what to use FEA?



Application of FEA Simulation in Cold Forging



The following examples deal with very real cases to show the advantage of the use of FEA.

They are of different complexity and therefore show that the use of FEA is not only beneficial for complex applications.

All cases are recent applications of customers.

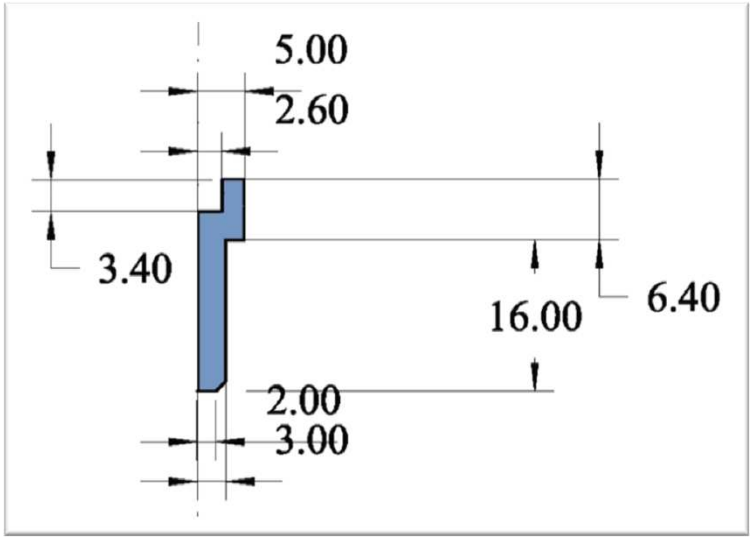
All of customers are long time in the market and have a sound reputation as good technology companies.

They provided these examples to show that consequent and continuous usage of FEA is a “must” in state of the art cold forging.

Application of FEA Simulation in Cold Forging

Design of a Process to form a Cylinder Head Bolt

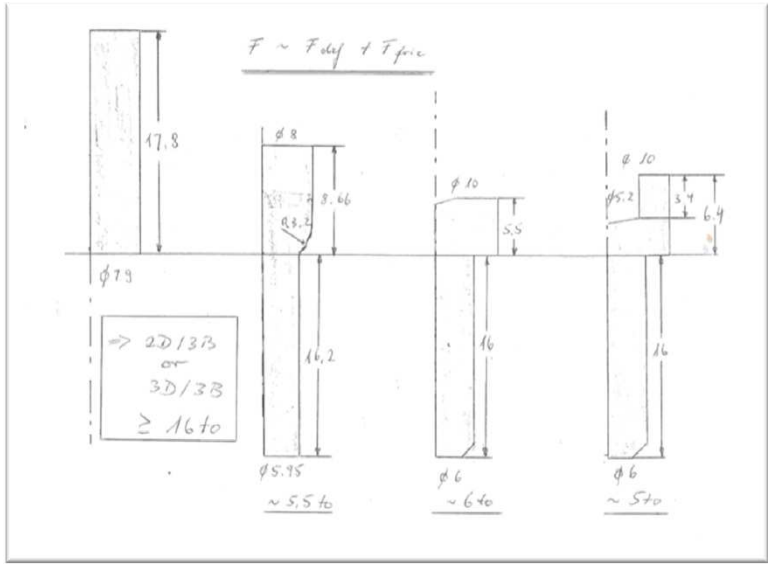
The following bolt had to be produced:



Application of FEA Simulation in Cold Forging

Design of a Process to form a Cylinder Head Bolt

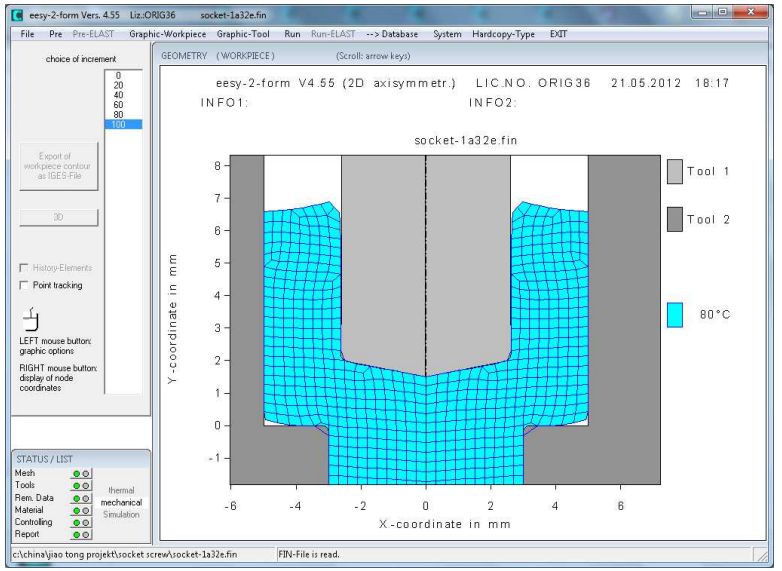
Using his knowledge and/or some support tools the engineer came up with his first approach to produce the fastener.



Application of FEA Simulation in Cold Forging

Design of a Process to form a Cylinder Head Bolt

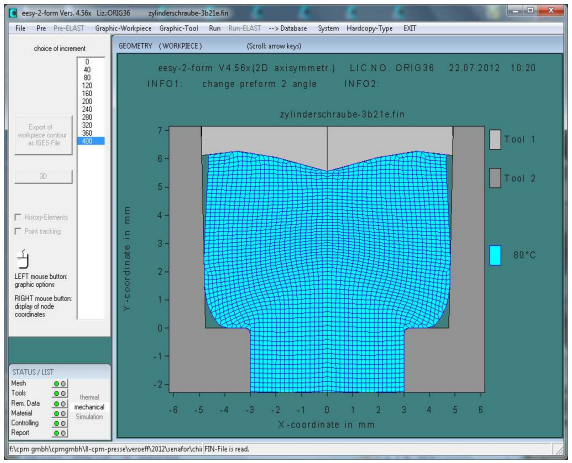
Simulations performed showed a bad (but typical) result:

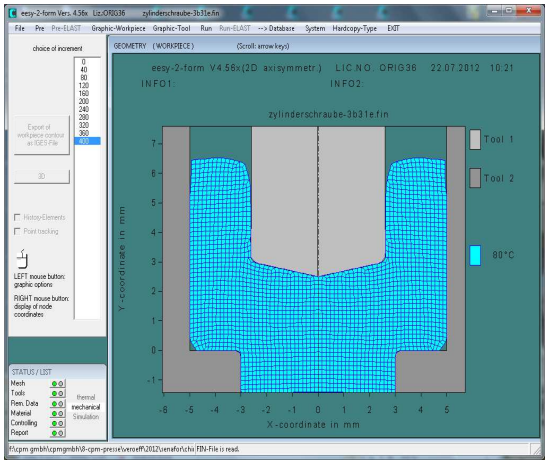


Application of FEA Simulation in Cold Forging

Design of a Process to form a Cylinder Head Bolt

Simulation based on empirical knowledge showed a bad result as well:

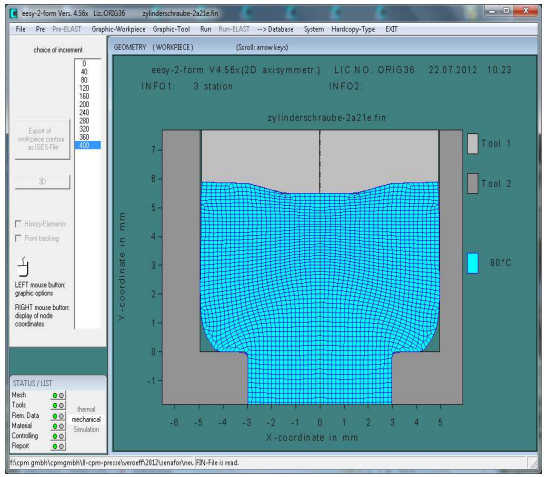


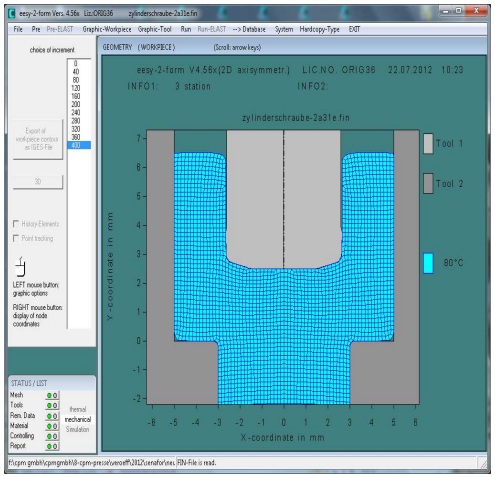


Application of FEA Simulation in Cold Forging

Design of a Process to form a Cylinder Head Bolt

Detailed studies of the material flow in several variations let to a good result:

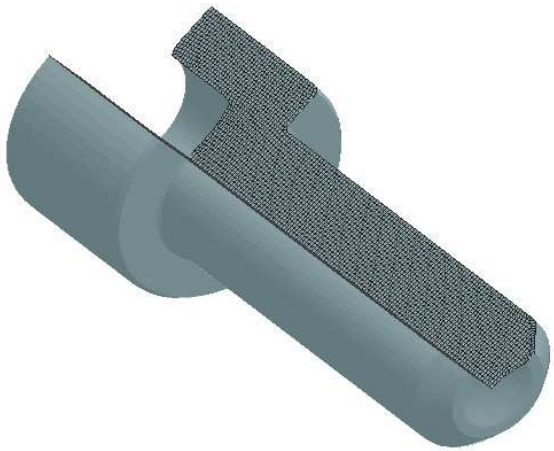




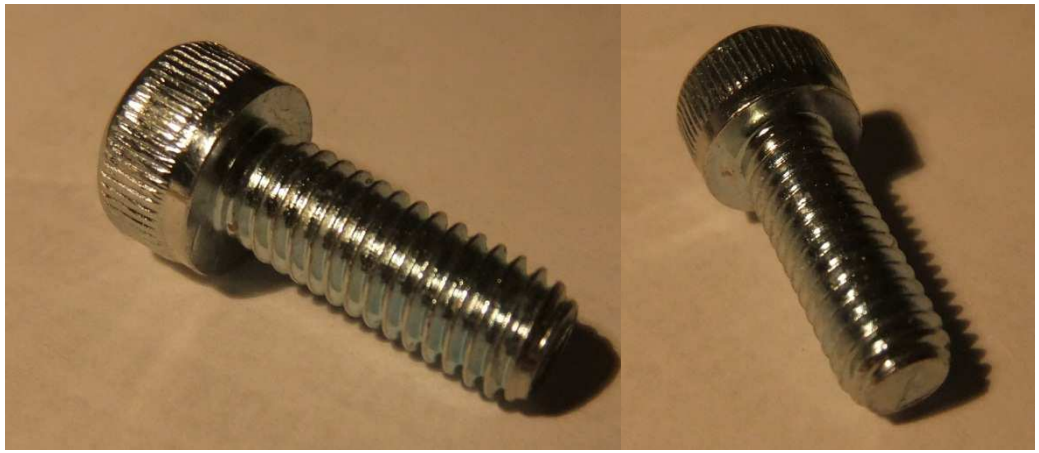
Application of FEA Simulation in Cold Forging

Design of a Process to form a Cylinder Head Bolt

Simulation

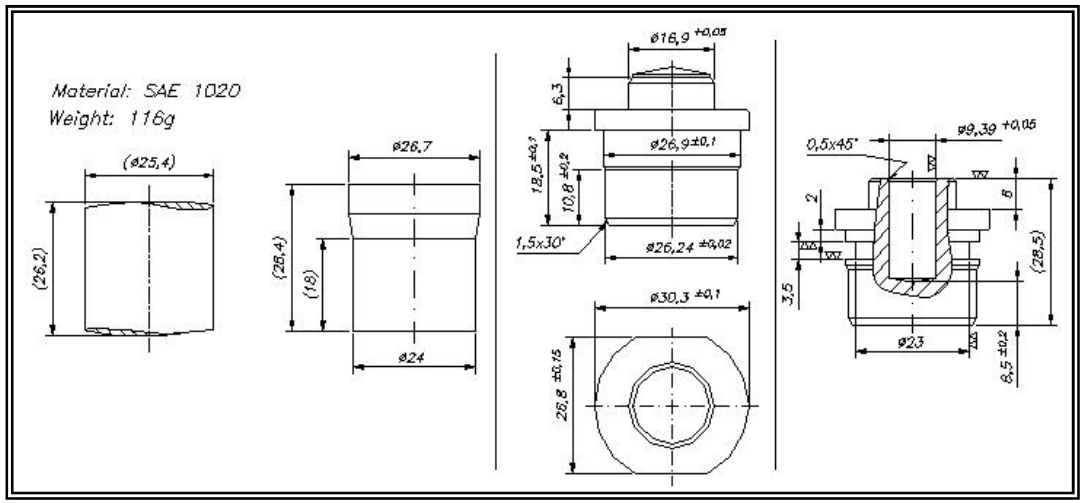


Real part.



Application of FEA Simulation in Cold Forging

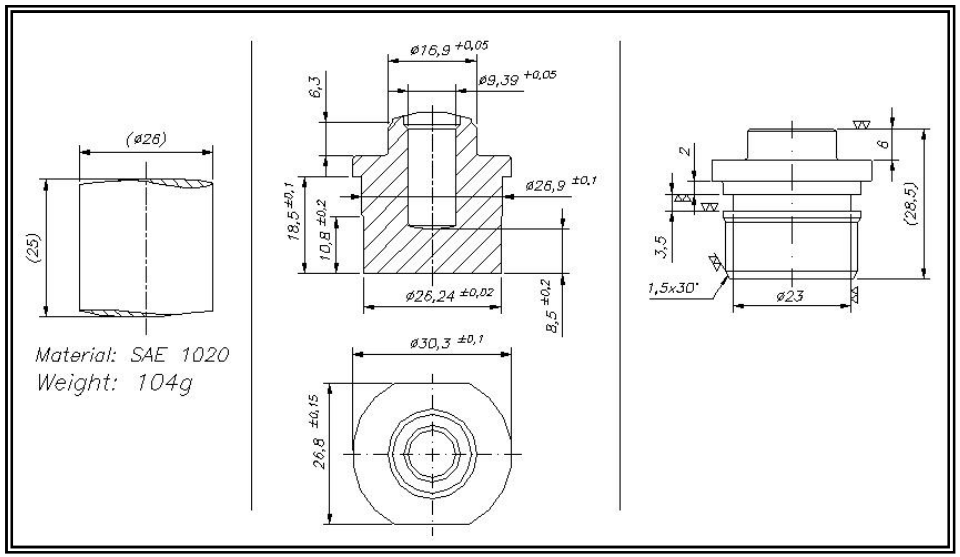
Production of a shock absorber



Conventional process

Application of FEA Simulation in Cold Forging

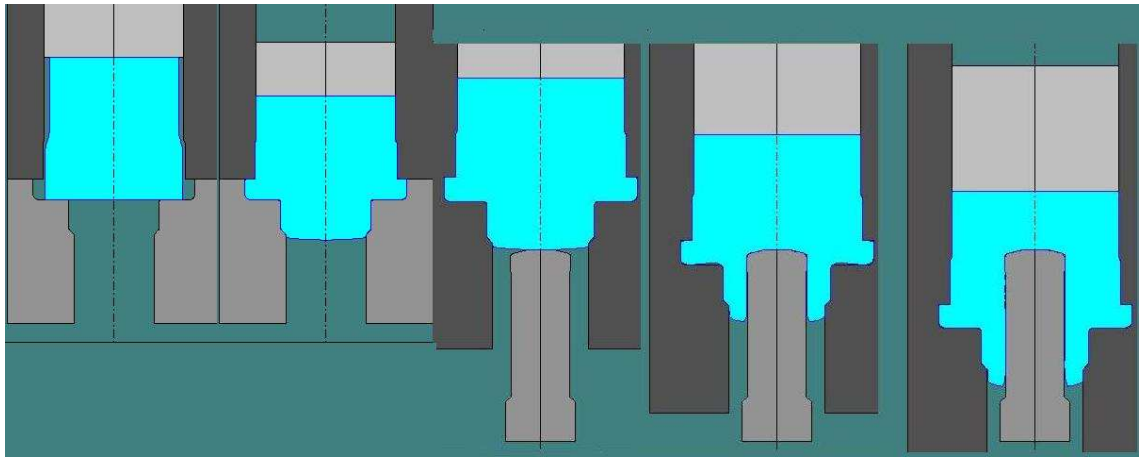
Production of a shock absorber



Single stage process

Application of FEA Simulation in Cold Forging

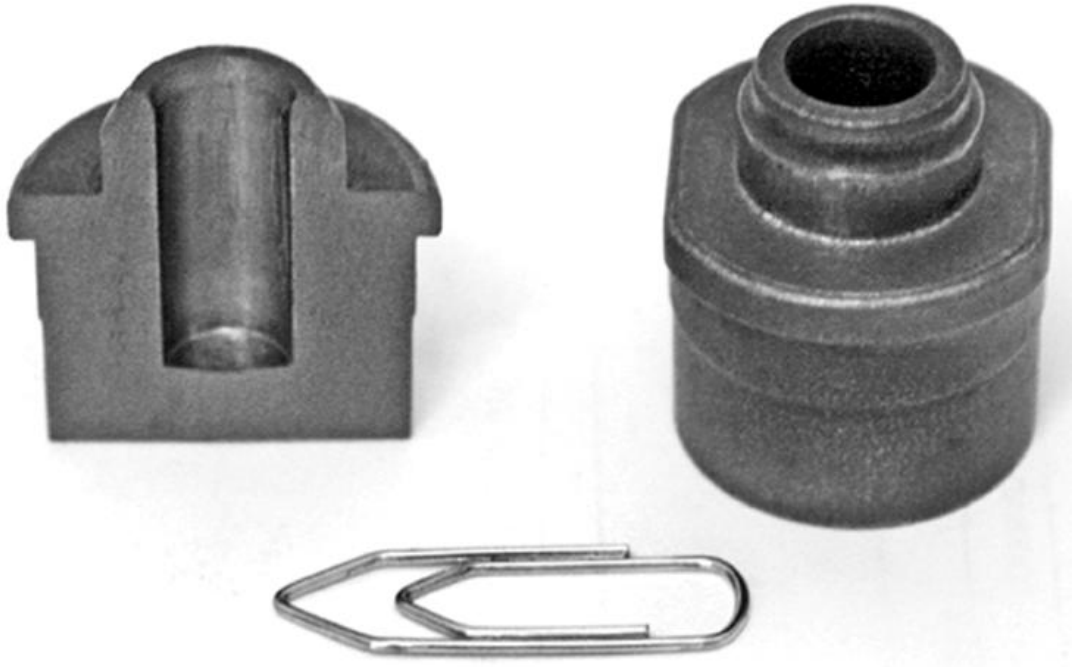
Production of a shock absorber



Simulation of the single stage process

Application of FEA Simulation in Cold Forging

Production of a shock absorber

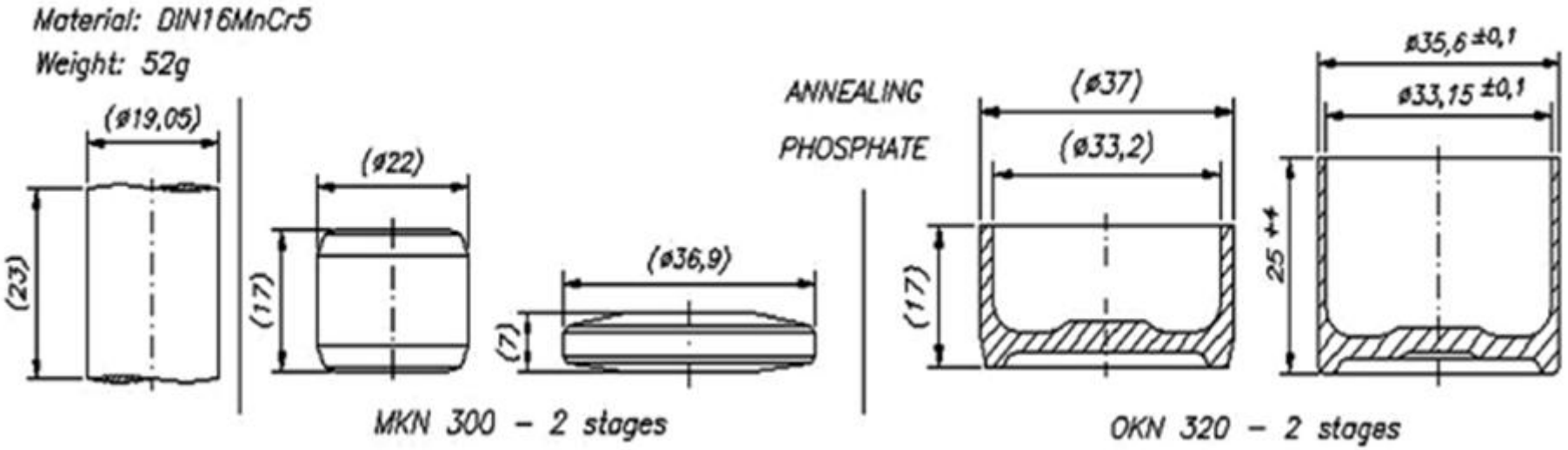


Application of FEA Simulation in Cold Forging

Test of new processes

Application of FEA Simulation in Cold Forging

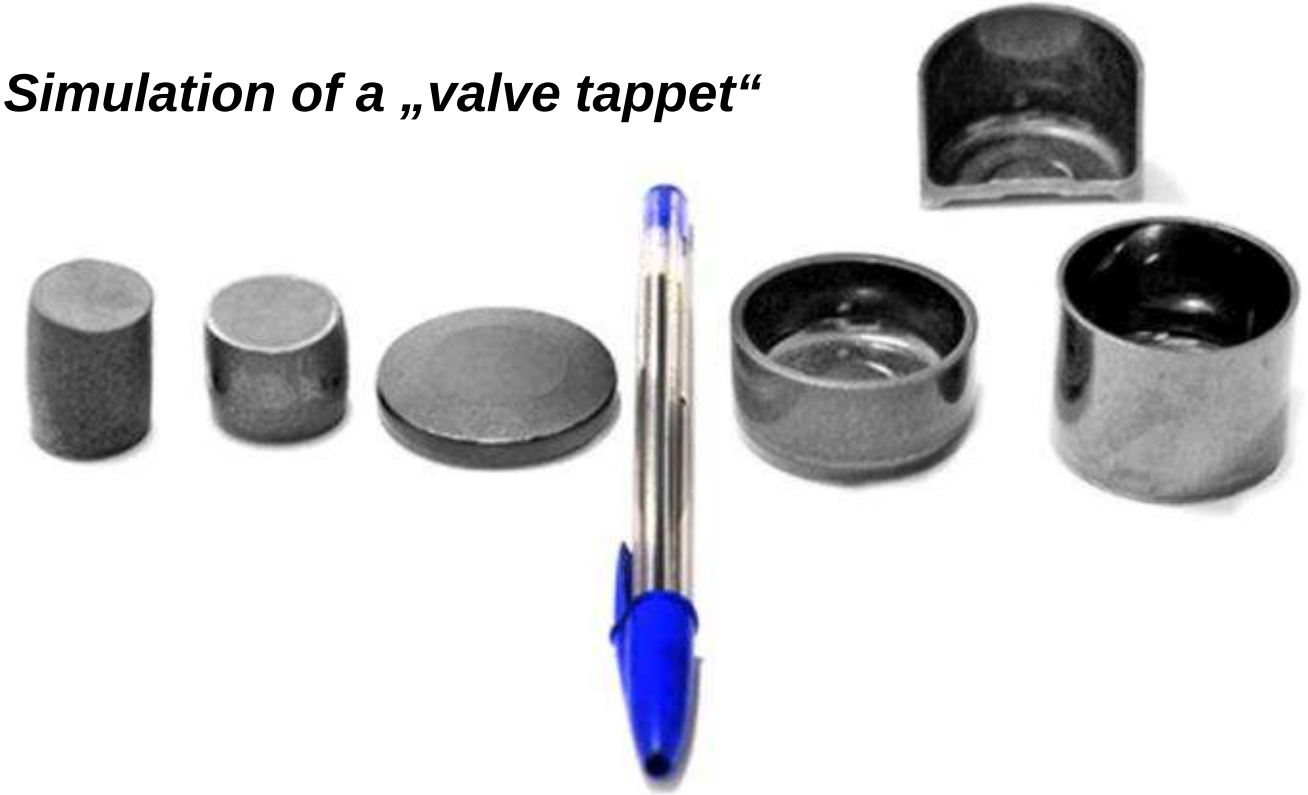
Simulation of a „valve tappet“



Traditional process

Application of FEA Simulation in Cold Forging

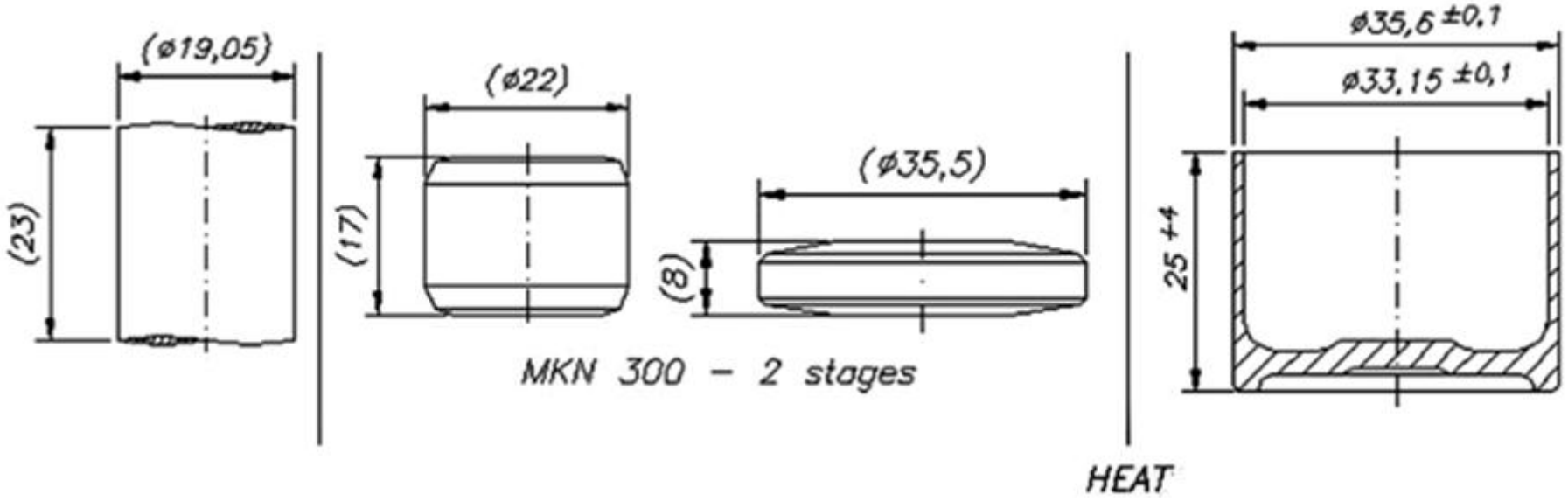
Simulation of a „valve tappet“



Traditional process

Application of FEA Simulation in Cold Forging

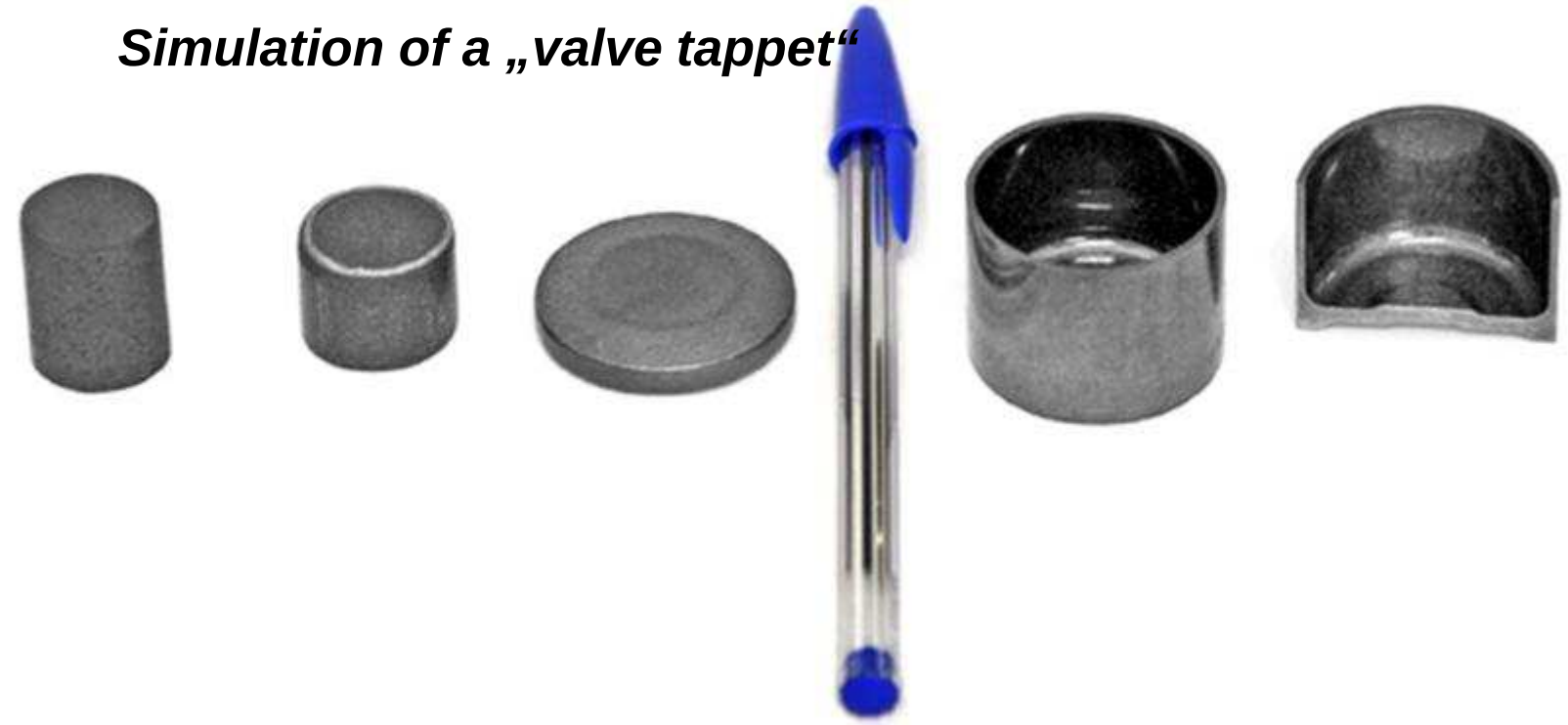
Simulation of a „valve tappet“



New process

Application of FEA Simulation in Cold Forging

Simulation of a „valve tappet“

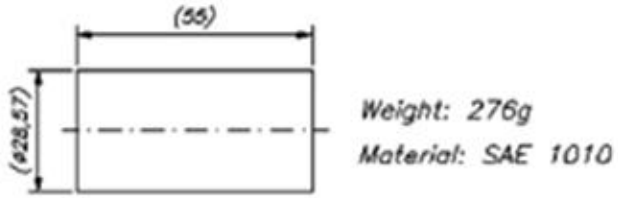


New process

Application of FEA Simulation in Cold Forging

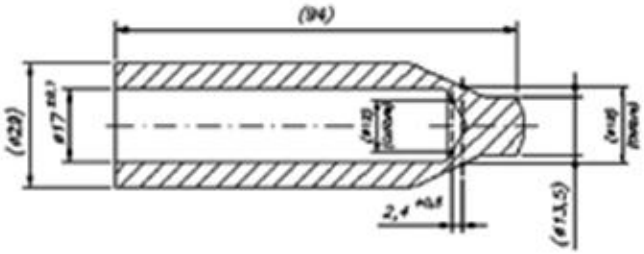
Production of a shock absorber body

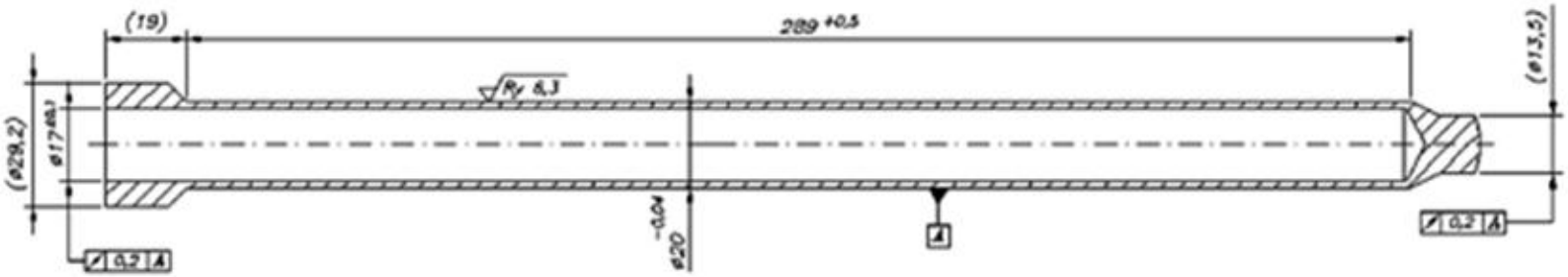
Application of FEA Simulation in Cold Forging



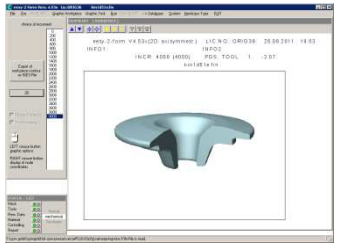
Weight: 276g
Material: SAE 1010

Production of a shock absorber body





Application of FEA Simulation in Cold Forging

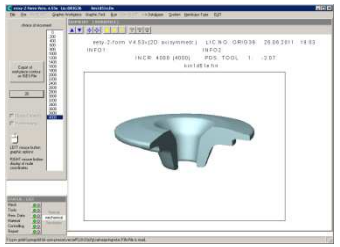


Production of a valve spring retainer – tool failure

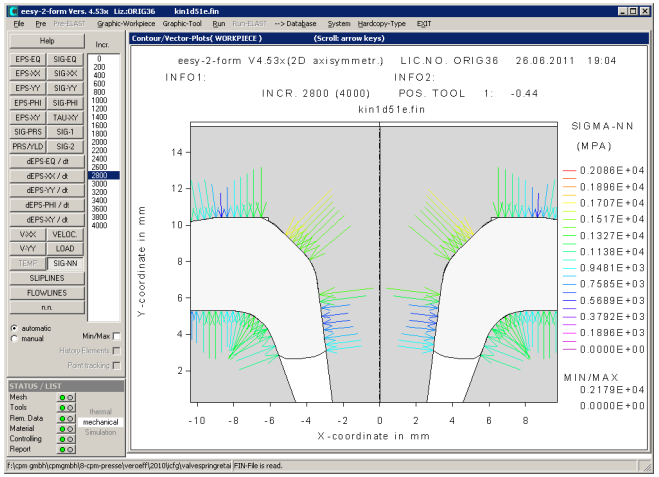
Progression

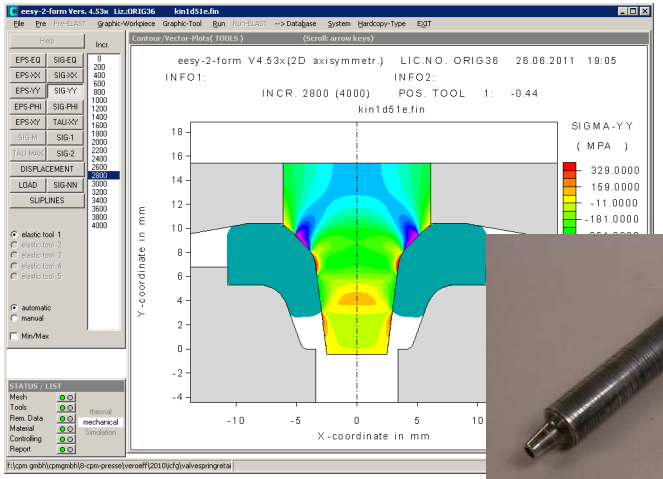
Premature tool failure

Application of FEA Simulation in Cold Forging



Production of a valve spring retainer – tool failure



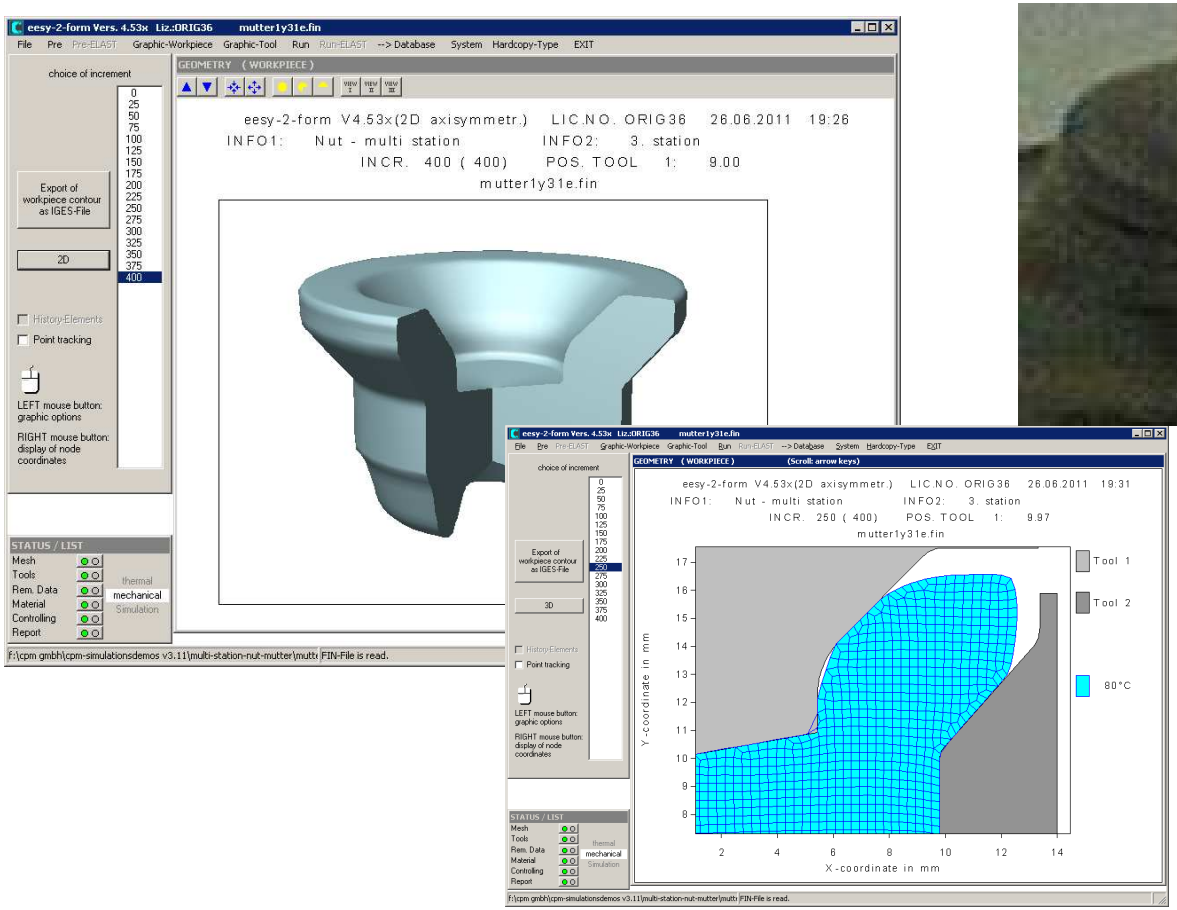


Normal Stresses

Axial Stress in the punch

Application of FEA Simulation in Cold Forging

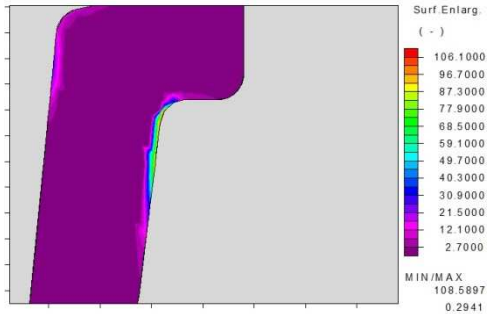
Production of a nut



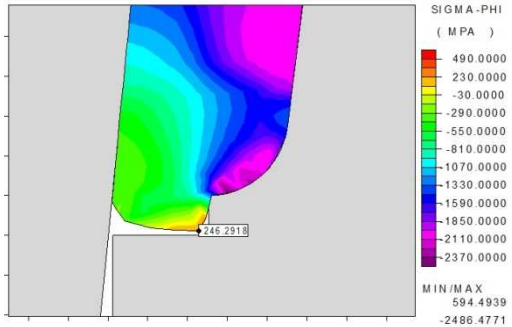
Premature tool failure

Application of FEA Simulation in Cold Forging

Roughness and cracking on a valve spring retainer



surface enlargement



high tangential stress

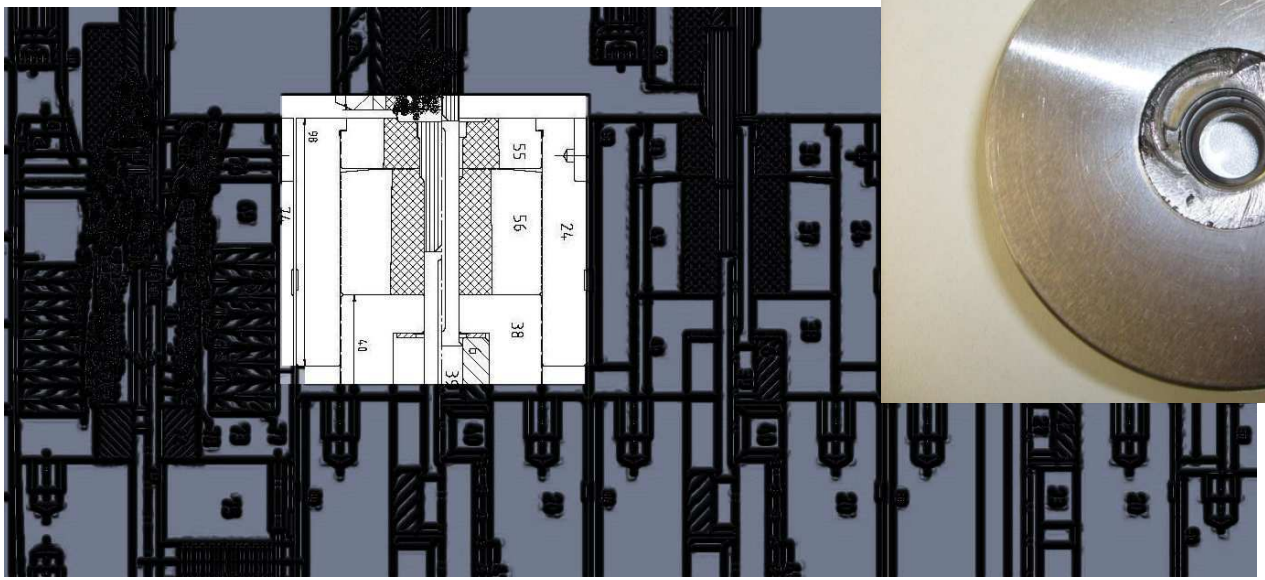
Application of FEA Simulation in Cold Forging

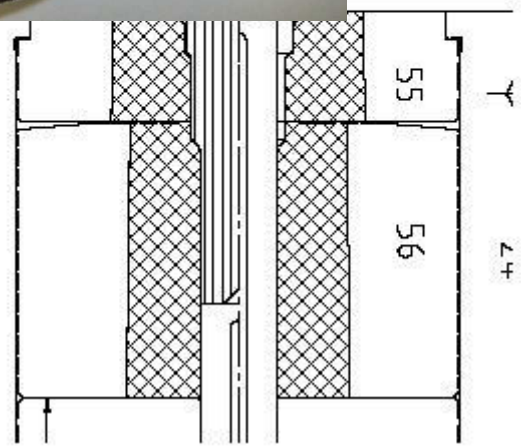
Production of a „bolt“

Premature tool failure in station 4

Application of FEA Simulation in Cold Forging

Production of a „bolt“

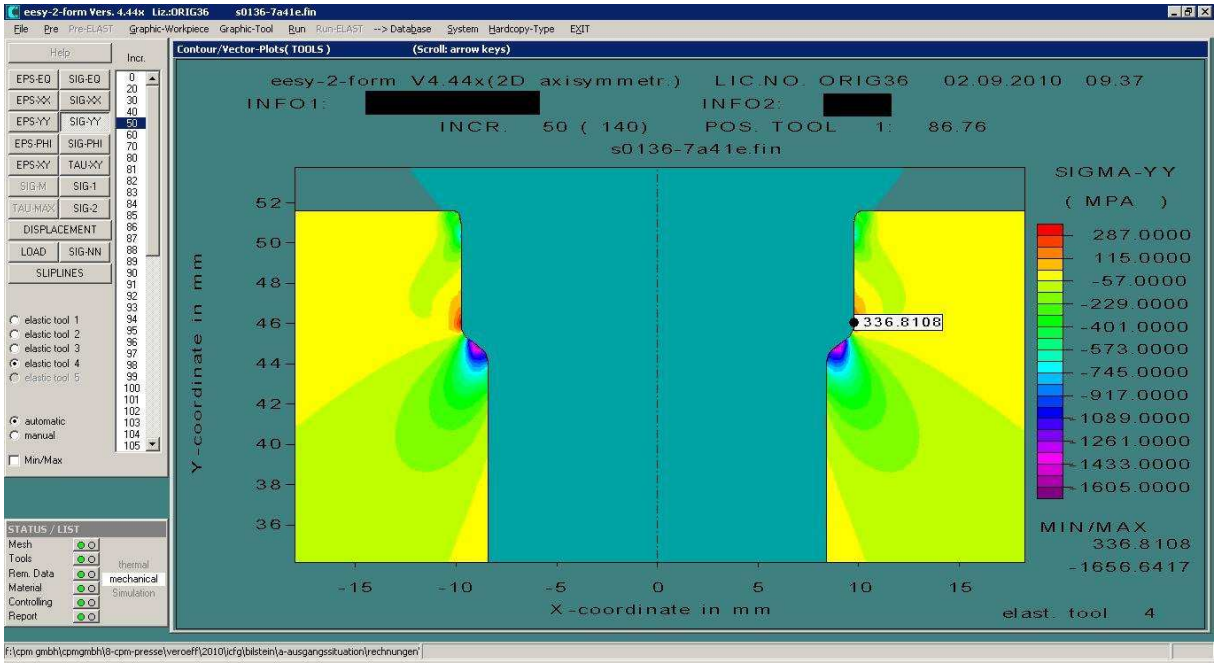




Premature tool failure in station 4

Application of FEA Simulation in Cold Forging

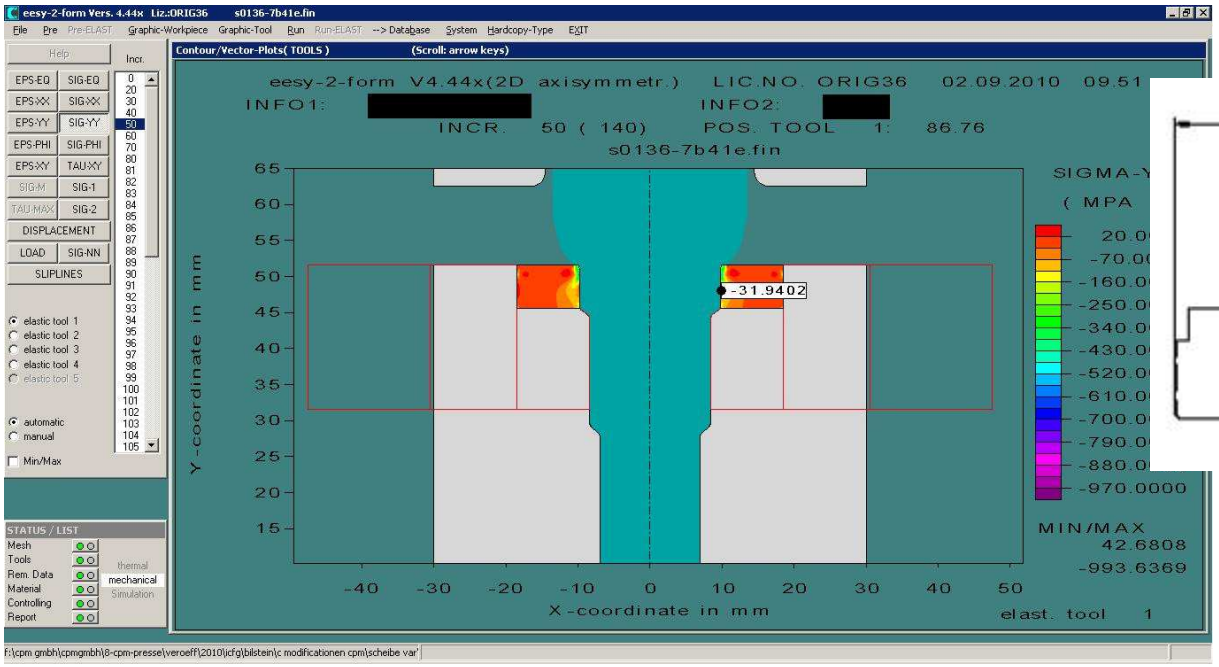
Production of a „bolt“

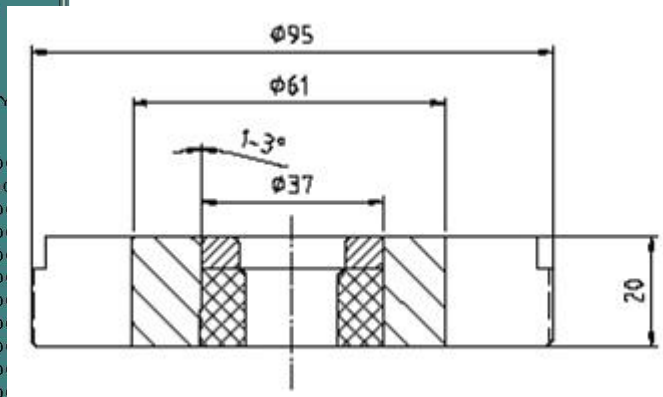


Positive stress in station 4 – 5.000 pieces tool life

Application of FEA Simulation in Cold Forging

Production of a „bolt“





Compressive stress in station 4 – new design – 100.000 pieces tool life

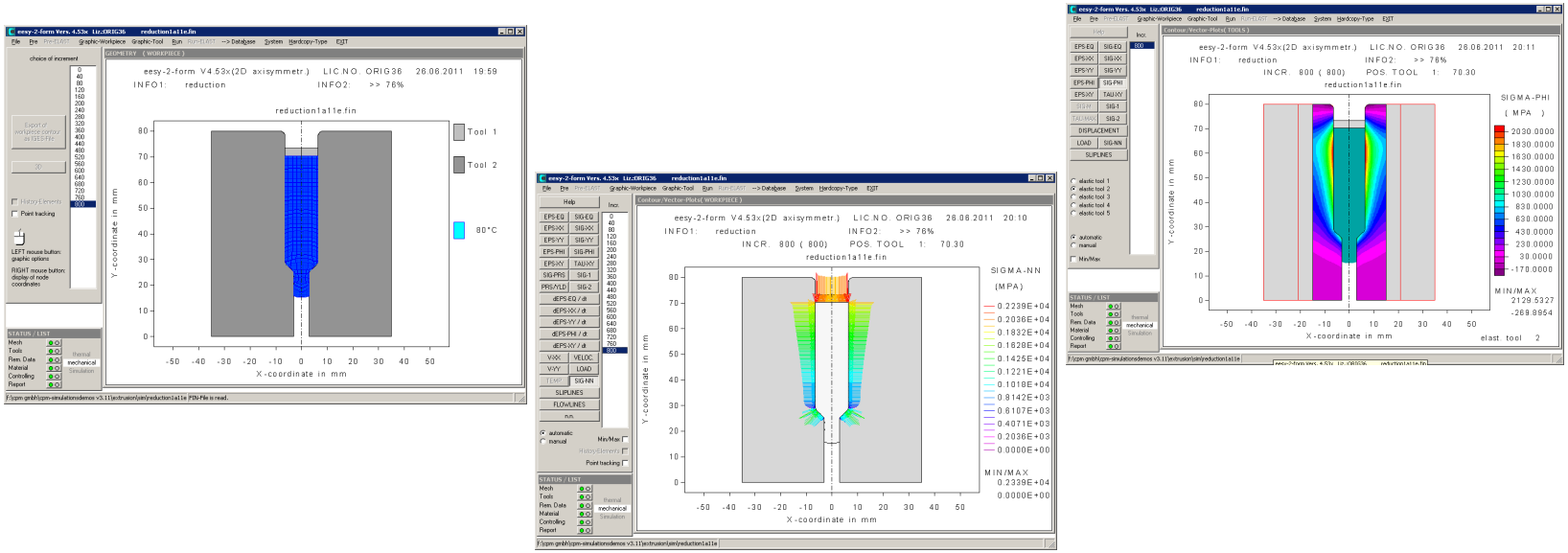
Application of FEA Simulation in Cold Forging

Design of an extrusion die

Overloaded die insert

Application of FEA Simulation in Cold Forging

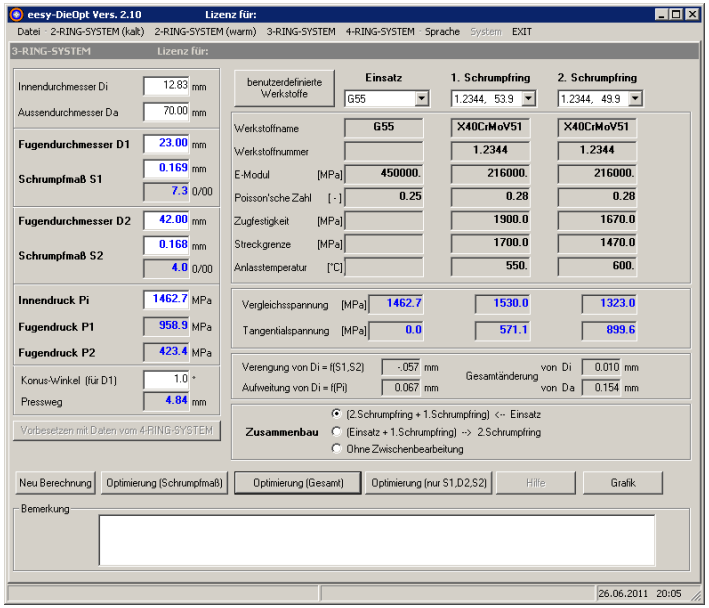
Design of an extrusion die

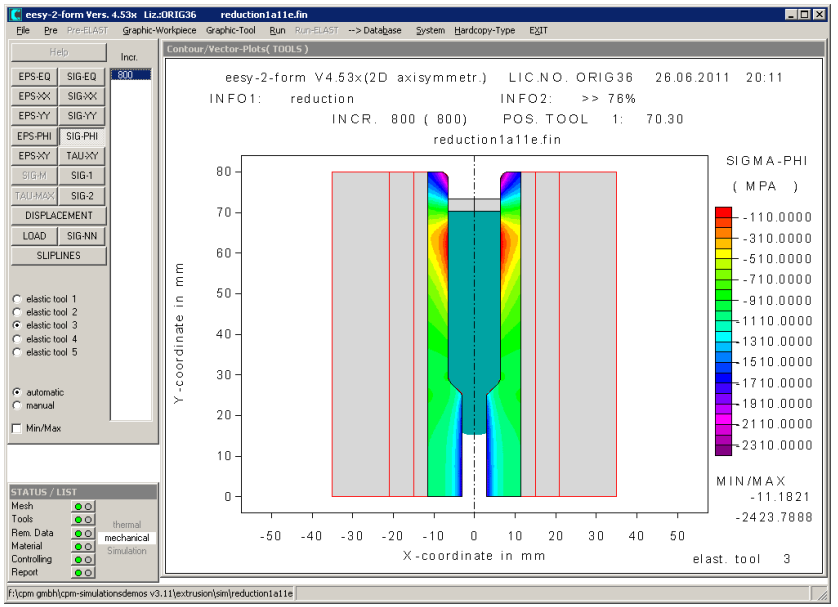


Stress analysis – Normal stresses on surface – Tangential stresses in the die

Application of FEA Simulation in Cold Forging

Design of an extrusion die

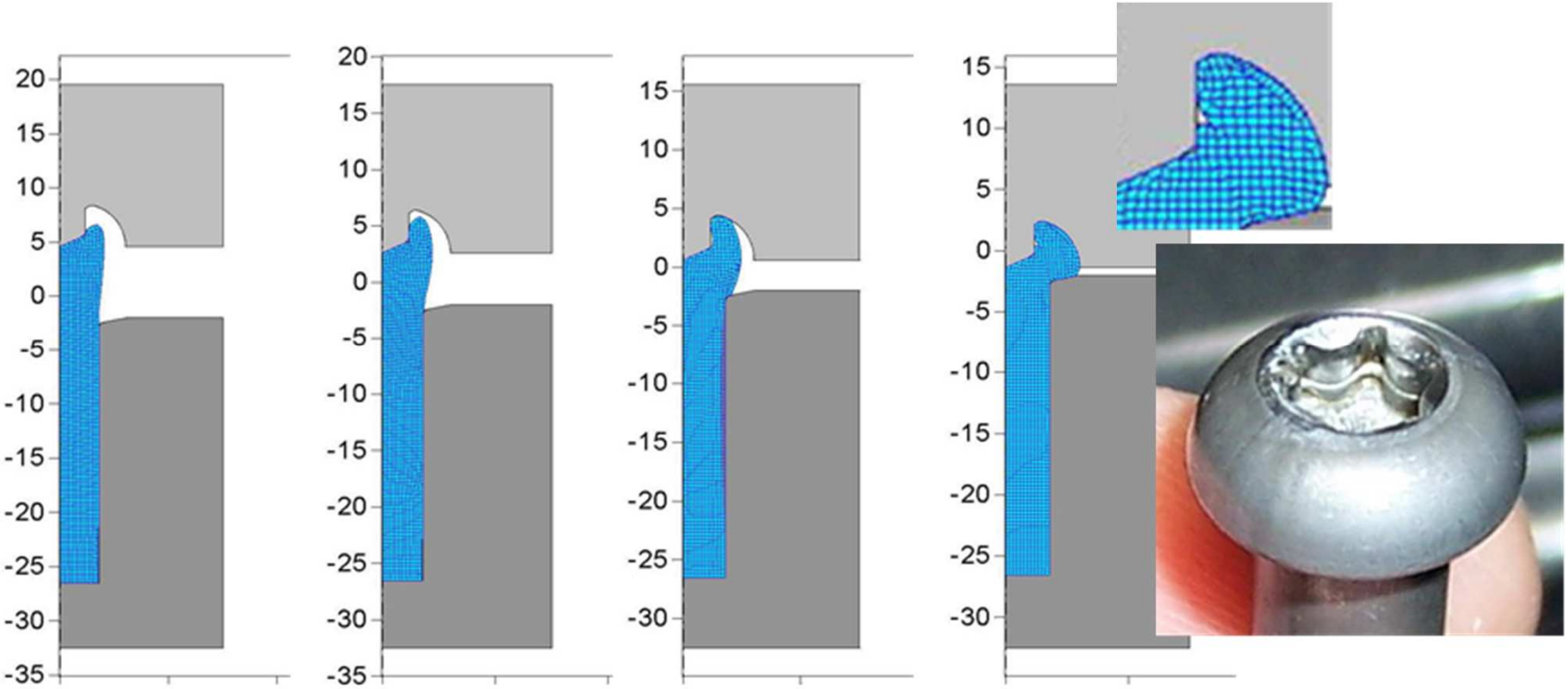




Optimization of the die design – resulting Tangential stresses in the die

Application of FEA Simulation in Cold Forging

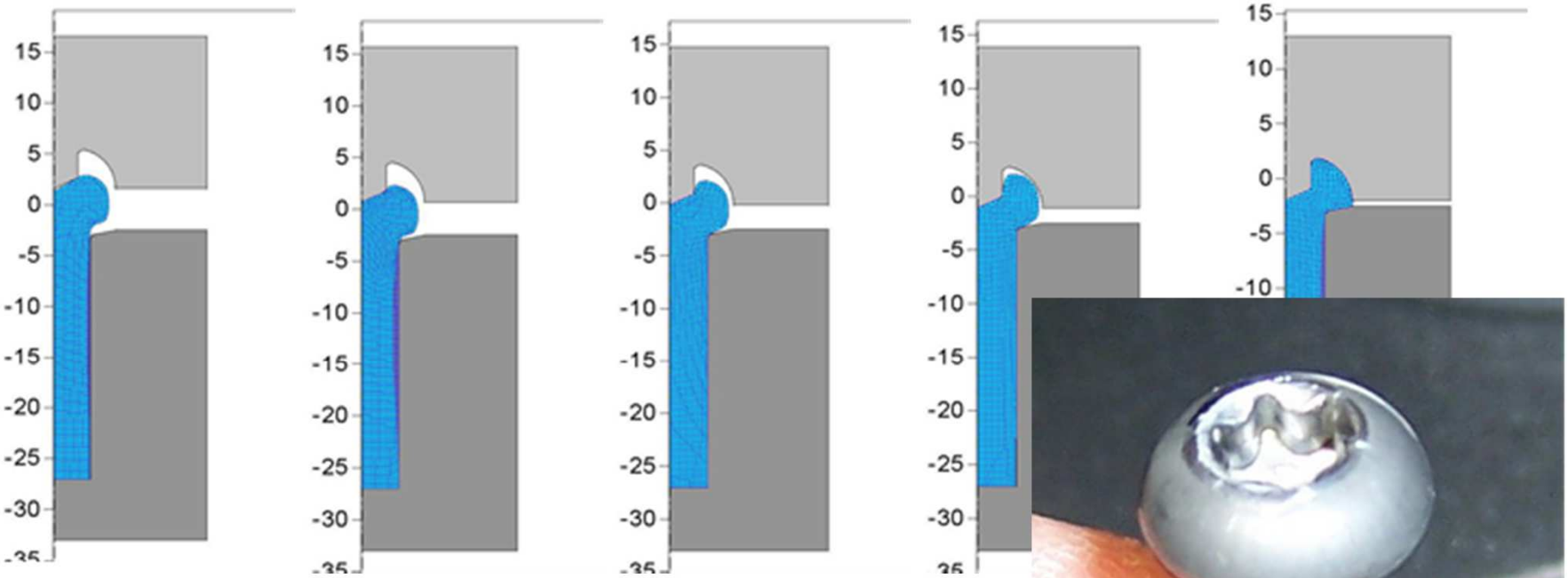
Production of a bolt



Original progression with folding

Application of FEA Simulation in Cold Forging

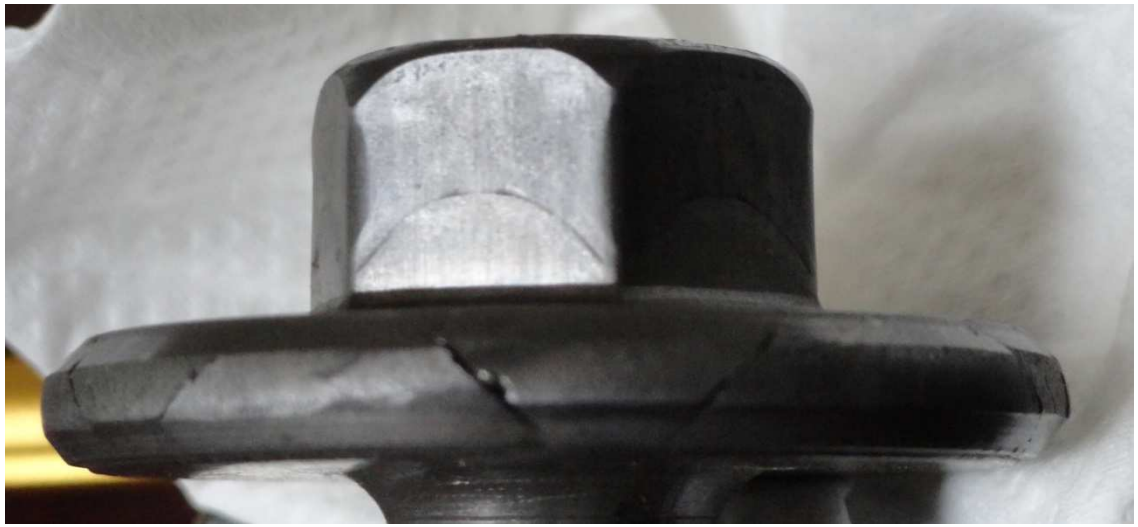
Production of a bolt



New progression without folding

Application of FEA Simulation in Cold Forging

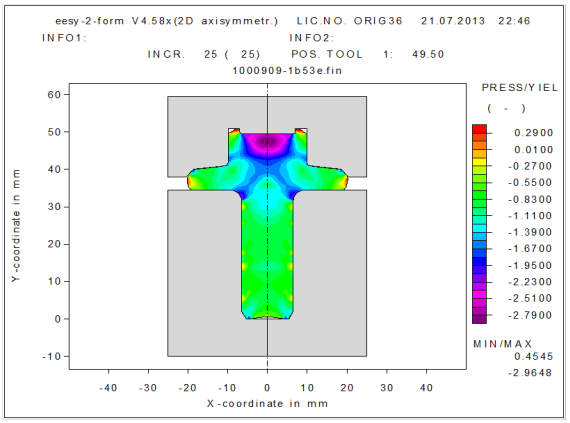
Production of a hex bolt

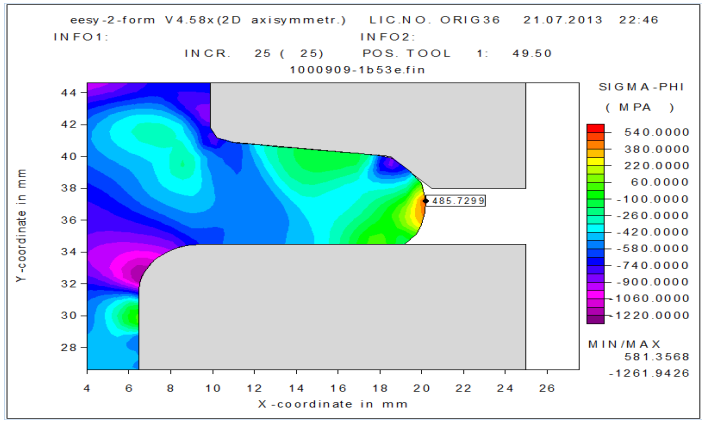


The hex bolt shows cracks on the surface

Application of FEA Simulation in Cold Forging

Production of a hex bolt





Stress analysis

After the stress analysis the engineer understands the reason and can change the design to avoid the failure.

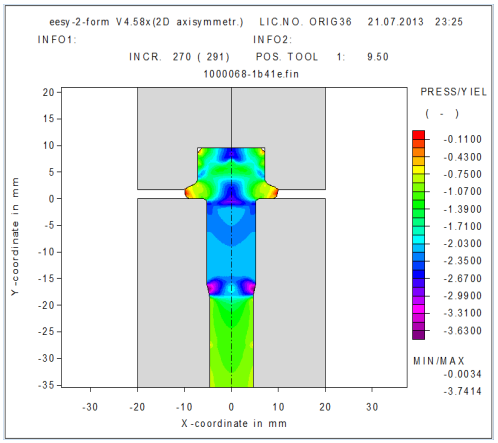
Learning this once the engineer will not make this mistake again.

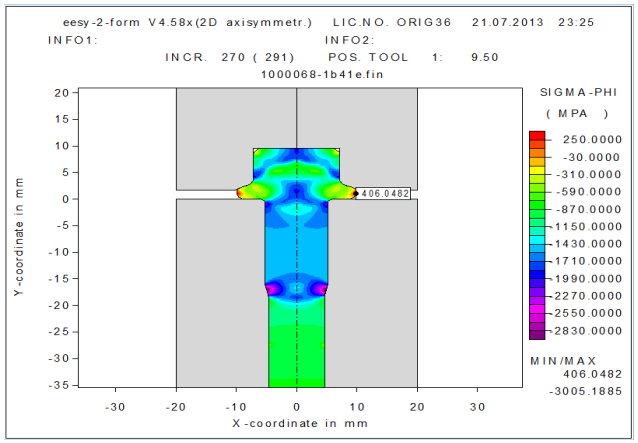
Application of FEA Simulation in Cold Forging

Failure of a screw that is not caused by wrong progression

Application of FEA Simulation in Cold Forging

Failure of a screw that is not caused by wrong progression



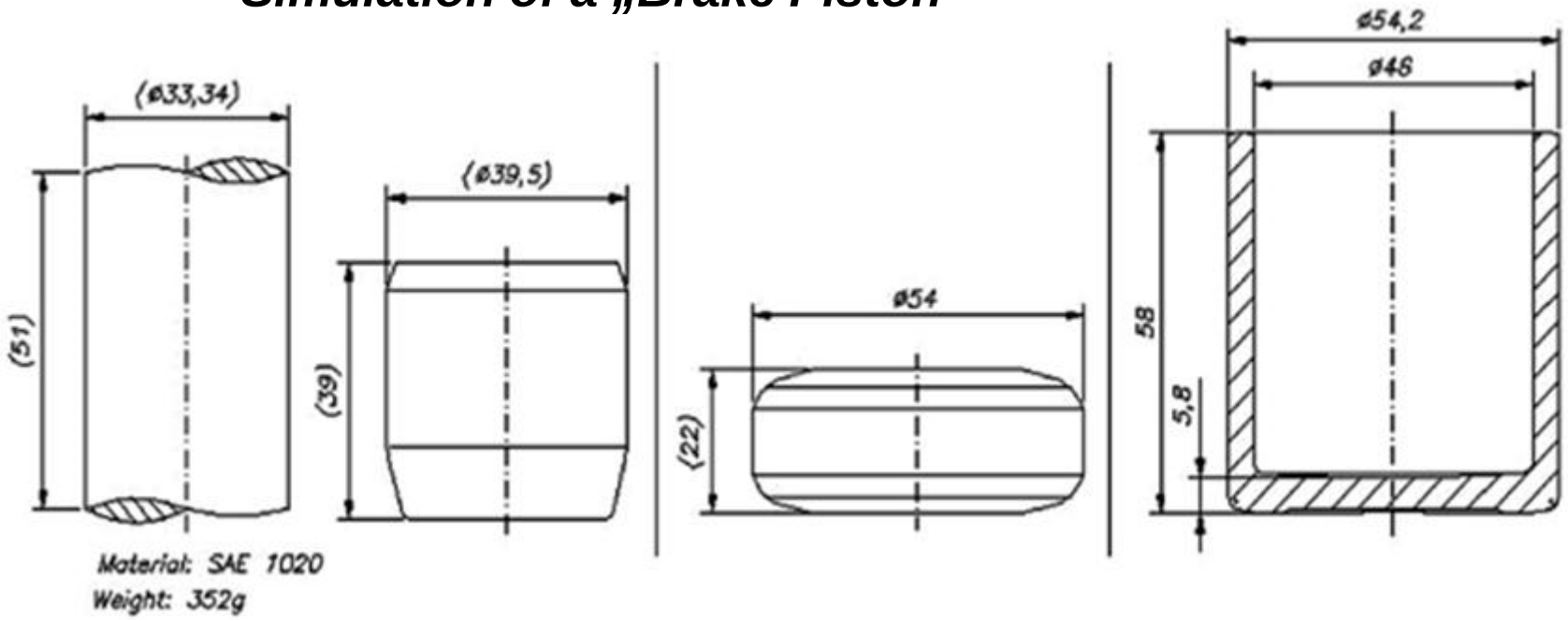


Stress analysis – all values (tangential stress and ration of hydrostatic pressure to yield stress) are safe

In this case the engineer can call the supplier to replace the material directly. This kind of failure is provable a material problem.

Application of FEA Simulation in Cold Forging

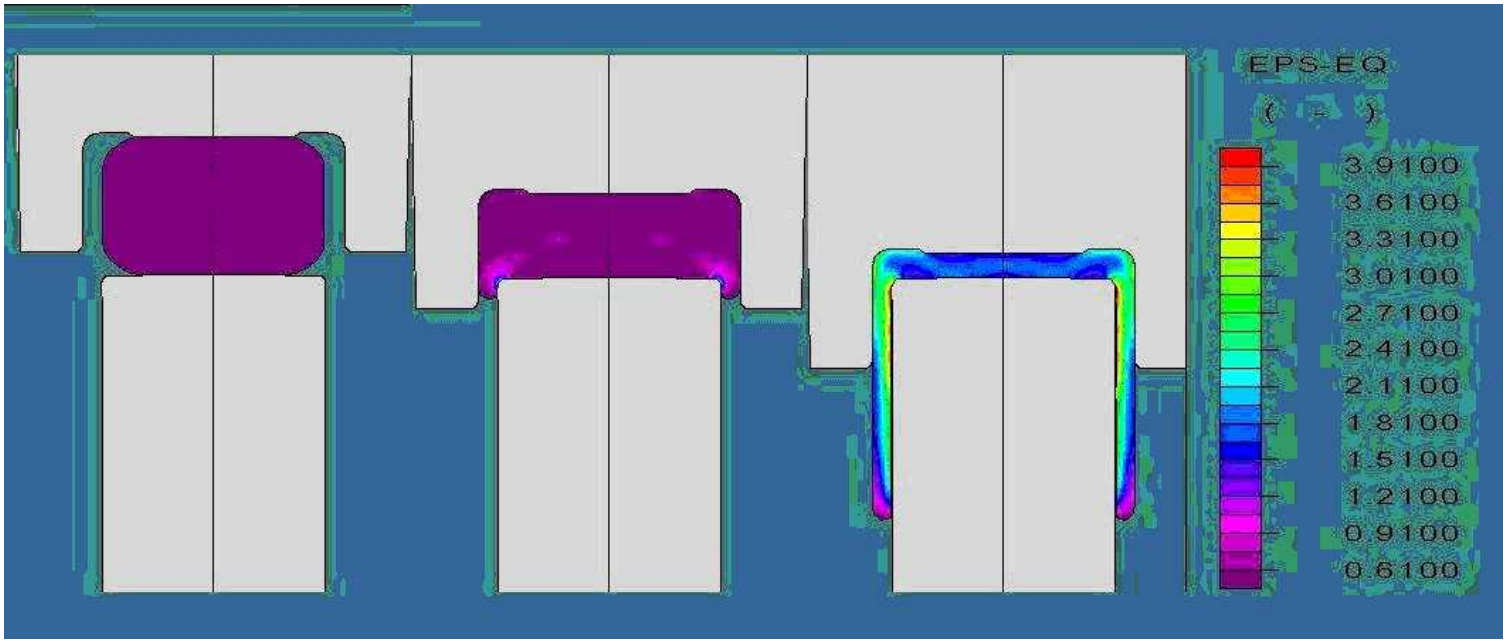
Simulation of a „Brake Piston“



traditionel process

Application of FEA Simulation in Cold Forging

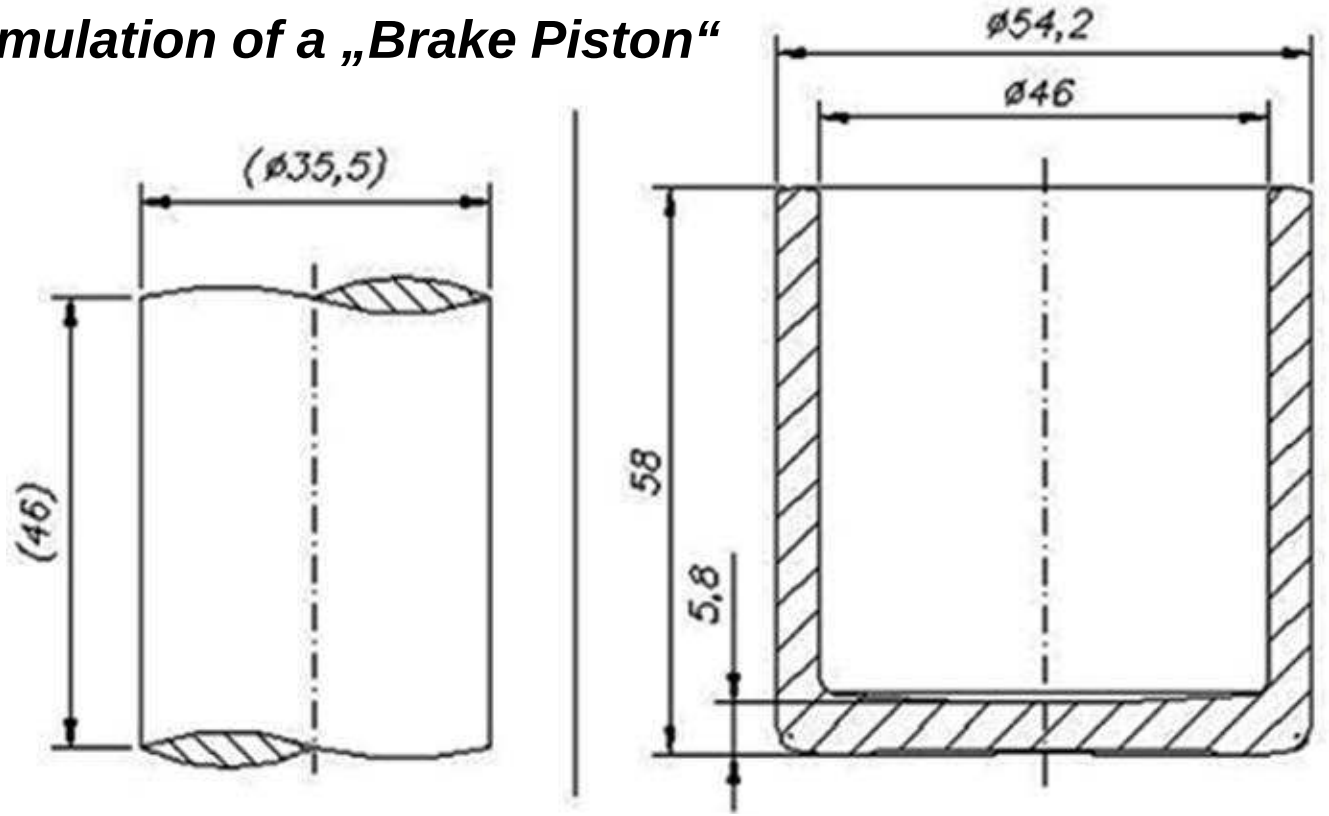
Simulation of a „Brake Piston“



traditionell process

Application of FEA Simulation in Cold Forging

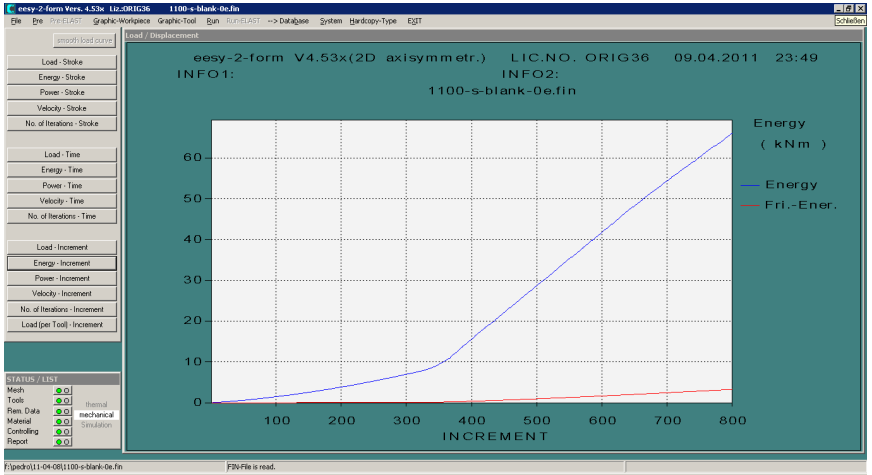
Simulation of a „Brake Piston“

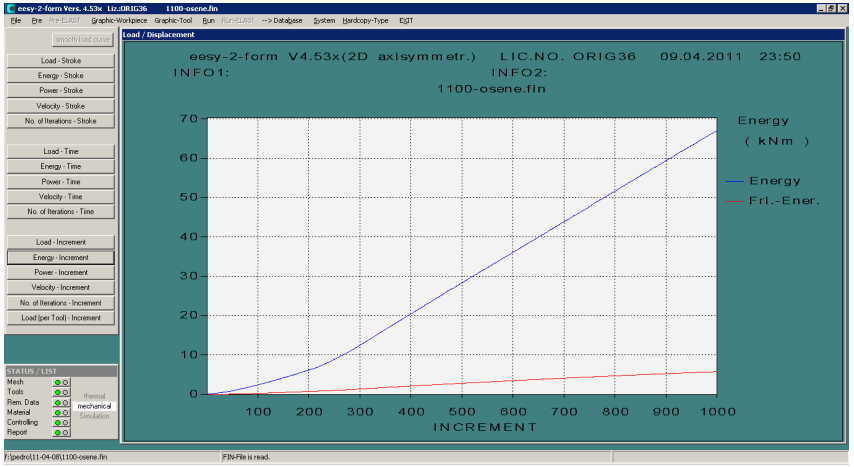


new process – osen-

Application of FEA Simulation in Cold Forging

Simulation of a „Brake Piston“





Comparison – work ***Backward*** ***Osen***

Since both processes need the same work (besides small differences in friction etc) the Osen process requires less load.

The Osen process requires about 180 to
while the backward extrusion requires 450 to.

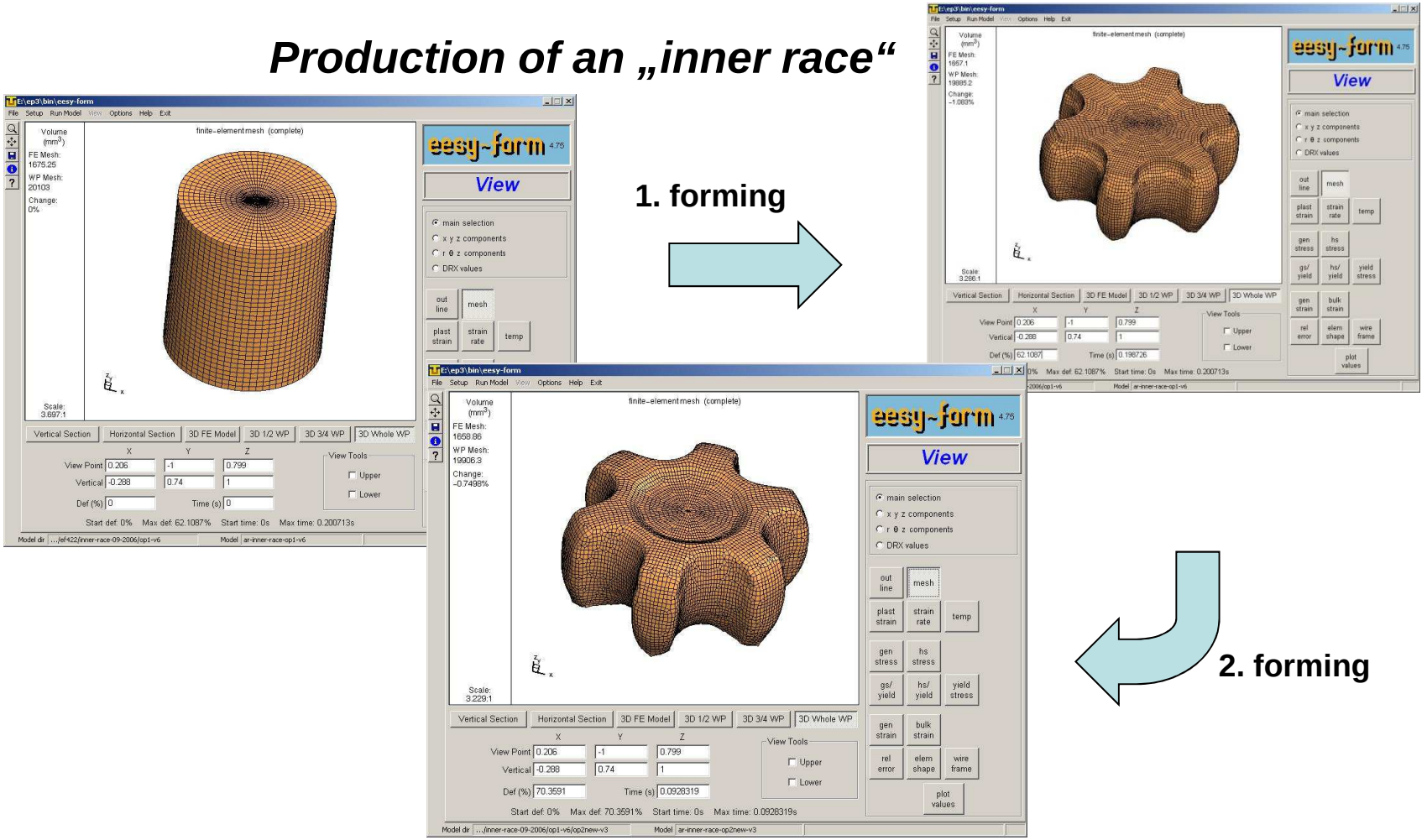
Application of FEA Simulation in Cold Forging

Production of an „inner race“

Inner race – process developement

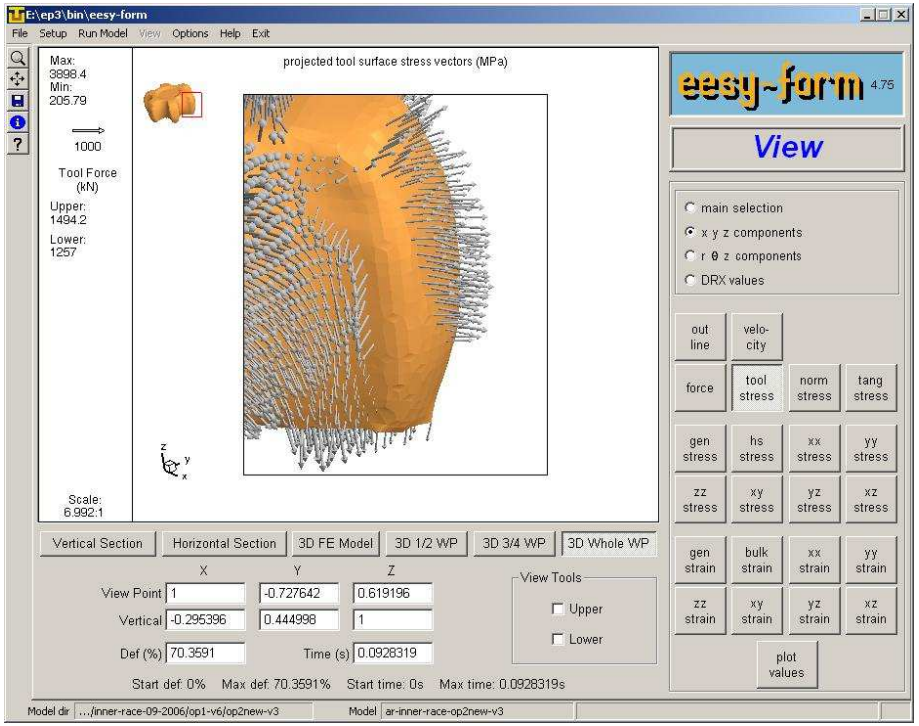
Application of FEA Simulation in Cold Forging

Production of an „inner race“

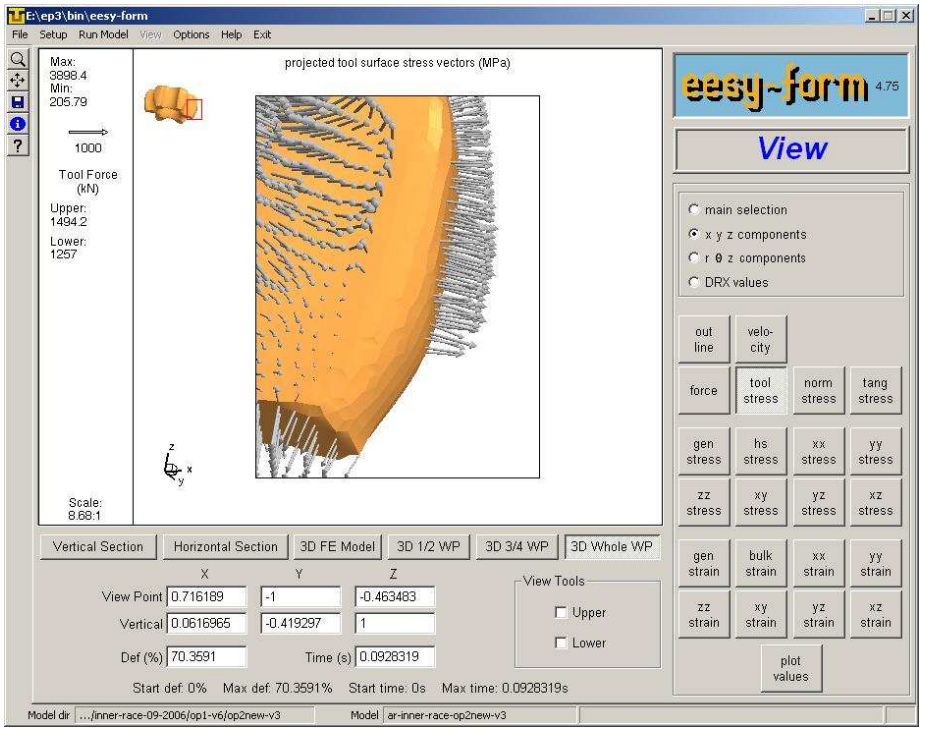


Application of FEA Simulation in Cold Forging

Production of an „inner race“

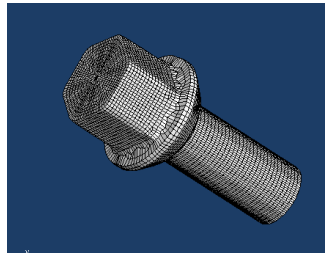


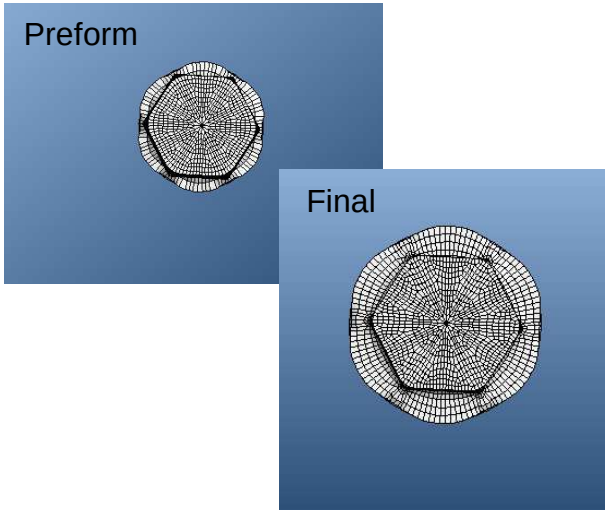
No sufficient filling
(normal pressure on surface)

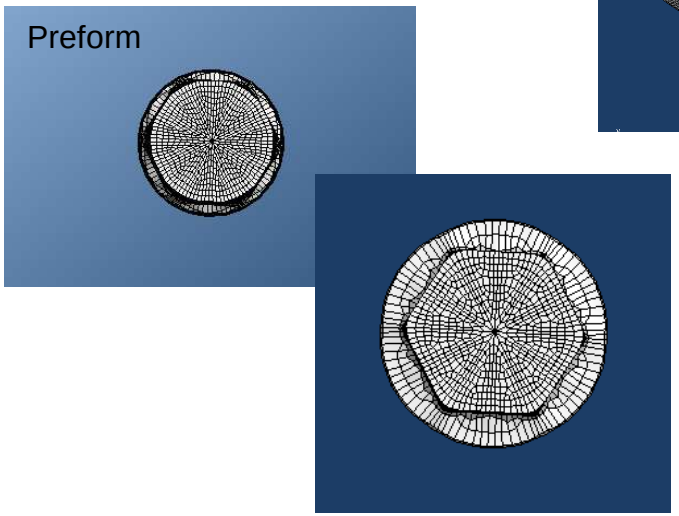


Application of FEA Simulation in Cold Forging

Production of an hexagonal fastener

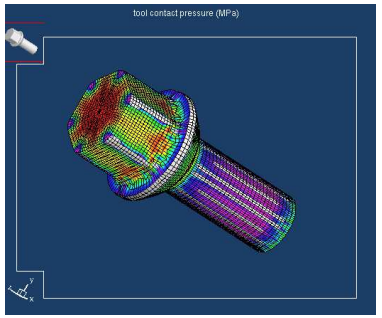




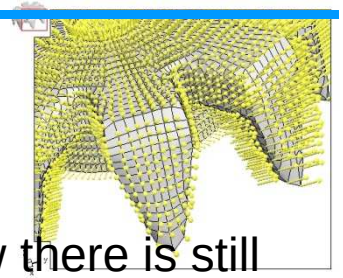


First approach

Final approach



Avoid „flower“ Shape



Application of FEA Simulation in Cold Forging

Conclusion

After 25 years of usage of FEA software to analyze plastic material flow there is still some discussion about the sense or nonsense of using simulation in forging industry. Still some argue that the systems are too complex to be used others think that they would be not precise enough still.
Scientists sometimes mention that the data and algorithm used are scientifically not really correct.

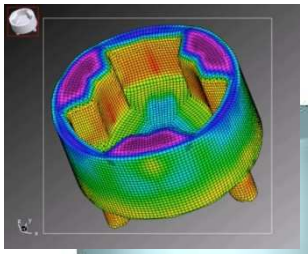
Despite all these discussions FEA is established as a very useful tool for industry. The examples showed a part of the wide range of **successful application in industry**.

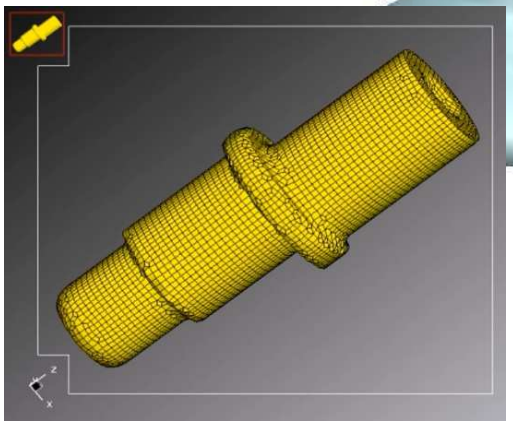
It helps to avoid a lot of costs. It helps to improve technology.
And finally despite of some certain “weakness” of FEA it opens the user areas of technology that he would not reach otherwise.

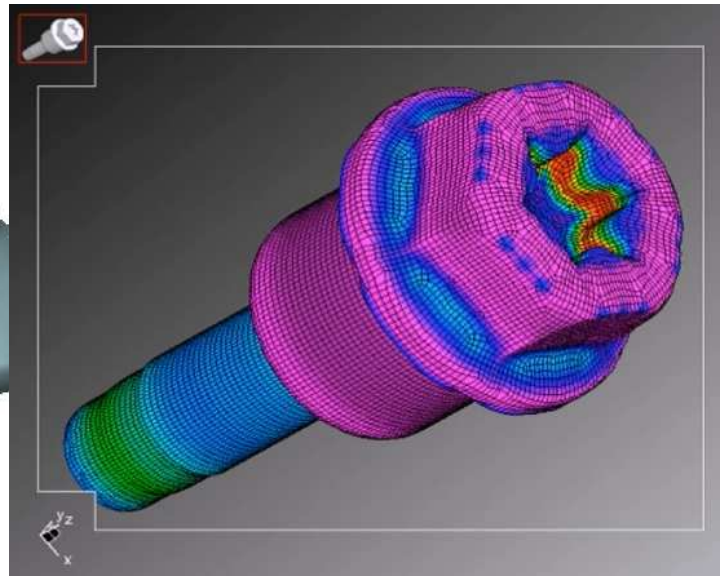
Today FEA is a “must” for companies who want to be in the lead

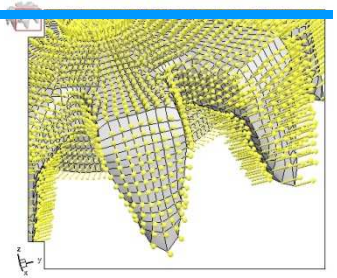
– who want to win.

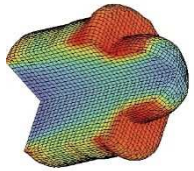
Application of FEA Simulation in Cold Forging



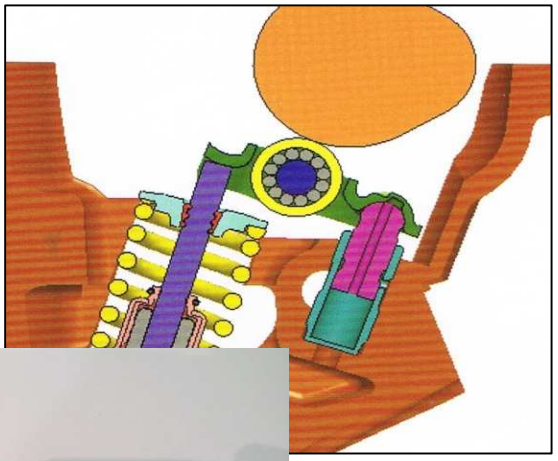




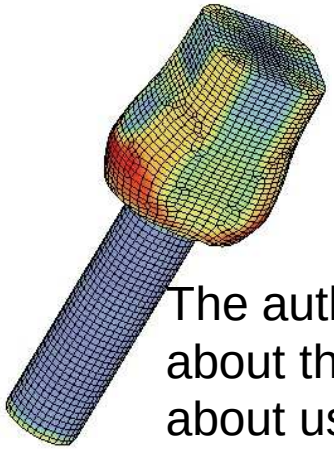


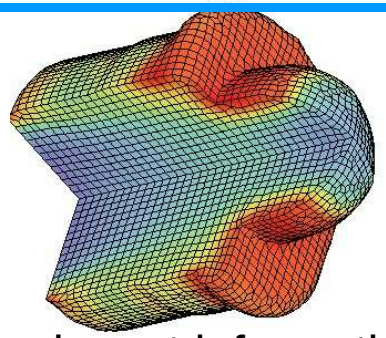


Latest developments



XZB, PR China

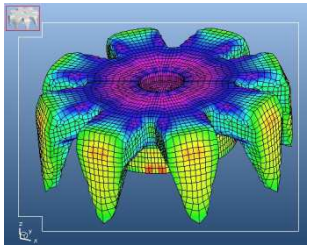




Acknowledgements

The authors thank their customers for providing them with relevant information about the practical cases and about their general comments about using FEA in their daily work.

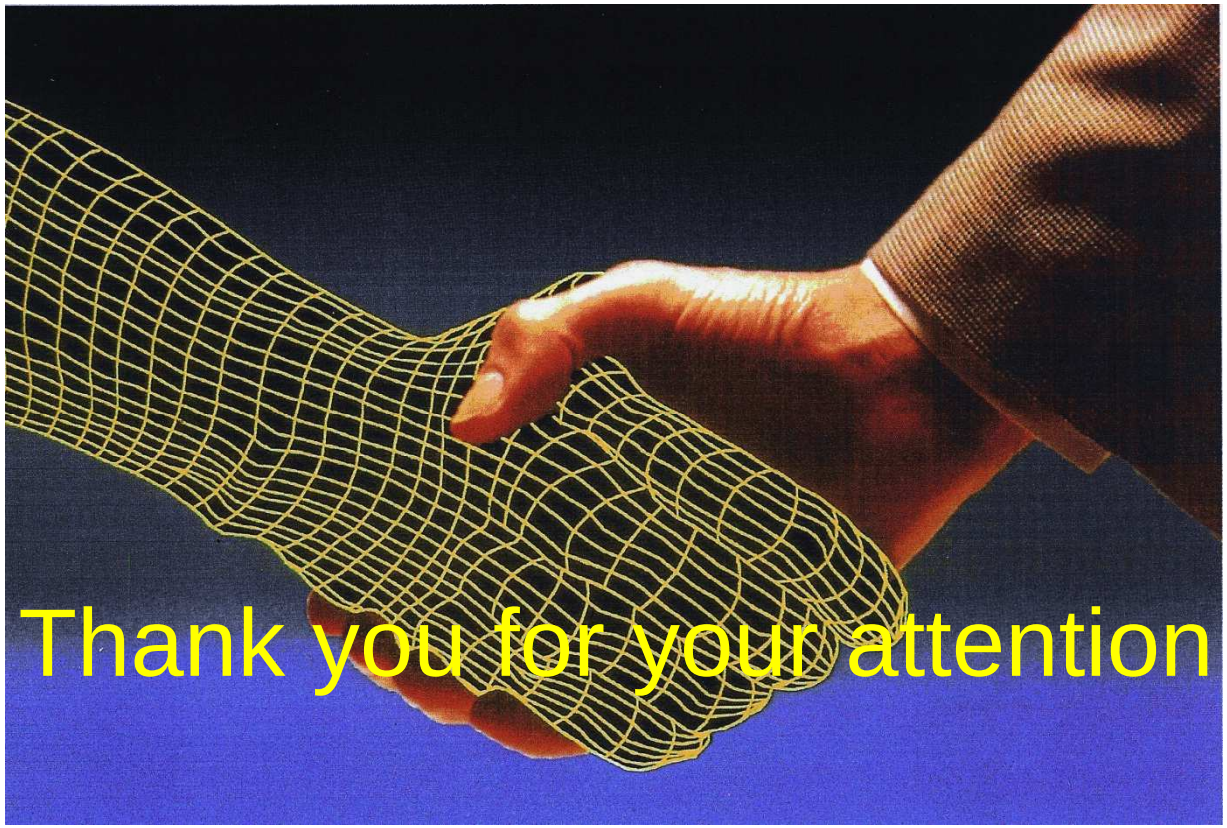
This information and the comments are very helpful to improve FEA software and promote its use in presentations like this.



Besides others we would like to mention:

Acopecas,Brasil; XZB, PR China; Barton Cold Forging,UK; Fuchs, Germany; Bilstein und Sikermann,Germany; Hema,Germany; Philidas,UK; SQB,PR China; Manzato,Brazil; Gerneral Screw, PR China; CQB, PR China; Nedschroef, Belgium

Trust in "eesy" simulation



Customers are happy to solve their daily problems with simulation