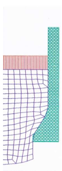
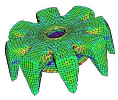


EESY FEA Simulation und Technology to support process and tool design

-from the beginnings till today-



Dr. Gerhard H. Arfmann
CPM GmbH, Herzogenrath

Introduction

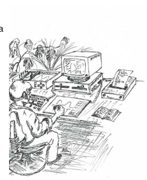
History
Since the 1980´s CPM develops simulation systems.

1981 IBM PC

Wikipedia

Typical work
environment
of an engineer

Idea:



The „CA"engineer

Introduction

Hist
Since lops simlation systems.
1981

Wikipedia

Development of a **„simple to use" simulation system**
to simulated metal forming and tool layout on personal computers

The „CA"engineer

Introduction

Basic Developments FEA (2D)

Element Types

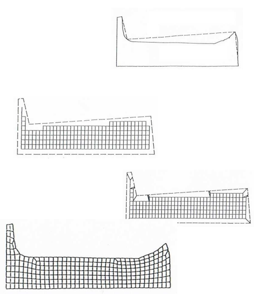
Contact Algorithm

Solver for equation systems

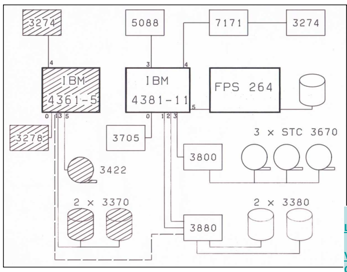
Meshing Methodes

Material Laws and Data

Simple User Interface



Introduction



Leistung	ca.. 60 MFLOPS
Vergleich Core i7, 3,47 GHz, 6 Kerne	83,2 GFLOPS

Development environememt in the 1980´s

CPM Gesellschaft für Computeranwendung,
Prozeß- und Materialtechnik

Introduction

First Prototype of an FEA System to be used on PC
CAPS-Finel V1.0 (1989)

2D Axis-symmetric, 2D plane

Integrated Modelling, Simulation and Post-processing in a single System

Simple interaction by a “question and answer” dialog

Rigid-plastic material law

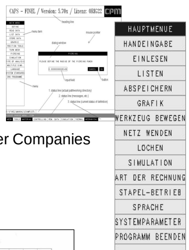
Thermal – mechanical simulation

Automatic Meshing

CPM Gesellschaft für Computeranwendung,
Prozeß- und Materialtechnik

Introduction

Next Steps



Development of a graphical interface

Development project with German Fastener Companies

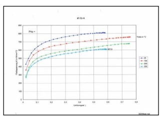
Improvement of technological modules

Simple handling of Multi-station processes

Elastic tooling

Microstructure

Material Data

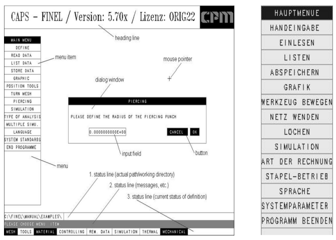


CPM Gesellschaft für Computeranwendung,
Prozeß- und Materialtechnik

VDI 30

FEM Simulation in der Kaltumformung **Industrieeinführung und spezielle ….**

Entwicklung eines grafischen Interfaces und erste Installationen



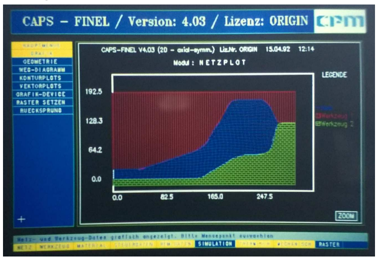
Grafische Oberfläche und Menüführung
CAPS-Finel

CPM Gesellschaft für Computeranwendung, Prozeß- und Materialtechnik

FEM Simulation in der Kaltumformung — Industrieeinführung und spezielle ....

Entwicklung eines grafischen Interfaces und erste Installationen

Grafische Oberfläche CAPS-Finel

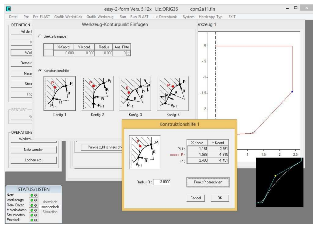


CPM Gesellschaft für Computeranwendung, Prozeß- und Materialtechnik

FEM Simulation in der Kaltumformung — Industrieeinführung und spezielle ....

Verbesserung technologischer Module

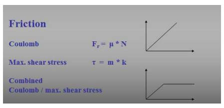
Hier: Möglichkeit der Ergänzung nicht vermasster Geometrien



Aktuelle Version Eesy-2-form

CPM Gesellschaft für Computeranwendung, Prozeß- und Materialtechnik

Introduction



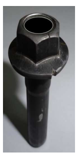
Next steps -2-

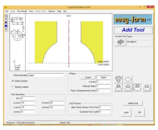
New friction laws

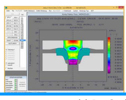
Failure analysis

3D Applications

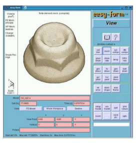
3D Toolbox







New „eesy“ Windows Design (eesy-2-form, eesy-form)



CPM Gesellschaft für Computeranwendung, Prozeß- und Materialtechnik

FEM Simulation in der Kaltumformung — Industrieeinführung und spezielle ....

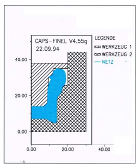
Projekt der deutschen Schraubenindustrie

Ab 1991 Aufnahme von CPM in ein Projekt des DSV

Neben Prozeßüberwachung, Stadiengangauslegung, Pressenbewegungsablauf und Kollisionsanalyse sollte auch

Simulation
mit Hilfe der FEM

entwickelt werden.



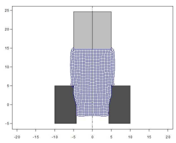
Simulation einer Faltenbildung 1994

FEM Simulation in der Kaltumformung **Industrieeinführung und spezielle ….**

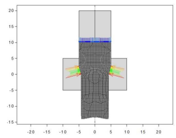
VDI 30

Verbesserung technologischer Module

Hier: Reibung



Falsches Ergebnis



Richtiges Ergebnis

Reibungsbeschreibung, hier: Reduktion

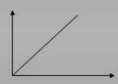
FEM Simulation in der Kaltumformung **Industrieeinführung und spezielle ….**

VDI 30

Neuer Reibungsansatz

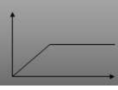
Friction

Coulomb $F_r = \mu * N$

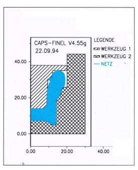


Max. shear stress $\tau = m * k$

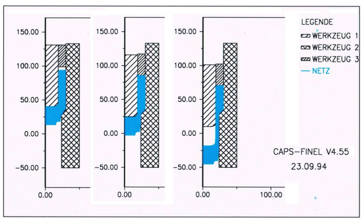
Combined
Coulomb / max. shear stress



Introduction



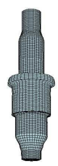
Simulation of folding 1994

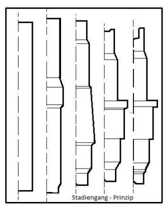


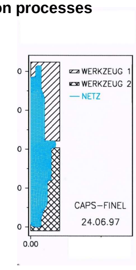
Tooling with spring

Introduction

Automatic simulation of multi station processes







CPM Gesellschaft für Computeranwendung, Prozeß- und Materialtechnik

FEM Simulation in der Kaltumformung

Industrieeinführung und spezielle ….

Einfache Handhabung Mehrstufiger Prozesse

Zündkerze 2000

(c) Dr. Gerhard H. Arfmann CPM GmbH, Germany 17
Presentation to Henan University of Science and technology, Luoyang, China 17.11.2015

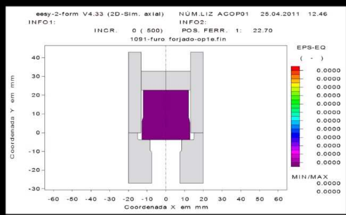
CPM Gesellschaft für Computeranwendung, Prozeß- und Materialtechnik

FEM Simulation in der Kaltumformung

Industrieeinführung und spezielle ….

Einfache Handhabung Mehrstufiger Prozesse

„Mehrstufen in einer Stufe“ mit komplexer Werkzeug-bewegung



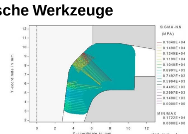
(c) Dr. Gerhard H. Arfmann CPM GmbH, Germany 18
Presentation to Henan University of Science and technology, Luoyang, China 17.11.2015

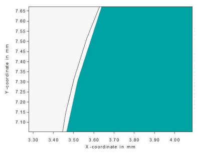
CPM Gesellschaft für Computeranwendung, Prozeß- und Materialtechnik

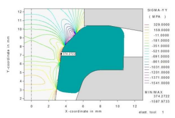
FEM Simulation in der Kaltumformung

Industrieeinführung und spezielle ….

Elastische Werkzeuge







Analyse

- Druck auf der Oberfläche
- Axialspannung alternierend im Werkzeug

und Erklärung

- Fehlender Kontakt während der Umformung (keine Luft oder Öl!)

Stempelbruch beim Fertigen eines Ventilfedertellers

(c) Dr. Gerhard H. Arfmann CPM GmbH, Germany 19
Presentation to Henan University of Science and technology, Luoyang, China 17.11.2015

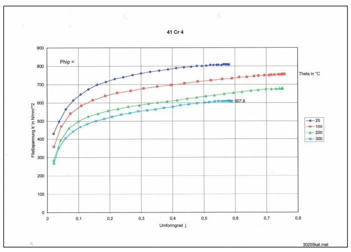
CPM Gesellschaft für Computeranwendung, Prozeß- und Materialtechnik

FEM Simulation in der Kaltumformung

Industrieeinführung und spezielle ….

Materialdaten

Ein Projekt des Landes NRW ermöglichte es einen ersten umfassenden Bestand von Fließkurven zu ermitteln

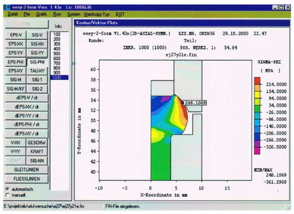


(c) Dr. Gerhard H. Arfmann CPM GmbH, Germany 20
Presentation to Henan University of Science and technology, Luoyang, China 17.11.2015

CPM Gesellschaft für Computeranwendung, Prozeß- und Materialtechnik

FEM Simulation in der Kaltumformung **Industrieeinführung und spezielle ….**

Schadenanalyse

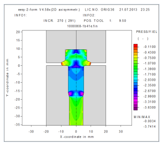


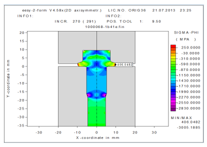
Hier Spannungsanalyse zur Erklärung eines Risses an einer Alu Schraube

CPM Gesellschaft für Computeranwendung, Prozeß- und Materialtechnik

FEM Simulation in der Kaltumformung **Industrieeinführung und spezielle ….**

Schadenanalyse





Hier Spannungsanalyse zur Erklärung einer Aufplatzung (Materialfehler)

CPM Gesellschaft für Computeranwendung, Prozeß- und Materialtechnik

FEM Simulation in der Kaltumformung **Industrieeinführung und spezielle ….**

Erste 3D Entwicklungen

Ende des 90er Jahre wurde die Entwicklung der 3D Software intensiviert

Hexaederelemente

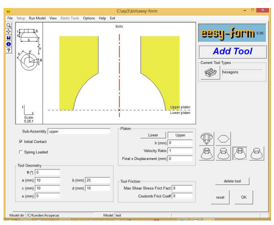
Elastisch-plastisches Materialgesetz

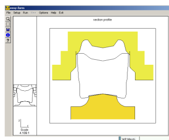
Möglichkeit der Generierung einfacher Geometrien direkt im System (zusätzlich zum üblichen Transfer via stl aus CAD Systemen)

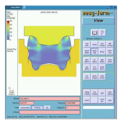
CPM Gesellschaft für Computeranwendung, Prozeß- und Materialtechnik

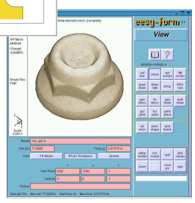
FEM Simulation in der Kaltumformung **Industrieeinführung und spezielle ….**

3D Toolbox





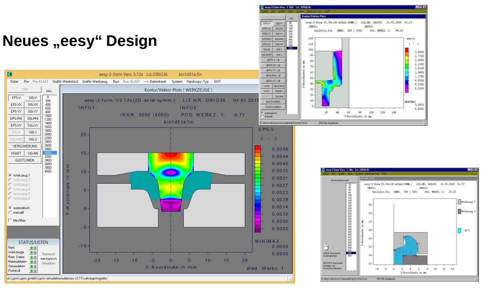




3D Simulation Mutter – Modulierung über Toolbox

FEM Simulation in der Kaltumformung **Industrieeinführung und spezielle ….**

Neues „eesy“ Design



FEM Simulation in der Kaltumformung **Vervollständigung….3D…. (2000er)**

Vervollständigung und Ertüchtigung technologischer Module, Werkzeuganalyse und 3D Simulation mit automatischem generieren hexagonaler Elemente (2000er)

Verbesserung und Vervollständigung technologischer Module (Kontakt, Reibung, Faltenbildung, lokal unterschiedliche Reibung…)

System zur Auslegung und Optimierung von Werkzeugen

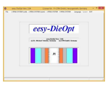
Vollautomatisches Vernetzen (hex) in 3D

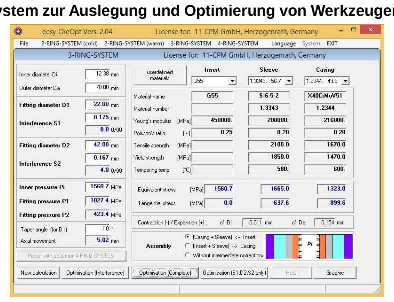
Lokale Reibungsbeschreibung

Zusätzliche oberflächennahe Analysen -> Tribosystem

FEM Simulation in der Kaltumformung **Vervollständigung….3D…. (2000er)**

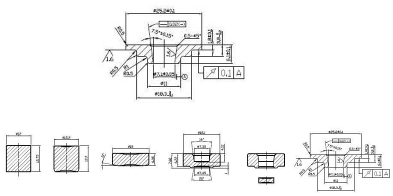
System zur Auslegung und Optimierung von Werkzeugen





FEM Simulation in der Kaltumformung **Vervollständigung….3D…. (2000er)**

System zur Auslegung und Optimierung von Werkzeugen



Fertigung eines Ventilfedertellers

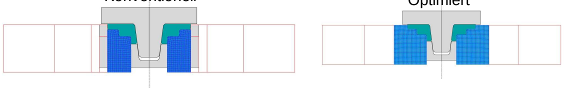
CPM Gesellschaft für Computeranwendung,
Prozeß- und Materialtechnik

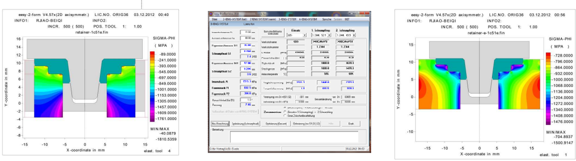
VDI 30

FEM Simulation in der Kaltumformung **Vervollständigung….3D…. (2000er)**

System zur Auslegung und Optimierung von Werkzeugen

Konventionell | Optimiert



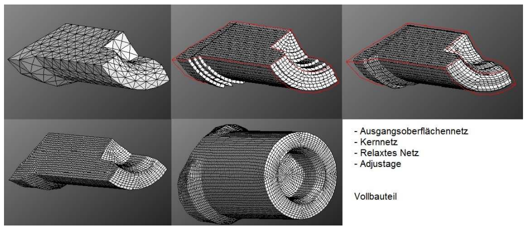


CPM Gesellschaft für Computeranwendung,
Prozeß- und Materialtechnik

VDI 30

FEM Simulation in der Kaltumformung **Vervollständigung….3D…. (2000er)**

Vollautomatisches Vernetzen (hex) in 3D



- Ausgangsoberflächennetz
- Kernnetz
- Relaxtes Netz
- Adjustage

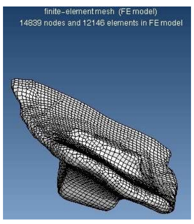
Vollbauteil

CPM Gesellschaft für Computeranwendung,
Prozeß- und Materialtechnik

VDI 30

FEM Simulation in der Kaltumformung **Vervollständigung….3D…. (2000er)**

Vollautomatisches Vernetzen (hex) in 3D



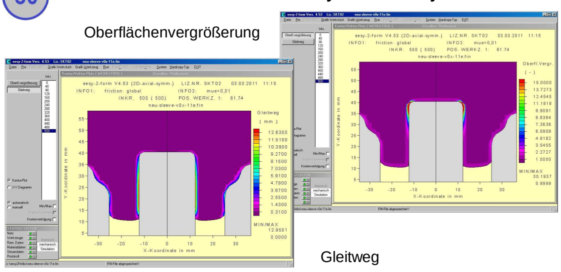
CPM Gesellschaft für Computeranwendung,
Prozeß- und Materialtechnik

VDI 30

FEM Simulation in der Kaltumformung **Vervollständigung….3D…. (2000er)**

Zusätzliche oberflächennahe Analysen -> Tribosystem

Oberflächenvergrößerung



Gleitweg

CPM Gesellschaft für Computeranwendung, Prozeß- und Materialtechnik

FEM Simulation in der Kaltumformung **Aktuelle .....-beispiele und Ausblick**

Aktuelle Anwendungsbeispiele und Ausblick

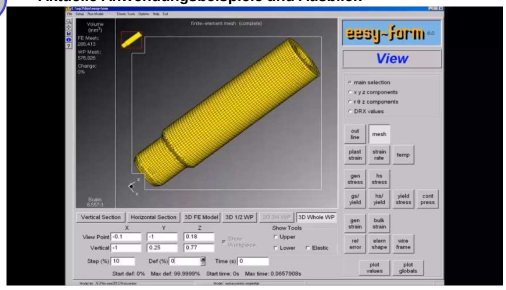
Im Folgenden werden einige aktuell Anwendungsbeispiele gezeigt und zukünftige Entwicklungen angesprochen

(c) Dr. Gerhard H. Arfmann CPM GmbH, Germany 33
Presentation to Henan University of Science and technology, Luoyang, China 17.11.2015

CPM Gesellschaft für Computeranwendung, Prozeß- und Materialtechnik

FEM Simulation in der Kaltumformung **Aktuelle .....-beispiele und Ausblick**

Aktuelle Anwendungsbeispiele und Ausblick



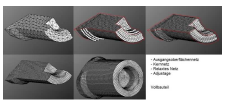
(c) Dr. Gerhard H. Arfmann CPM GmbH, Germany 34
Presentation to Henan University of Science and technology, Luoyang, China 17.11.2015

CPM Gesellschaft für Computeranwendung, Prozeß- und Materialtechnik

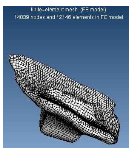
Introduction

Next steps -3-

Push of 3D Simulation using

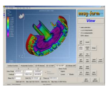


- Automatic meshing and re-meshing of Hexahedral elements



- Elastic-plastic Material law

- Interfacing with CAD



- ....

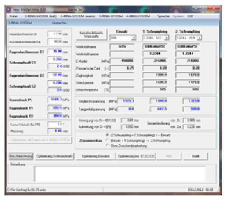
(c) Dr. Gerhard H. Arfmann CPM GmbH, Germany 35
Presentation to Henan University of Science and technology, Luoyang, China 17.11.2015

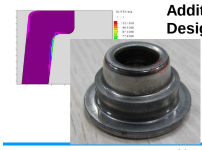
CPM Gesellschaft für Computeranwendung, Prozeß- und Materialtechnik

Introduction

Next steps -4-

More and better technological modules
Contakt,
Friction,
Folding,
...)





Additional System eesy-DieOpt for Design and optimization of tooling systems

Local Description of friction

Additional analysis of local surface properties -> Tribo-system

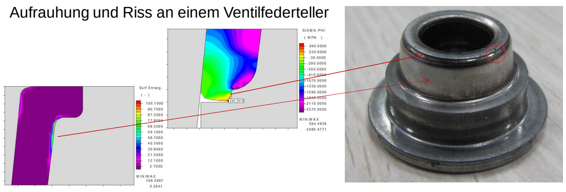
(c) Dr. Gerhard H. Arfmann CPM GmbH, Germany 36
Presentation to Henan University of Science and technology, Luoyang, China 17.11.2015

CPM Gesellschaft für Computeranwendung, Prozeß- und Materialtechnik

FEM Simulation in der Kaltumformung **Aktuelle …..-beispiele und Ausblick**

Aktuelle Anwendungsbeispiele und Ausblick

Aufrauhung und Riss an einem Ventilfederteller



Oberflächen vergrößerung | Umfangsspannung | Fehlerhafter Ventilfederteller

(c) Dr. Gerhard H. Arfmann CPM GmbH, Germany 37
Presentation to Henan University of Science and technology, Luoyang, China 17.11.2015

CPM Gesellschaft für Computeranwendung, Prozeß- und Materialtechnik

Introduction

Example of complex cold forging operations

Hydraulic pivot element

(c) Dr. Gerhard H. Arfmann CPM GmbH, Germany 38
Presentation to Henan University of Science and technology, Luoyang, China 17.11.2015

CPM Gesellschaft für Computeranwendung, Prozeß- und Materialtechnik

FEM Simulation in der Kaltumformung **Aktuelle …..-beispiele und Ausblick**

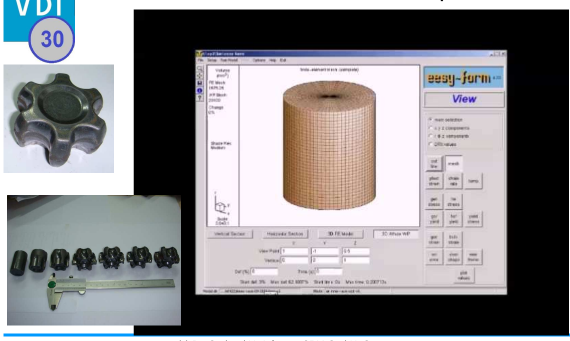
Aktuelle Anwendungsbeispiele und Ausblick

Inner Race

(c) Dr. Gerhard H. Arfmann CPM GmbH, Germany 39
Presentation to Henan University of Science and technology, Luoyang, China 17.11.2015

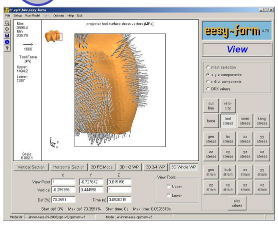
CPM Gesellschaft für Computeranwendung, Prozeß- und Materialtechnik

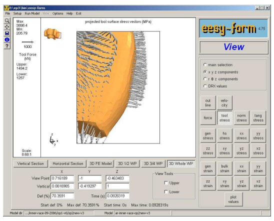
FEM Simulation in der Kaltumformung **Aktuelle …..-beispiele und Ausblick**



(c) Dr. Gerhard H. Arfmann CPM GmbH, Germany 40
Presentation to Henan University of Science and technology, Luoyang, China 17.11.2015

Aktuelle Anwendungsbeispiele und Ausblick





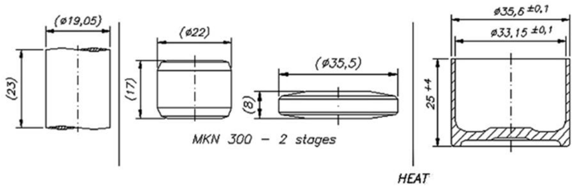
Inner Race

CPM Gesellschaft für Computeranwendung,
Prozeß- und Materialtechnik

VDI 30

FEM Simulation in der Kaltumformung Aktuelle …..-beispiele und Ausblick

Aktuelle Anwendungsbeispiele und Ausblick



Ventilstößel

CPM Gesellschaft für Computeranwendung,
Prozeß- und Materialtechnik

VDI 30

FEM Simulation in der Kaltumformung Aktuelle …..-beispiele und Ausblick

Aktuelle Anwendungsbeispiele und Ausblick

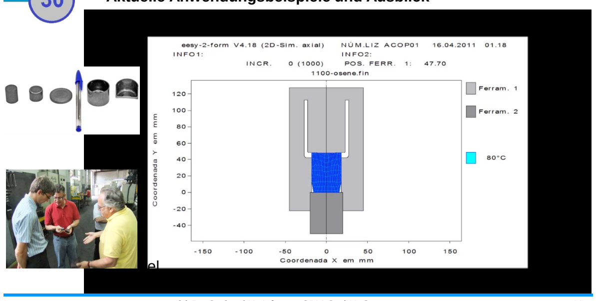
Ventilstößel

CPM Gesellschaft für Computeranwendung,
Prozeß- und Materialtechnik

VDI 30

FEM Simulation in der Kaltumformung Aktuelle …..-beispiele und Ausblick

Aktuelle Anwendungsbeispiele und Ausblick

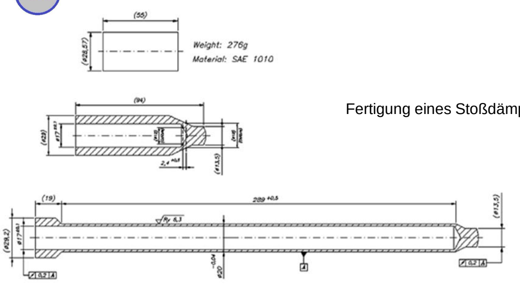


CPM Gesellschaft für Computeranwendung, Prozeß- und Materialtechnik

VDI 30

FEM Simulation in der Kaltumformung **Aktuelle …..-beispiele und Ausblick**

Aktuelle Anwendungsbeispiele und Ausblick



Fertigung eines Stoßdämpfers

CPM Gesellschaft für Computeranwendung, Prozeß- und Materialtechnik

VDI 30

FEM Simulation in der Kaltumformung **Aktuelle …..-beispiele und Ausblick**

Aktuelle Anwendungsbeispiele und Ausblick

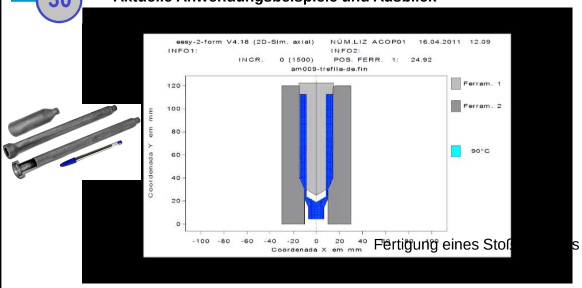
Fertigung eines Stoßdämpfers

CPM Gesellschaft für Computeranwendung, Prozeß- und Materialtechnik

VDI 30

FEM Simulation in der Kaltumformung **Aktuelle …..-beispiele und Ausblick**

Aktuelle Anwendungsbeispiele und Ausblick

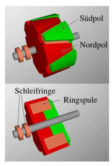


Fertigung eines Stoß…s

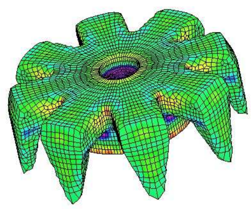
CPM Gesellschaft für Computeranwendung, Prozeß- und Materialtechnik

Introduction

Example of complex cold forging operations



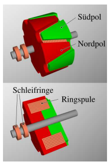
(Claw pole motor – Wikipedia)



Claw

CPM Gesellschaft für Computeranwendung,
Prozeß- und Materialtechnik

Introduction

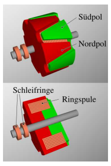


(Claw pole motor – Wikipedia)

(c) Dr. Gerhard H. Arfmann CPM GmbH, Germany
Presentation to Henan University of Science and technology, Luoyang, China 17.11.2015 49

CPM Gesellschaft für Computeranwendung,
Prozeß- und Materialtechnik

Introduction



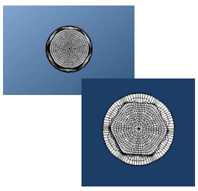
(Claw pole motor – Wikipedia)

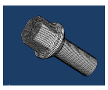
(c) Dr. Gerhard H. Arfmann CPM GmbH, Germany
Presentation to Henan University of Science and technology, Luoyang, China 17.11.2015 50

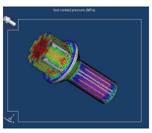
CPM Gesellschaft für Computeranwendung,
Prozeß- und Materialtechnik

Introduction

Example of complex cold forging operations







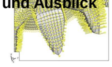
To avoid a „flower“ shape

(c) Dr. Gerhard H. Arfmann CPM GmbH, Germany
Presentation to Henan University of Science and technology, Luoyang, China 17.11.2015 51

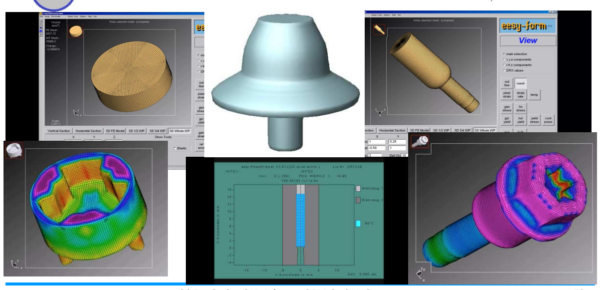
CPM Gesellschaft für Computeranwendung,
Prozeß- und Materialtechnik

VDI 30

FEM Simulation in der Kaltumformung **Aktuelle …..-beispiele und Ausblick**



Aktuelle Anwendungsbeispiele und Ausblick



(c) Dr. Gerhard H. Arfmann CPM GmbH, Germany
Presentation to Henan University of Science and technology, Luoyang, China 17.11.2015 52

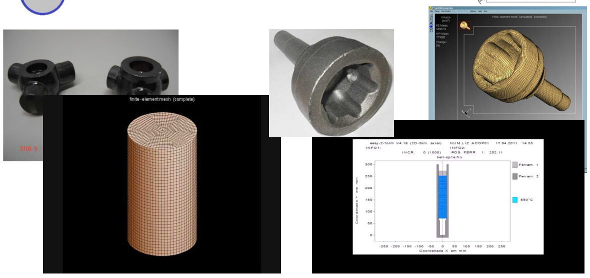
CPM Gesellschaft für Computeranwendung,
Prozeß- und Materialtechnik

VDI 30

FEM Simulation in der Kaltumformung

Aktuelle …..-beispiele und Ausblick

Aktuelle Anwendungsbeispiele und Ausblick



(c) Dr. Gerhard H. Arfmann CPM GmbH, Germany 53
Presentation to Henan University of Science and technology, Luoyang, China 17.11.2015

CPM Gesellschaft für Computeranwendung,
Prozeß- und Materialtechnik

Introduction Tool Design

This was a small overview about what can be done in simulation today.

But besides the forming sequence the

tool design

is decisive for a good productivity.

In the following is shown how
Simulation can help with Tool design

(c) Dr. Gerhard H. Arfmann CPM GmbH, Germany 54
Presentation to Henan University of Science and technology, Luoyang, China 17.11.2015

CPM Gesellschaft für Computeranwendung,
Prozeß- und Materialtechnik

Tool Design Task - generel

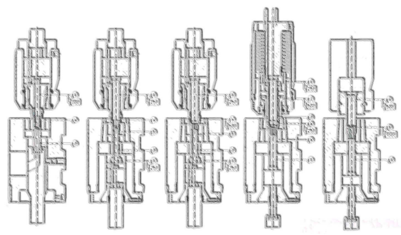
Spark Plug

(c) Dr. Gerhard H. Arfmann CPM GmbH, Germany 55
Presentation to Henan University of Science and technology, Luoyang, China 17.11.2015

CPM Gesellschaft für Computeranwendung,
Prozeß- und Materialtechnik

Tool Design Task - generel

Spark Plug

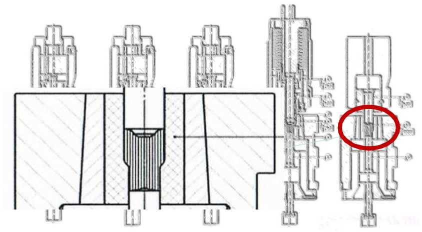


The idea how to make the tool design may be known in general.

(c) Dr. Gerhard H. Arfmann CPM GmbH, Germany 56
Presentation to Henan University of Science and technology, Luoyang, China 17.11.2015

Tool Design Task - generel

Spark Plug



How to do in detail ?

Tool Design Task

The presentation will show you examples how to systematically design the tooling using simulation and calculation systems.

1. Analysis of punches
2. Analysis of a die insert (Carbide)
3. Design of an extrusion die
4. Example of a practical applications

Tool Design Task

The presentation will show you examples how to systematically design the tooling using simulation and calculation systems.

1. **Analysis of punches**
2. Analysis of a die insert (Carbide)
3. Design of an extrusion die
4. Example of a practical applications

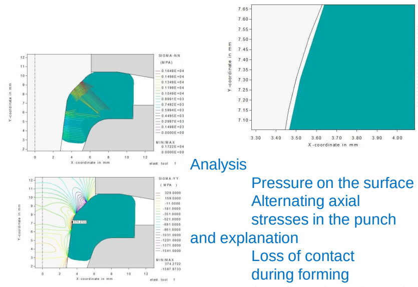
Tool Design Task – Analysis of punches

Examples of punch failure

Tool Design Task – Analysis of punches

Punch failure during
production of a
valve spring retainer

Tool Design Task – Analysis of punches

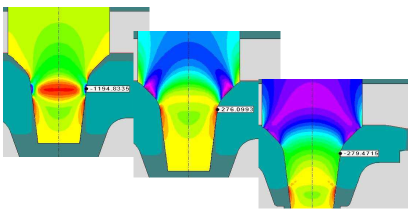


Punch failure during production of a retainer

Analysis
- Pressure on the surface
- Alternating axial stresses in the punch

and explanation
- Loss of contact during forming (no oil or air enclosure)

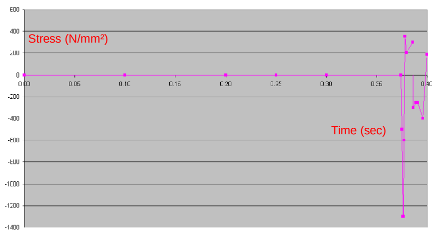
Tool Design Task – Analysis of punches



Alternating Stresses

Failure due to fatigue

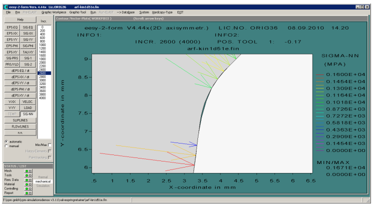
Tool Design Task – Analysis of punches



Alternating Stresses in due time

Failure due to fatigue

Tool Design Task – Analysis of punches



Reason for the stress situation:
the material flow during the forming.
(Temporarily no contact – gap some 1/100 mm)

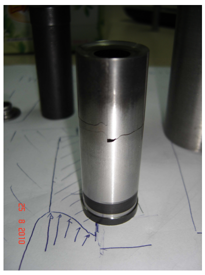
Tool Design Task – Analysis of punches

Fatal failure of a punch

Tool Design Task – Analysis of punches

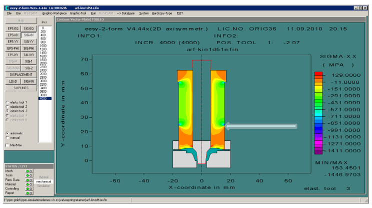
Fatal failure of a punch

Tool Design Task – Analysis of punches



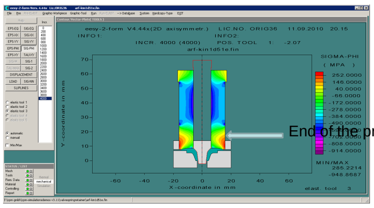
Crack Initiation

Tool Design Task – Analysis of punches



Stress concentration at the point of crack initiation (Sig xx)

Tool Design Task – Analysis of punches



Positive tangential stress below the contact point

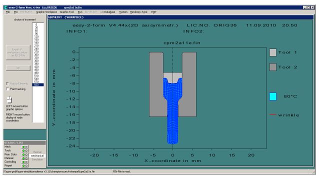
Tool Design Task – Analysis of punches

Punch failure during production of spark plug

Picture from a similar case(Picture ICFG Workgroup Simulation)

Tool Design Task – Analysis of punches

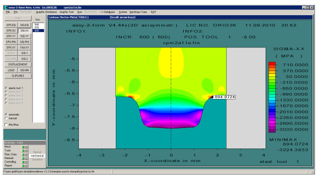
Failure of punch during extrusion



Punch failure during production of spark plug

Tool Design Task – Analysis of punches

Failure of punch during extrusion

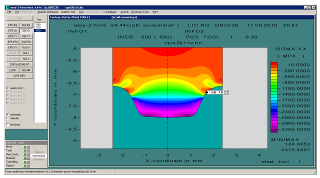


Punch failure during production of spark plug

High local positive radial stress -> punch failure

Tool Design Task – Analysis of punches

Failure of punch during extrusion



Punch failure during production of spark plug

No concentration of positive radial stress after

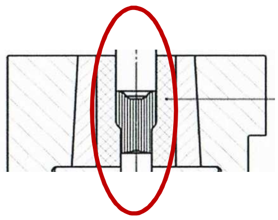
Changing the radius -> no failure

Tool Design Task

The presentation will show you examples how to systematically design the tooling using simulation and calculation systems.

1. Analysis of punches
2. **Analysis of a die insert (Carbide)**
3. Design of an extrusion die
4. Example of a practical applications

Tool Design Task – Analysis of a die insert – carbide insert



Tool Design Task – Analysis of a die insert – carbide insert

Horizontal split
(breakage)

due

to axial stresses

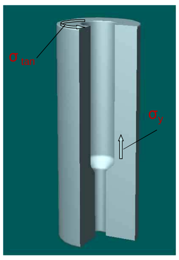
Tool Design Task – Analysis of a die insert – carbide insert

Fatal cracking

due to

overloading

Tool Design Task – Analysis of a die insert – carbide insert

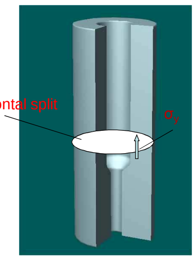


σ_{tan}: critical for axial crack

σ_y: critical for horizontal crack

Tool Design Task – Analysis of a die insert – carbide insert

Horizontal split

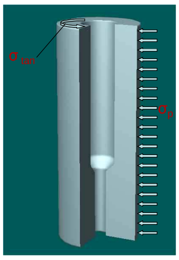


σ_y: critical for horizontal crack

horizontal split of the insert

to avoid

Tool Design Task – Analysis of a die insert – carbide insert

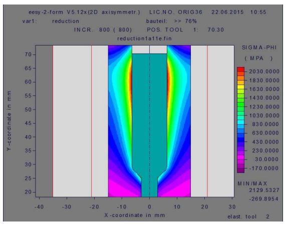


σ_{tan}: critical for axial crack

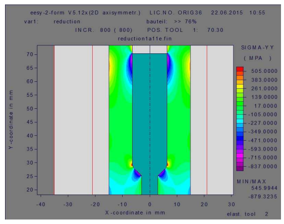
Pre-stressing of the insert

to avoid

Tool Design Task – Analysis of a die insert – carbide insert



Tangential Stress to be compensated by pre-stressing



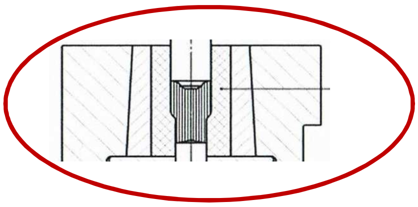
Axial stress to be avoided by split

Tool Design Task

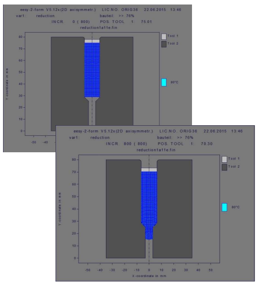
The presentation will show you examples how to systematically design the tooling using simulation and calculation systems.

1. Analysis of punches
2. Analysis of a die insert (Carbide)
3. **Design of an extrusion die**
4. Example of a practical applications

Tool Design Task – Design of an extrusion die

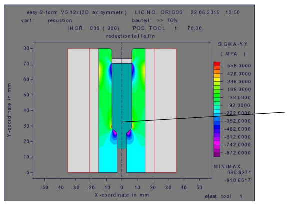


Tool Design Task – Design of an extrusion die



Simulation of an extrusion

Tool Design Task – Design of an extrusion die

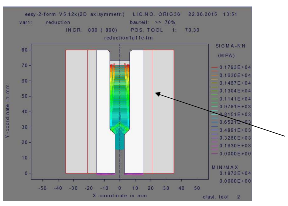


- Avoiding of failures (elastic analysis of the insert with FEM)

  Splitting of the die due to high axial stresses

Tool Design Task – Design of an extrusion die

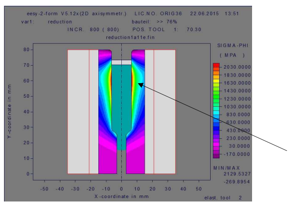
Tool design



Die insert without pre-stressing

Tool Design Task – Design of an extrusion die

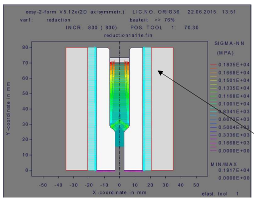
Tool design



Positive stress in the die without pre-stressing

Tool Design Task – Design of an extrusion die

Tool design

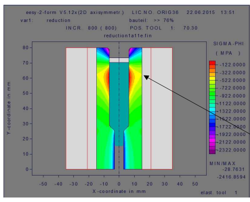


Die with pre-stressing (900 MPa)

Tool Design Task – Design of an extrusion die

- Design of a cold forming process

Tool design



Pressure in the die with pre-stressing

Tool Design Task – Design of an extrusion die

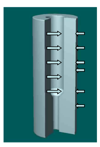
Procedure

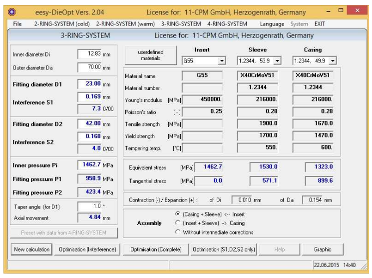
After the FEM analysis of the part an optimal design layout is calculated with the die-design system

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

Tool Design Task – Design of an extrusion die

System to calculate and optimize the pre-straining in a die





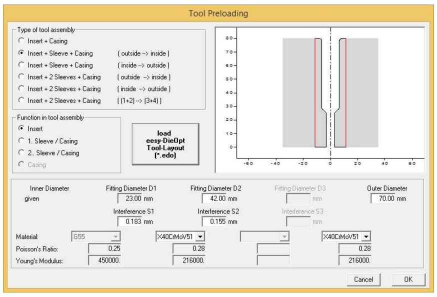
CPM Gesellschaft für Computeranwendung,
Prozeß- und Materialtechnik

Tool Design Task – Design of an extrusion die

Interface

EESY-DieOpt

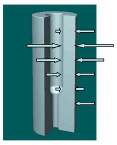
EESY-2-form



CPM Gesellschaft für Computeranwendung,
Prozeß- und Materialtechnik

Tool Design Task – Design of an extrusion die

Principle



New methode for die design

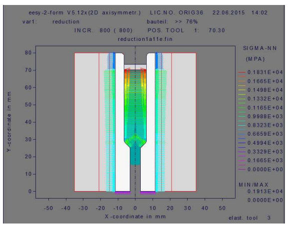
Pre-stress = f ($P_i(t,y)$; $d_i(y)$; y; ...)

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

CPM Gesellschaft für Computeranwendung,
Prozeß- und Materialtechnik

Tool Design Task – Design of an extrusion die

The pre-stress on the insert shows a distribution now



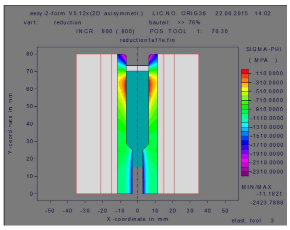
CPM Gesellschaft für Computeranwendung,
Prozeß- und Materialtechnik

Tool Design Task – Design of an extrusion die

The stress distribution in the insert is different, too.

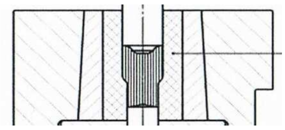
In this case the result is ok.

Otherwise the engineer has to make changes in the design again.



CPM Gesellschaft für Computeranwendung, Prozeß- und Materialtechnik

Tool Design Task – Design of an extrusion die



Final design:

inner dia: 12.83 mm
outer dia: 70.00 mm

fitting dia: 23.00 mm
interf.: 0.169 mm

fitting dia 2: 42.00 mm
interf: 0.168 mm

Mat insert: G55
Mat sleeve: SKD61 HRC 54
Mat body: SHD61 HRC 50

CPM Gesellschaft für Computeranwendung, Prozeß- und Materialtechnik

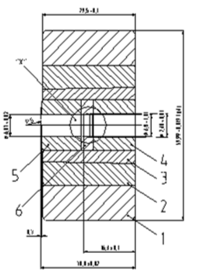
Tool Design Task

The presentation will show you examples how to systematically design the tooling using simulation and calculation systems.

1. Analysis of punches
2. Analysis of a die insert (Carbide)
3. Design of an extrusion die
4. **Example of a practical applications**

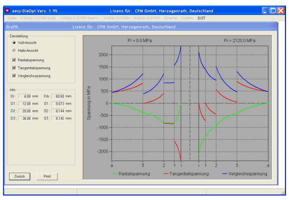
CPM Gesellschaft für Computeranwendung, Prozeß- und Materialtechnik

Tool Design Task – Design of an extrusion die



(c)WALLRAM

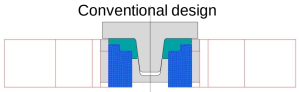
- Even complex design could be realised



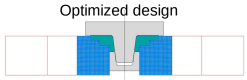
CPM Gesellschaft für Computeranwendung, Prozeß- und Materialtechnik

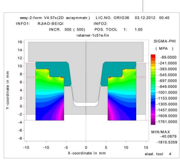
Tool Design Task – 1st Example of practical applications

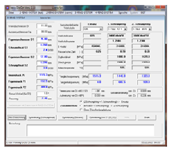
Conventional design

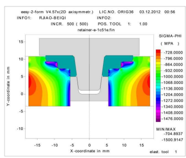


Optimized design









CPM Gesellschaft für Computeranwendung, Prozeß- und Materialtechnik

Tool Design Task – 2nd Example of practical applications

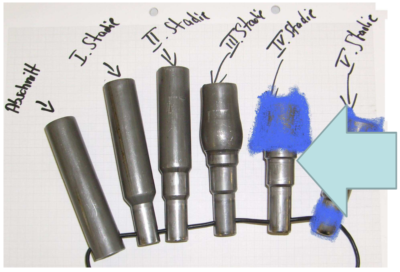
5 station

cold forging

process

CPM Gesellschaft für Computeranwendung, Prozeß- und Materialtechnik

Tool Design Task – 2nd Example of practical applications



5 station

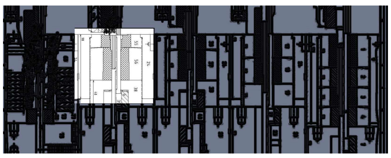
cold forging

process

Location of the problem in the tooling

CPM Gesellschaft für Computeranwendung, Prozeß- und Materialtechnik

Tool Design Task – 2nd Example of practical applications



5 station

cold forging

process

Initial tool design in operation 4

CPM Gesellschaft für Computeranwendung, Prozeß- und Materialtechnik

Tool Design Task – 2nd Example of practical applications

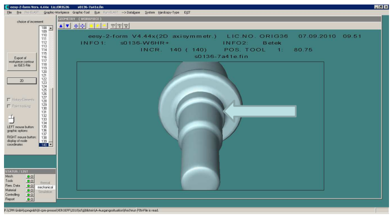
5 station

cold forging

process

Premature failure of the die

Tool Design Task – 2nd Example of practical applications



5 station

cold forging

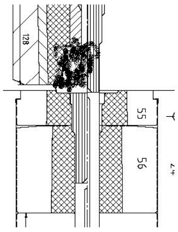
process

Forming in operation 4

Tool Design Task – 2nd Example of practical applications

Initial design of the die in operation 4

(Carbide – pre-stressed by one ring)

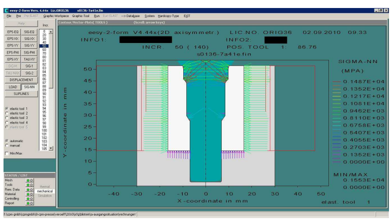


5 station

cold forging

process

Tool Design Task – 2nd Example of practical applications



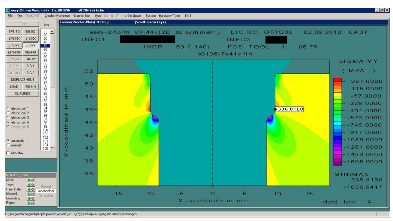
5 station

cold forging

process

Distribution of pressure in the die

Tool Design Task – 2nd Example of practical applications



5 station

cold forging

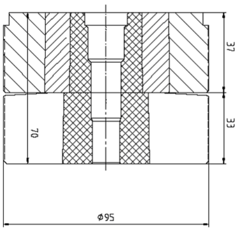
process

Positive stress in the carbide → failure

Tool Design Task – 2nd Example of practical applications

New design of the die in operation 4

(Carbide – pre-stressed by two rings)

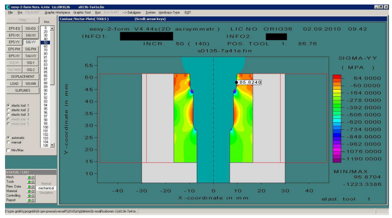


5 station

cold forging

process

Tool Design Task – 2nd Example of practical applications



5 station

cold forging

process

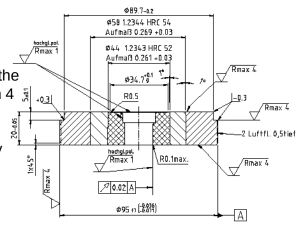
Positive stress in the carbide → failure

The carbide has to be split as well due to positive axial stresses in the lower area

Tool Design Task – 2nd Example of practical applications

New design of the die in operation 4

(Carbide – pre-stressed by two rings and splitted)

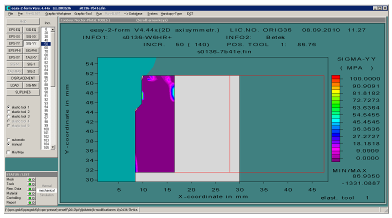


5 station

cold forging

process

Tool Design Task – 2nd Example of practical applications



5 station

cold forging

process

Positive stress in the carbide still → failure

Tool Design Task – 2nd Example of practical applications

Prove of the failure in practical test

5 station

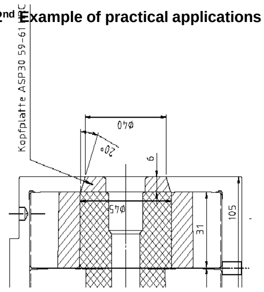
cold forging

process

Tool Design Task – 2nd Example of practical applications

New design of the die in operation 4

(disc made out of ASP 30, Carbide split – pre-stressed by two rings)



5 station

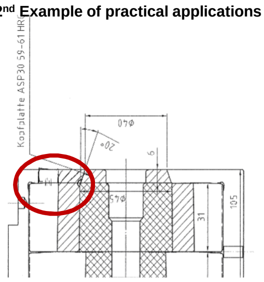
cold forging

process

Tool Design Task – 2nd Example of practical applications

Corrected design of the die in operation 4

(disc made out of ASP 30, Carbide split – pre-stressed by two rings)



5 station

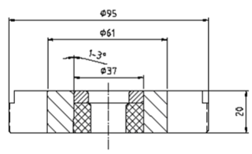
cold forging

process

Tool Design Task – 2nd Example of practical applications

Final design of the die in operation 4

(disc made out of ASP 30, Carbide split – pre-stressed by two rings)



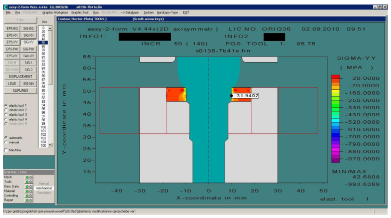
5 station

cold forging

process

CPM Gesellschaft für Computeranwendung, Prozeß- und Materialtechnik

Tool Design Task – 2nd Example of practical applications



5 station

cold forging

process

Stresses are compressive now

Tool life could be improved from 1000 pieces to 25000 pieces

CPM Gesellschaft für Computeranwendung, Prozeß- und Materialtechnik

Tool Design Task – 2nd Example of practical applications

5 (6) station

cold forging

process

Meanwhile the tool life could be improved to 120000 pieces by introducing a further station before # 4.

CPM Gesellschaft für Computeranwendung, Prozeß- und Materialtechnik

Tool Design Task – 3rd Example of practical applications

Pre-stressed punch to form a TORX® recess

After optimization

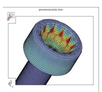
a tool life of 2,5 Mio

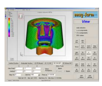
was reached

(**stable for more than 10 years now**)

CPM Gesellschaft für Computeranwendung, Prozeß- und Materialtechnik

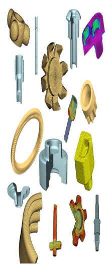
Future





Future developments

* Integration of the simulation in the entire production chain
* Completion of the material data needed
* Development of further technological modules
* Reducing the simulation systems to very specialized systems for industry sectors

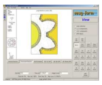


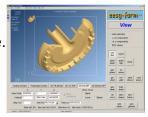
CPM Gesellschaft für Computeranwendung,
Prozeß- und Materialtechnik

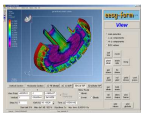
Aknowledgements

CPM is much obliged to their customers that provided relevant information
to enable CPM to present successful applications of their simulation software.

Such information is very helpful to promote CPM software and the application of
simulation in general by presentations like this one.

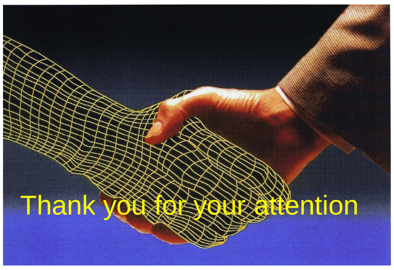






CPM Gesellschaft für Computeranwendung,
Prozeß- und Materialtechnik

Trust in "eesy" simulation



Customers are happy to work on their daily tasks with "eesy" simulation