Successful introduction of FEA at SQB

Mr. Feng Jinyao*), Mr. Chen Wei*), Dr. Gerhard Hermann. Arfmann)**

Abstract

In 2010 SQB introduced the FEA system ***eesy-2-form*** of CPM GmbH, Germany.
This article shows how the system could be used in practical application with very good results after a short time of introduction. The aims of introducing such simulation software and the achievable results will be explained using a case study from the production floor.

Introduction

With the increasing demand to produce more sophisticated products because of the competition from third level countries and the demand of the developing industry in China SQB decided to invest into engineering to meet the new requirements. Besides good education of the engineers and introduction of new technology and machines from abroad it means to introduce latest development and design tools as well. So the consequent further step was to introduce FEA technology. With using FEA technology expensive trails and error developments can be avoided and the down to market time can be shorted significantly. Tool live can be increased and process understanding improved. It may help as well in discussing product changes with the customer by showing the abilities of cold forging processes when a part shall be made by cold forging instead of machining.
The decision was taken to introduce the German system ***eesy-2-form*** of CPM for process simulation and optimization and together with introducing the software to get relevant training on technology as well. After the first training units some case studies were performed to prove the usability and precision of the system. One of these case studies will be explained here to show how such technology and software can be used with success after a very short period of introduction.

Keywords: Cold Forging, Finite Element Analysis

***)**
Feng, Jin Yao
Chairman and General Manager
Shanghai Shang Biao Automotive Fasteners Co., Ltd.
Shanghai, P.R.China,

Wei, Chen
Development Engineer
Shanghai Shang Biao Automotive Fasteners Co., Ltd.
Shanghai, P.R.China,

****)**
Dr. Arfmann, Gerhard Hermann
Joint Managing Director
CPM Gesellschaft für Computeranwendung, Prozeß-
und Materialtechnik, Herzogenrath, Germany, www.metalforming.de

Case Study

As a case study the production process optimization for the product “37-3” of SQB will be explained.
The part is produced on a JBF-13B4S machine of Jern Yao. The material is SWRCH35K
Figure 1 shows the product drawing.

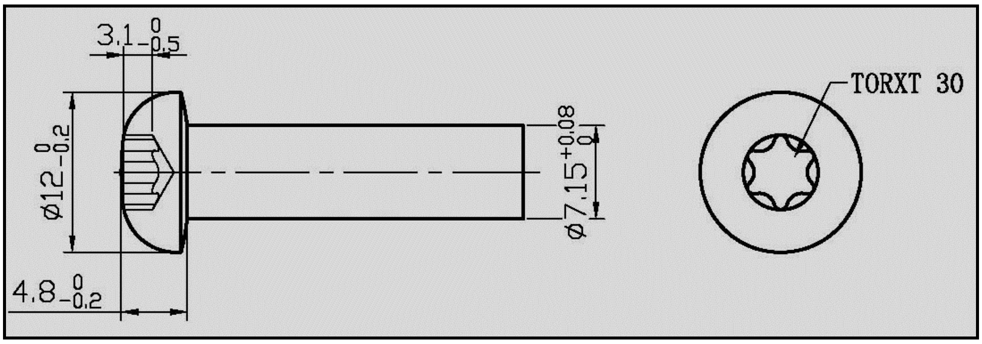

Fig. 1: Product drawing of part “37-3”

One of the problems SQB faced was that the T30 punch used to form the recess was braking premature. The lifetime of the punch was about 100 pieces only. So the productivity was not good. From experience it was known that this product had bad tool life in history always.

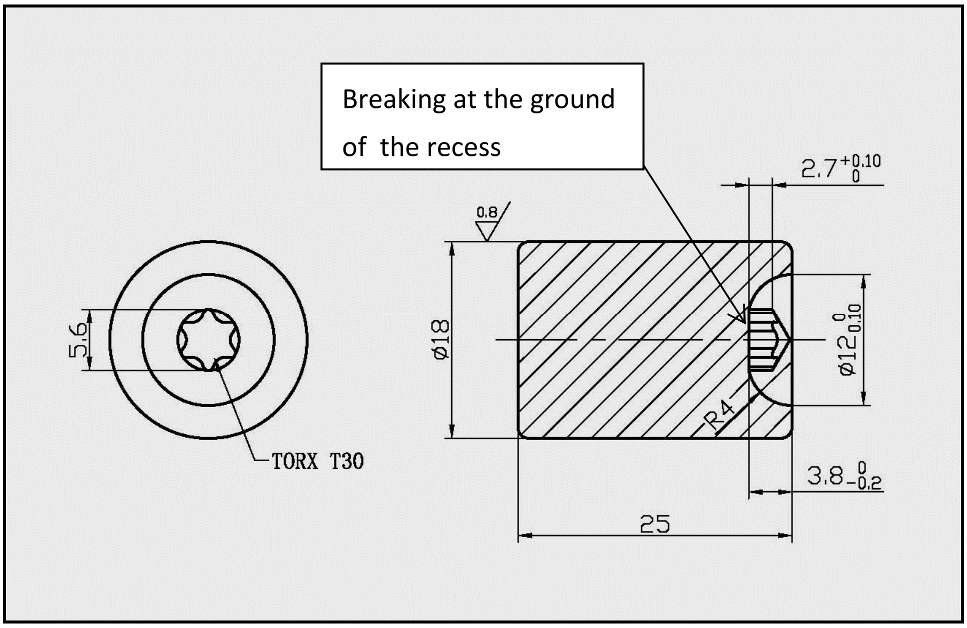

Fig. 2: Punch breaking at the ground of the recess

Another problem was the possibility to get a folding in the recess depending on the preform. The reason for this was not really understood. So the task was to improve tool life and to get rid of that folding as well.

The original forging sequence is shown in Figure 3.

Fig. 3: Original Forging sequence

Obviously the preforming in operation one was not enough. It was tried as well to preform the recess in operation one (Figure 4). But the result for the tool life did not change. Figure 4 shows the potential folding in the recess as well.

Fig. 4: Sequence with preformed recess

After having CPM introduced FEA eesy-2-form in the engineering the process was studied by simulation to better understand what happened.

Figure 5 shows the simulation results (geometry) of the variation of the process using the preforming of the recess. The simulation shows the folding in the recess as well. Figure 6 shows a picture of the recess. It can be clearly seen that the prediction of the simulation is very exact. Depth and position of the folding is predicted exactly.

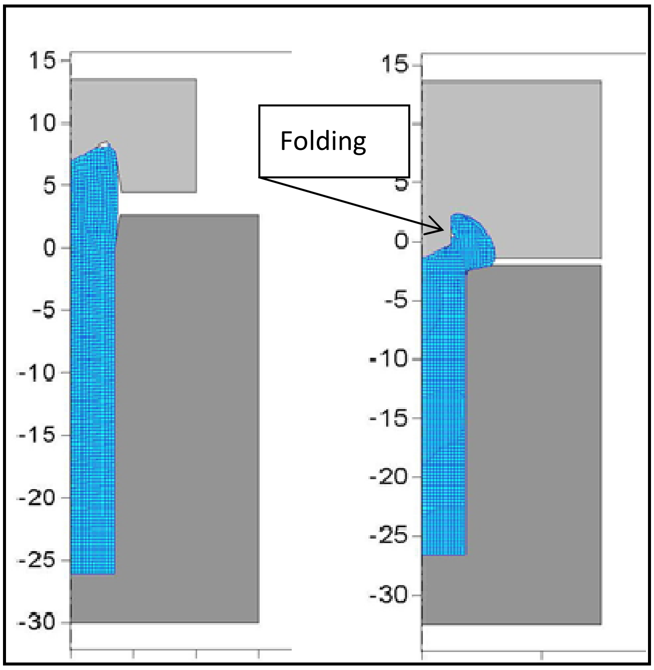

Fig. 5: Second operation of the variation with preforming the recess

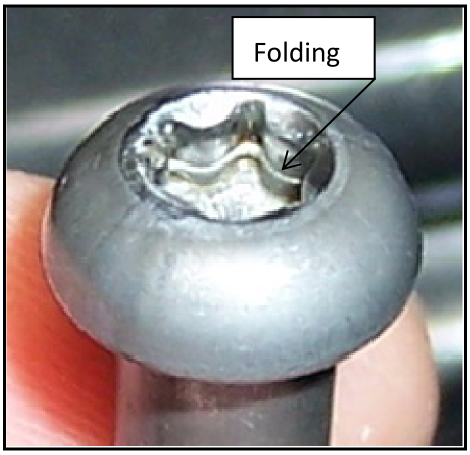

Fig. 6: The folding in the recess corresponds very well with the simulation result

A more detailed analysis of the simulation results helped to understand the material flow much better.
In figure 7 a sequence of pictures of the process for intermediate tooling positions shows and explains how the material flows.

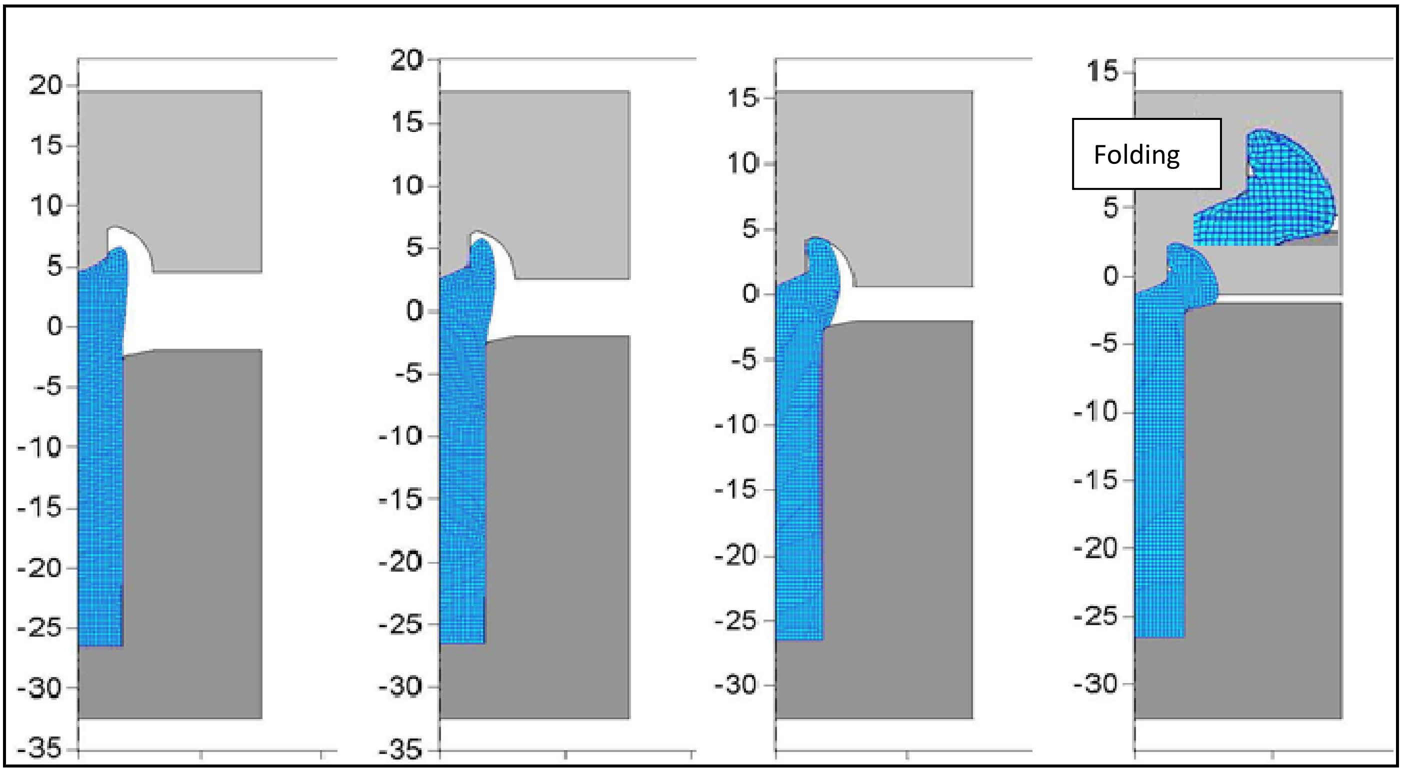

Fig. 7: Sequence of tooling positions during the process

It is easy to understand how the material touches at the basis of the recess punch first and then will be pushed downwards to fill the head. There is no radial pressure on the shaft of the recess. There is radial material flow from the tip of the punch and from the ground of the punch into the head but not from the shaft. This leads to the folding. The stress analysis given in figure 8 shows a very high pressure at the tip of the TORX punch. The value of max 3158 MPa overloads the material (SWRCH35K) and will make it plastic while there is no load on the shaft of the punch. This will lead to the stresses shearing the punch in the TORX ground and lead to the premature failure.

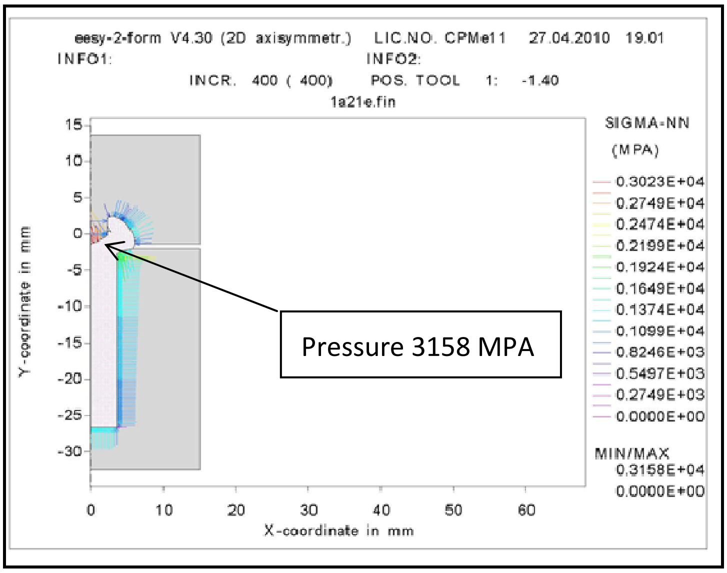

Fig 8: Normal stresses (pressure) on the punch and the die.

As the material flow was understood much better now the preform was changed. The height of the head was reduced und the width increased. No preforming of the recess was really needed. Figure 9 shows the preform chosen finally.

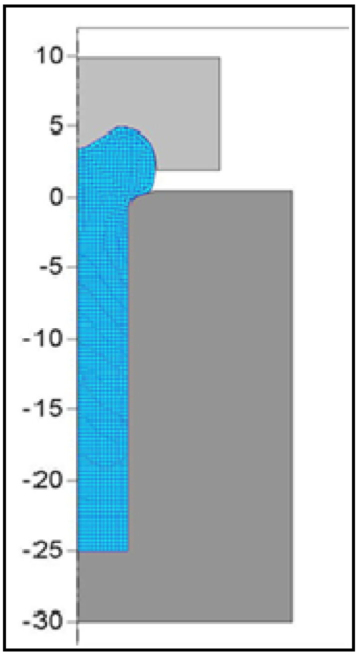

Fig. 9: New preform

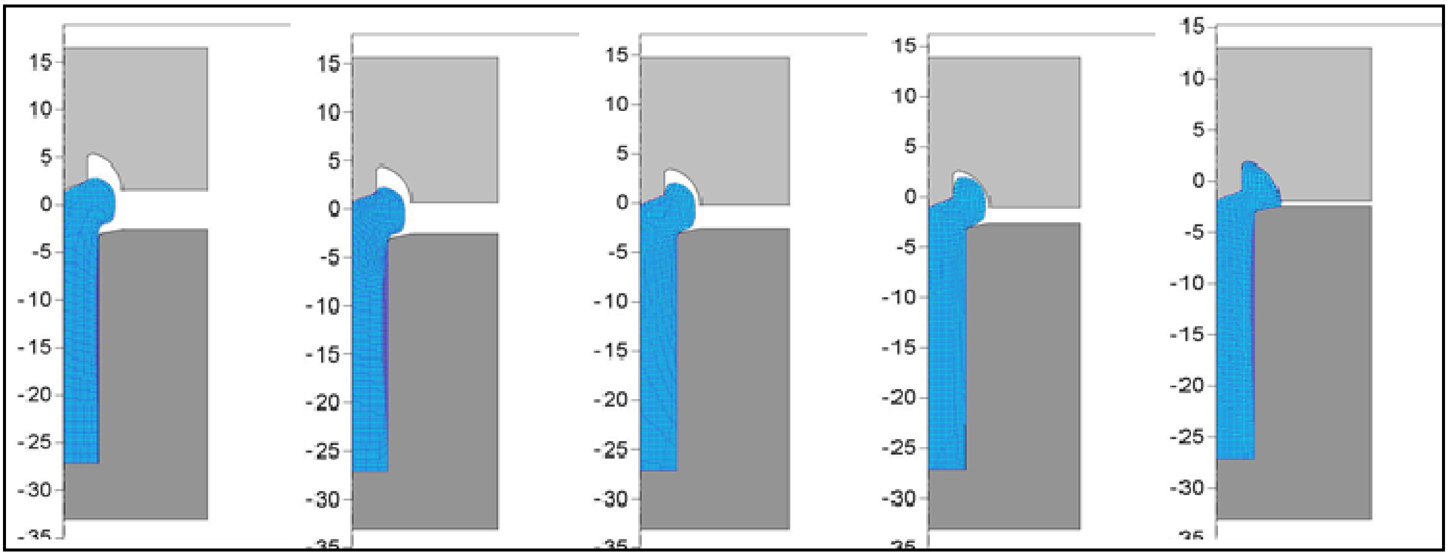

Fig. 10: Forming in the second blow (new design)

Figure 10 shows how the material fills the form without folding in the new design.

The analysis of the normal stresses on the punch shows much lower values (Figure 11). And there is no stress in the ground but on the shaft of the recess.

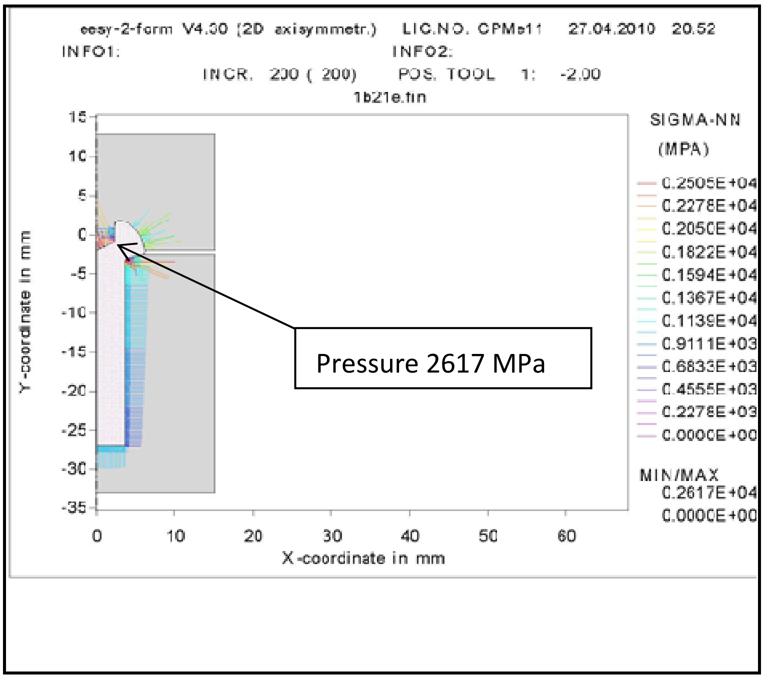

Fig. 11: Normal stresses on the punch (new design) (max. 2617 MPa)

Fig. 12: Production samples (new design)

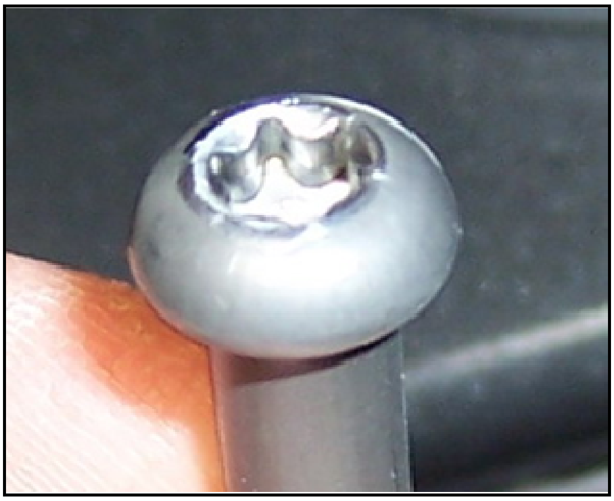

Fig. 13: Production sample (new design): no folding

The optimized process gives a perfect geometry. The folding disappeared and the tool life could be improved.

Summary
After a short period of training by CPM for eesy-2-form and exercising the engineers were able to apply the new technology to the daily work. In the example the pre form in the process could be optimized to reach better material flow and lower tool loads to allow for better tool life.

After optimizing the product could be produced at a speed of 140 pcs /min with a tool life of 10.000 pieces.

Literature

[1] G. H. Arfmann, M. Twickler
„eesy“ Simulationssoftware
CPM Gesellschaft für Computeranwendung, Prozeß- und Materialtechnik mbH
Herzogenrath, Germany, 2010