Progress Through Shared Knowledge

by Peter Standring

Introduction

Fasteners, as the name suggests are designed to join things. For example, primary strands can be captured by weaving, knitting, knotting, etc., into cloth, fabric, baskets, furniture and structural walls. These can be held together mechanically by stitching, wedge locking, pegging or chemically by gluing.

Exactly the same technologies invented and developed in the earliest centres of human habitation and refined into the mass produced products of today are also used to manufacture the super lightweight polymer based composites which help give the aerospace, military and motor sports industries their cutting edge.

The bias of a piece of fabric to a seamstress or tailor is as significant as the fibre structure in a piece of metal along with the attendant anisotropic properties resulting from the grain structure produced by the manufacturing process. Part orientation is just as important to the press worker and fastener manufacturer as the 'cut' of the cloth to every garment maker. Defects in fabric are generally picked up by inspection and rejected. In aerospace and motorsport the customer demand is for zero defects which is why, in those markets, things cost so much.

For the metalworker, the specifications agreed with the material supplier are generally broad unless the customer pays a premium to obtain tighter tolerances. Standard values of tensile strength, elongation and hardness are usually achieved in the processing regime which the primary supplier follows. The chemistry of every metal falls within the widest range of elements that the producer can sell as stock volume. Therefore, the elemental range of a 'standard' metal from melt to melt will vary, sometimes quite substantially. Although still within 'spec' the resulting 'as received' material properties can be very different.

However, unlike the seamstress, tailor or composite maker who can readily spot a weaving or bonding problem either visually or electronically, a secondary processor of metal must rely entirely on the test data provided by the supplier as to the likely quality/performance of the product unless they repeat the tests themselves.

It is not an uncommon cry heard in most metalforming shops that when any formed part fails, suspicion/blame first falls on the quality of the 'as received' material. For pressworkers dealing with small to large scale parts, produced singly or on a multi stage transfer press, the evidence of failure is generally easy to see resulting from either buckling or splitting. For the fastener manufacturer, catastrophic failure is also easy to recognise but there can be other far less obvious factors which only reveal their existence in the service quality of the parts produced and in the truncated life of the tooling used to make them.

This article seeks to reflect on some of the problems encountered in fastener manufacture which, over many years, have captured the Author's attention and interest.

Technology Transfer

The International Cold Forging Group (ICFG) can trace its existence through OECD support in the 1960's to studies of German manufacturing capabilities during World War II. The invention of a 'conversion coating' bonded to a base material and which could carry a lubricant thus allowing steel to be cold formed took place in Germany in 1935. It was classified as a 'State Secret'.

Post War investigators from the UK and USA discovered the success of cold forming technology when they realised how efficient German manufacturing had been compared with their own often poor material utilisation.

Today, the ICFG is a global organisation, the membership of which is primarily individually based but operates through National bodies. The Author has been Technical Secretary to the British Cold Forging Group (BCFG) now Industrial Metalforming Technologies (IMfT) and hence an ICFG member since the 1980's.

It was in this role in the early 1990's that the Author was invited to sit on the Executive Council of the Confederation of British Metalforming (CBM), the UK Lead Trade Body for cold/hot forging and sheet metal. As the senior metalforming academic at the University of Nottingham, UK, these direct involvements with the industrial metalforming community was considered highly beneficial to the Author's teaching and research activities. In an attempt to develop an investigative dialogue between often competing CBM member companies, the Author established and chaired a Technology Transfer Group (TTG) primarily made up of fastener companies and their supply chain. To minimise time away from the workplace, all meetings were held between 8.00 am and 10.00 am at the premises of one of the Group. The venues changed for every meeting held generally at two month intervals. The format involved the 'host' company presenting a non-confidential manufacturing problem they had, or were experiencing and the rest of the Group would discuss this technically. It was the 'host's' responsibility to ensure that nothing commercially damaging to them was disclosed. However, it quickly became apparent that those attending left their 'company hats' at the door and entered the discussions as metalformers sharing a common interest. The following cases reflect the spirit of the meetings.

Case 1

The venue was a well known fastener manufacturer based in the UK for over 50 years. Their facilities included multiple one die, two blow; two die, three blow and three die four blow machines producing a wide range of fasteners for a number of industrials sectors. The Company is still operating today.

The problem presented by the host's Technical Director is long forgotten and could have been tooling, material and/or lubricant related. Representatives of all these three supplier groups were in attendance at the meeting. A description of the process was provided which began with a specification of the wire used to which the Supplier added a brief history of its manufacture and delivery.

The Technical Director then informed the meeting of the lubrication and pre drawing qualifying station prior to the wire entering the cold forming machine. He then stated that the process did not run.

A competitor fastener manufacturer present, asked what was done to solve the problem (which must be emphasised was not the problem being addressed at the meeting) to which the Technical Director answered, "We just turned the coil round and ran it the other way." The representative from the competitor company along with other fastener manufacturers present agreed that what had been described was indeed standard practice across the industry.

This statement immediately caused the Author chairing the meeting, to ask of the material suppliers and process users what was the technical reason for the presumed direction of the draw to make the wire behave in this manner. Those present simply shrugged their shoulders and the collective response was that, "Sometimes it happens that way and when it does, we simply turn the coil round and the machine runs."

Over many years, the Author has asked cold forming experts working in the fastener industry for an explanation of this apparently well known phenomenon which it would appear has never been investigated? If there are wire producers or process users who know of any documented study of this presumably anisotropic conundrum and can provide a science based technical answer, then I will certainly post it on the IMfT website along with my grateful thanks for ending what has proved to be a long time puzzle.

Case 2

Sometimes difficult to explain things happen.

One such case presented to the TTG concerned the cold forming of a valve spring retainer for a well known automotive OEM.

As shown in Figure 1 the part was cropped, dumped and cold formed in a conventional manner, using FEA to establish the process route. In developing the part, the Technical Manager told the Group that shear failure of the final punch was their problem. Initial trials resulted in failure after 200 piece parts. Further trials using numerous punches made from various tool steel grades suggested by suppliers, had only managed to achieve a punch life of 1000 pieces.

Figure 1. Production sequence for valve spring retainer (courtesy KMS)

The Manager then informed the Group that a tooling salesperson acting on behalf of a Taiwanese manufacturer one day simply walked in off the street and asked if the Company had any work they might give him by way of a free trial.

Somewhat cynically, the Manager provided a drawing of the failing punch and was surprised seven days later, when the salesman returned with a new punch to try. The Manager's previous surprise turned to utter astonishment when the punch made in Taiwan recorded over 74,000 pieces before failure.

Of course immediately the tool failed and the Manager had it analysed to find out what magic material had been given to them with everything else in the process route being as before.

The result, it transpired, was a very ancient M50 HSS which completely turned the previous discussions the Company had held with various tool steel material suppliers upside down. The Manager informed his TTG guests, that the obvious conclusion to be drawn from the exercise was that irrespective of the material used, the quality of tool manufacture and the heat treatment regime it is subjected to are fundamental to achieving success. In this particular case he lamented, we now need to review our entire tool procurement procedure in hopeful anticipation of obtaining other savings elsewhere. Perhaps, he suggested, it would profit your Companies to do the same?

Case 3

As will be appreciated from the previous case, the first step in any tool improvement programme must begin with the establishment of a tool monitoring scheme. In 1999/2000, the ICFG formed a Tool Life and Tool Quality Sub Group which in 2002 published a booklet Part 1: General Aspects of Tool Life (1). This Group is still active and over the years has published four further booklets covering: Tool Manufacture (2), a comparison of PM versus tungsten carbide materials for tools (3), Tool Life (4) and Surface Finishing (5). These booklets, written in English, are all available for purchase from Meisenbach Verlag Bamberg, Germany.

As an original member of the Tool Life Sub Group, the Author involved the BCFG membership in a UK based study on Tooling, the results of which were fed into the ICFG work programme. This involved a detailed tooling survey of ~30 active cold forging companies, many of which produced fasteners. From the work, it was apparent that to make any sensible forward progress in terms of obtaining Tool Life Improvement, all companies need to constantly monitor what they do and record and compare how things perform. In short, it was necessary to develop an on-going and dynamic Tool Monitoring Database. Figure 2 illustrates the agreed version of what BCFG members believed a Tool Monitoring Database should be based on and the information it should contain.

Item	Level 1	Level 2
Component	Designation code	Customer Contact Design details Date of first production Modifications/date*
Machine	Designation code	Type Specification Age Service record Settings for production Previous production record Modifications/date*
Work Material	Designation code Purchase code*	Supplier(s) Condition Properties Method of processing Preform geometry Modifications/date*
Personnel	Shift details* Production achieved* Time(s) for tool change*	Setter(s) Operator(s) Inspection details Modifications/date*
Tool	Designation code(s) New* Reworked*	Description Supplier/contact Material details Method of manufacture Heat treatment Surface treatment Lubrication Modifications/date*
Tool Life (number of parts produced)	Design life No. Average life No.* Actual life No.*	Tool No.* No. of parts produced* Mode of failure* Lost production due to tool change/failure*

*denotes input required where appropriate

Trend analysis (obtained automatically from database)

Is tool life normal?	(Yes) no action (No) investigate
Are tool life trends upward?	(Yes) continuous improvement (No) investigate
Tool failure economics	Tool costs + lost production (action/no action)
Influence of modifications on tool life (%)	Improvement/no change/worse
Cost of modification per component	Accept/further investigation/reject

Figure 2. Proposal for Tool Monitoring Database

It must be recognised that Figure 2 provides a very simple first stage a company needs to take if it is serious in seeking to understand and analyse its own tooling performance. However, it represents only a small fraction of the accumulation of work and across the board effort that global members of the ICFG have put into their published documentation on the subject. It is also worth noting that the ICFG have been publishing detailed analyses on all aspects of cold forging technology for over 50 years. Today, China, Japan and South Korea have very strong national links with the ICFG which those in the region who work in cold forging might find it useful to approach.

Footnote. In 2003, recognising that the main players in cold forging technology had relocated out of the UK or been sold or closed, it was evident that the BCFG could not continue in its previous role. So, the name was changed to Industrial Metalforming Technologies (IMfT) to embrace the new global environment and include all aspects of metalforming technology, e.g.: equipment, materials/treatment and process/finishing. In this way, IMfT seeks to collaborate with interested parties worldwide whilst continuing its non aligned and independent support for an industry without which we would all live in a very strange place.

References

Tool Life & Tool Quality in Cold Forging

Part 1. ICFG Document 14/02

Part 2. ICFG Document 16/04

Part 3. ICFG Document 17/06

Part 4. ICFG Document 22/12

Part 5. ICFG Document 23/13

Printed by inprint GmbH

Published by Meisenbach Verlag Bamberg

on behalf of the International Cold Forging Group

Opportunities and Challenges in the Automotive Industry for Chinese Manufacturers

by Shervin Shahidi Hamedani

The automotive industry as a pillar of the global economy continues to face a growing number of challenges and pressures, including cost pressure, competition, globalization, market shifts, and volatility. However, the automotive industry in China has grown at more than 15 percent annually for a decade. In late 2015, when it looked like demand might decline, a tax break was introduced to keep the market growth in 2016.

Chinese automakers' efforts to expand into more emerging markets have spurred positive forecasts on export growth, amongst strengthening international political ties. The emerging markets such as the Middle East and North Africa are identified as key growth drivers for Chinese carmakers. Several trade relationships in these markets are promoted by the country's political relationships instead of market expansion. Other than the Middle East and North Africa, the fast-growing Indian and South Asian markets have been considered for their opportunities by many of Chinese manufacturers which have shifted their focus.

The automotive sector faces a range of challenges globally with complicated safety regulations. The majority of exported Chinese-branded vehicles are shipped to developing countries. There is room for development in Iran, India, Indonesia and Malaysia. The Indian market draws Chinese auto makers' attention because the demand is climbing and the market is developing at high speed.

Although Chinese companies are speeding up their pace to go abroad, the export environment in developed countries is not expected to change in the near future, as their saturated markets leave only limited opportunities for Chinese exports. Some developed countries have complex legal frameworks to protect local manufacturers. In the U.S., for instance, the market situation differs in each state, and has begun to levy heavy duties on truck and bus tires imported from China. That is, Chinese products are well-matched more to the local needs there, in terms of parts, materials, road performance, emission standards, and driving safety than markets in developed countries such as the US and EU.