Oracle

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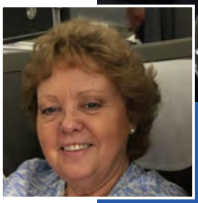

Image Ref -
Judges at ISME Skills Competition

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This Year's Skills Competition has been Cancelled due to Covid 19

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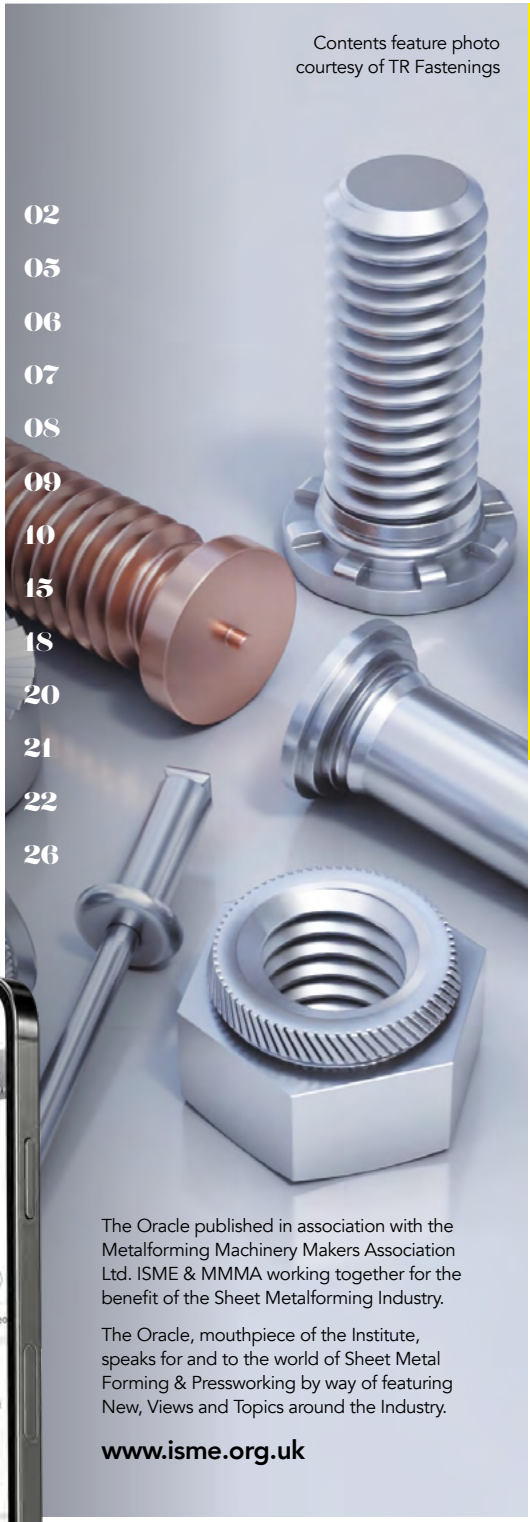
Contents feature photo courtesy of TR Fastenings



The Oracle published in association with the Metalforming Machinery Makers Association Ltd. ISME & MMMA working together for the benefit of the Sheet Metalforming Industry.

The Oracle, mouthpiece of the Institute, speaks for and to the world of Sheet Metal Forming & Pressworking by way of featuring New, Views and Topics around the Industry.

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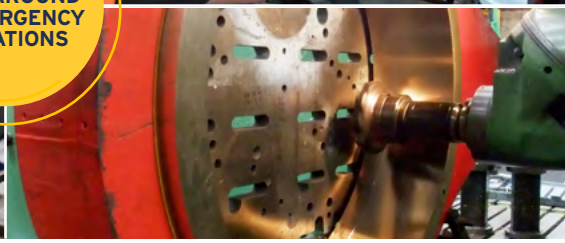

QUICK TURNAROUND IN EMERGENCY SITUATIONS

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From the President

Alan Shaw, President

Hello all,

How good it is to be able to contemplate some positive subjects again. As I was writing this, the Covid vaccination programme had provided jabs for over 21 million people in the UK, so be the time you are reading it, we should be well on the way to 25 million, a fantastic achievement.

Hopefully it means we can all look forward to returning to a more enjoyable way of life soon, albeit with the caveat that some things may have changed forever, and others may still be a while before we can say "back to normal".

There has been a lot of speculation about the extent to which working from home will be the new normal for many people. For those of us still engaged in actually making things I think the scope remains limited, not just because of the practical constraints around managing and operating machinery, but also because I really feel that we lose something valuable when you take away the face to face contact. Communicating by Zoom or MS teams is OK, and better than just phone or emails, but the exchange of views, ideas etc seems somehow lacking in inspiration.

For those who will find themselves working from home either entirely, or to a much greater extent, I note some commentators suggesting that assessing performance against set goals, rather than being paid by attendance time, could become the norm. I seem to recall we used to have a name for that type of thing, now what was it? – Oh yes, I remember now "Piece-Work"!

Chairman's Comments

Barry Smith - ISME Chairman

The need for adapting to the changing conditions

Now that we have all been informed by the Prime Minister of how our country will commence the process of coming out of lockdown, I am sure that there will be both opportunities and challenges along the way that we will all have to face.

Being involved in the Sheet Metal Industry, currently one of the biggest challenges that I am seeing is the availability of steel and the amount that the cost has increased.

Trying to pass these increases onto the customers will prove extremely difficult unless there is an agreement that has been negotiated and carried out on an annual basis.

It is not uncommon to have an agreement clause in your price agreements with your customers for between a 3% - 5% fluctuation in regards to raw material. This will give you the opportunity whereby, if the material moves up or down more than 3% - 5%, you can either issue the customers a credit for the difference between the base cost of the material and the new price for the material or you can issue a supplementary invoice for the difference.

However, having an agreement of this type is only of benefit if you are able to purchase the material requirement that will satisfy your customers' orders.

Once you have you will probably need to micromanage your material allocation and share it between your customers orders. By doing this you can expect additional costs for the setting and manufacturing smaller production runs. This is why it is imperative to adapt and invest in processes and methods of quicker tool changes.

On a positive note, by adopting quick tool changing (SMED) these processes and new working practices will improve your competitiveness for the future. I believe that there may be some companies who will not make the necessary improvements.

Unfortunately, the survival of these companies, once the recovery has started later this year could be in doubt of continuing.

From the Secretary

Bill Pinfold -
Honorary Secretary

The Coronavirus continues to affect all aspects of our way of life and ISME is no exception. Having had to cancel our two premier events in 2020 we are hoping for a much better 2021 especially since it's the Institute's 75th Anniversary. The year has started with a well-attended webinar on Digital Manufacturing held in January. However, when Adrian Nicklin contacted colleges and companies with potential entrants for the Skills Competition, he found that students are still distance learning and will not return to the workshops in time to produce test pieces so regrettably the 2021 event has had to be cancelled.

On a more positive note, the Metal Bashers Ball has been rearranged for Friday 15th October 2021 and with the success of the vaccine rollout and the hope to remove restrictions by mid-June we can be much more confident it will take place.

On Friday 19th November we will be holding a dinner to award the ISME Gold Medal at the Fairlawns Hotel in Aldridge. This year's recipient is Professor Jianguo Lin of Imperial College.

Professor Lin is passionate about developing UK capabilities in globally-leading sheet metal technologies. He is a long standing MISME and past Council member.

Adrian has also got four works visits to companies lined up for when conditions permit although it may have to be 2022 before companies are comfortable to allow them to take place.

Zoom has allowed Council meetings to continue and Council decided to increase the Institute's profile and membership by setting up a LinkedIn page, increasing Twitter postings and setting up an ISME YouTube channel. John Yarnall has volunteered to act as our social media coordinator.

Publicity for our 75th Anniversary was given by articles in the CBM Sheet Metal magazine and the International Sheet Metal Review (ISMR).

ISME members who wish to receive the ISMR digitally can do so free of charge at www.ISMR.co.uk.

The ISME 2021 AGM will be held by Zoom on 18th May (see separate notice) and will review the accounts for 2020 and 2019.

The UKCA (UK Conformity Assessed) marking is a new UK product marking that is used for goods being placed on the market in Great Britain (England, Wales and Scotland). It covers most goods which previously required the CE marking. There is extensive advice and information available on government web sites and from trade associations. The Institute will consider holding a webinar on this subject if members require more information and guidance.

In February we were saddened to hear of the passing of our much-respected past President and Chairman, Ray Jelf. His many friends and colleagues were unable to attend his funeral in person but we have included his obituary in this edition.

Welcome to New Members

Impression Technologies Ltd (ITL) produces parts and licenses our Hot Form Quench (HFQ®) Technology for forming complex, high strength parts from aluminium sheet in both the automotive and aerospace markets. We have high volume manufacture HFQ Tiers developing capability in EU, China, and US. Combining parts, light-weighting whilst achieving strength with dimensional accuracy are all benefits HFQ brings to further enable cost effective use of aluminium.

Daniel Cox has had a varied career in sheet metal, as product design engineer, project manager, and most recently Head of Engineering Services for ITL. Daniel now provides support to innovative companies, helping them get through protype development, trouble shooting and testing new products.

Stephen Hall C.Eng., Technical Director, Construction Metal Forming Ltd. Stephen has extensive expertise in cold-formed steel and composite structures.

Dr. Mohamed Mohamed C.Eng., Principal Technical Specialist, ITL Ltd joins ISME as a Fellow. Mohamed is involved in simulation and modelling. Mohammed Ismaeel, apprentice technician at ITL has joined as a Student Member.

Report CBM H&S Meeting February 2021

With regard to Covid related HSE visits, members shared the following:

- HSE employing contractors to help with spot checks. Using a mixture of telephone calls and visits. Very important to check ID.
- In many cases cleaning and disinfecting regimes (meeting rooms, offices, common areas) is often considered inadequate.
- Levels of supervision to ensure compliance with social distancing in the workplace is not good enough in some companies (complacency?)
- Track & Trace details should be destroyed after 21 days (GDPR guidance)
- An employer who had five cases in a month was required to give HSE weekly report.
- Inspector requested more ventilation with door left open on night shift.
- QR codes required on front door.

Typical measures being introduce by companies are: -

- Physical meetings attendees masked, socially distant. Regular temperature checks. Contractors escorted. Visitors by appointment only.
- Disciplinary procedures introduced for violation of Covid rules e.g., attending work if family member tested positive.
- Lateral flow testing being introduced in companies, particularly those with over 50 employees. Good practice is to set up test site outside of works gates if possible and require employees to attend before normal start time for test with result in 9 minutes. Employers are paying for this extra time. Tests are given twice a week and cost £3 plus the cost of professional staff to administer them. Home testing not encouraged as can't know for sure who took the test.
- Car sharing is being discouraged.
- Maintenance workers are a particular problem as they are often in close proximity and can be in any part of the premises. Many companies require them to wear masks, visors and gloves and maintenance workers are required to wipe down and disinfect an area after their work is complete.

ISME's new social media channel launched October 2020:

ISME has now further developed is range of social media outreach to promote engagement and support for the Sheet Metal Forming community. The LinkedIn channel has been chosen as the preferred platform for professionals and is well proven amongst engineering and technology forums. LinkedIn is also well suited for engineering manufacturing groups as well as their employees in the promotion of business skills and training. Moreover, engineering networking via this channel has proved to be a particular feature of the service which is proving to very popular by manufacturing and research organisations to further develop their services and products.

ISME is looking forward to making the best use of this social media platform for the benefit of further expansion of its services for both its corporate and individual members. We would welcome our members and the many new LinkedIn followers to join in and support this exciting new development to ISME's Website and Oracle magazine of sheet metal forming news features.

John Yarnall is ISME's Social Media Editor for LinkedIn, and Twitter. Dan Cox has been undertaking the design and implementation of LinkedIn page since October 2020. Dan will be further helping to develop LinkedIn to attract engineers and additional members with interests sheet metal forming and supply services to join ISME in the coming months.

Scan the codes to visit the social media channels

ISME celebrates 75th anniversary and looks into the future

The Institute of Sheet Metal Engineering (ISME) has a long and glorious history as a standard-bearer for British industry, and in these volatile and uncertain times, it's reassuring to see it celebrate its 75th year.

ISME's Honorary Secretary Bill Pinfold looks first to the past to note the landmark anniversary, pointing out that its origins lay in the immediate aftermath of World War Two.

"ISME started in 1946 as the Sheet and Strip Metal Users Trade Association when members were firms rather than individuals. It provided a unifying element in a fragmented industry, quickly became active and was very well received," he says.

"The immediate success of SASMUTA saw it convert into an Institute and also introduce individual membership. Anyone could join who worked in the sheet metal industry at any level without the need for formal qualifications.

"Its council then set up regional branches with committees of volunteers who would arrange their own programmes of activities, lectures, works visits and other events. The organisation flourished because it was based on friendship and a willingness to share know-how with other members.

"The years up to the mid-60s saw British industry transformed, and ISME expanded to a record size with something like 1,200 individual and 300 corporate members," says Bill.

"Inevitably, the decline of industrial manufacturing during the 70s and 80s was tough for all organisations, although the institute continued its activities throughout those years, and strengthened its focus on promoting both the science and the working of sheet metal."

ISME also widened its social agenda by launching an annual dinner dance (known tongue-in-cheek as the Metal Bashers' Ball) and introduced a craft award which continues to this day as the annual ISME Skills Competition.

In 1997, as the need to give industry a new national voice became evident, the institute was a driving force behind the creation of the British Metal Forming Trade Association, which later evolved into the CBM.

Today, ISME has the same membership structure and ethic which have been its strengths since its formation, which is a source of great pride to Bill.

"We've always been what I call a 'learned body', providing opportunities for members to exchange ideas and information, encouraging the development of skills in the next generation, and driving innovation across the sector," he says.

Judges at ISME Skills Competition

"Our journal (Oracle) is still published twice a year, featuring technical articles of interest to those in the sheet metal sector, academics and other observers.

"At the same time, we recognise that change is just as vital for ourselves as for industry. We have to remain relevant in the digital age, so we recently widened our presence by setting up feeds on LinkedIn and Twitter, which rapidly gained traction and raised ISME's profile within new audiences.

"Celebrating our anniversary during a pandemic is unfortunately impossible, but as the pace and scale of vaccination increases, we hope to hold our annual Skills Competition in June, and expect to publish a special edition of Oracle and hold our Metal Bashers' Ball in October."

Details of the events will appear on the ISME website **www.isme.org.uk**

Ray Jelf

19th March 1934 –10th February 2021

The Institute is sad to announce the passing of our past President and Chairman, Ray Jelf. The following is based on the citation when Ray was awarded the ISME Gold medal in 2018.

"Ray was born in Birmingham in 1934 and attended Central Grammar School.

After a brief period in Commercial Art, he joined the British Oxygen Company in 1950 as a trainee Draughtsman. 1952 to 1954 saw National Service in the Royal Electrical and Mechanical Engineers before returning to BOC.

Late 1954, he was made aware of vacancies at Hordern Mason and Edwards (HME). The following successful interview led to 17 years of gainful employment with this advanced firm.

1971 a change in direction lead to the position of Sales Manager at Clarks Press where he gained specific knowledge of coil feeding and associated ancillaries.

1973 He left Clarks to start Indicum Ltd, a Sales Company holding some 16 franchises from the USA and Europe specialising in the supply of Presses together with a wide range of complimentary equipment. Indicum became respected as the leading UK sales agency. 47 years later, he was still doing it.

Ray attended his first ISME meeting at Gosta Green Technical College, now the University of Aston. HME had a strong interest in the Institute and encouraged many to attend the various lectures etc held at the time. After going "on the road" in 1965 to the South East, Ray joined the South London Branch. In 1972 having moved to Chipping Norton, he joined the Coventry Branch which a few years later was absorbed into the Midlands Branch. In his time with the Branch and the Council he carried out many roles including Chairman and President but is particularly proud of three. His instigation of the house magazine "The Oracle", involvement as ISME Chairman with ICOSPA and the Dinner Dances which under pressure he agreed to run for one year.....after his 25th Dinner Dance he retired. Many members will have fond memories of the Metal Bashers Balls at the Chateau Impney. These events did much to foster good relationships in the sheet metal industry. In parallel with his ISME work Ray has been a very active member of the MMMA and Company Secretary.

Through his Indicum company and work with ISME and MMMA, Ray became one of the most well-known and respected people in the industry and did much to foster developments and relationships."

Ray passed away on 10 February 2021 at the age of 86.

Notice of Annual General Meeting

The 74th ANNUAL GENERAL MEETING of the Institute of Sheet Metal Engineering will be held by Zoom on Tuesday 18th May 2021 commencing at 10.30 prompt

18.05.2021 - 10.30am

Members wishing to attend should notify the Hon. Sec. at **ismesec@gmail.com** to receive a link to the meeting and the Agenda.

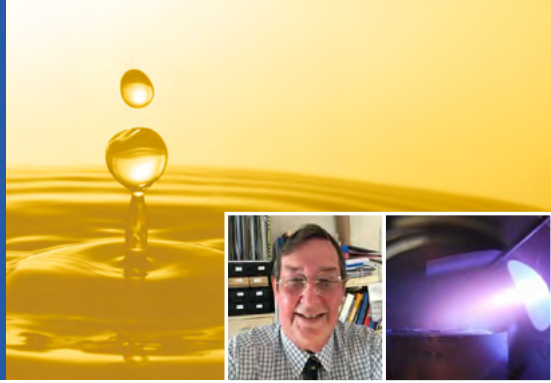
Interesting in joining ISME?

CURRENT MEMBERSHIP SUBSCRIPTIONS ARE:

Company Membership	£300
Fellows Membership	£85
Individual Membership	£60
Corporate Individual	£40
Student Membership	£20

Sheet Metal Forming Tools

John Yarnall



Part 2b of series 2

Advanced Surface Coatings & Treatments For Protecting Tools Against Wear In Service.

I am delighted to present this second instalment on tool coatings as part of ISME's75th anniversary year. Throughout these years 1946 to 2021, tools have always played a fundamental role in high volume manufacture of sheet metal parts. New CAD and metal simulation software has made possible considerable advances in design to make possible new part shape geometries for automotive and general engineering applications. It is also now recognised that without the advances in press forming equipment with integrated tool design features, these startling developments would not have happened. And now with the new world of digital engineering and manufacture, we can expect to see further striking advances in sheet metal forming technology. There are many more challenges on the horizon for our industry as the range of materials being selected for weight reduction is on the increase. High strength with low weight is now the new mantra for automotive and aerospace designers for their mission to further reduced energy and environmental impact of their products. To achieve their goals a new set of materials is now firmly on their agenda too. The start of this new criteria is now already with us, in the form of micro-alloyed high yield strength steels, high strength aluminium alloy grades, and an advanced set of high temperature and corrosion resistant Nickel/Chromium grades such as stainless steels and Inconel. Tooling materials and coatings are of necessity to enable these new materials to be formed economically. So to help meet these challenges of ever complex forming geometries with increased reliance on 'zero defect' high speed forming production, tools have to take the burden. A new generation of tool materials and coatings in combination with metal forming lubricants will need to be the choice of most sheet metal formers to ensure that the economics of their business process keep pace with demand for their high value/high quality products. As an example: existing high volume food and beverage can manufacture would not be possible without these three technologies: advanced tool materials, process lubrication, tool surface coatings and treatments. As a further illustration to give a historical perspective, press tools used during the periods WW1 &WW2 and up to the 1970's for stamping and deep drawing, tools were generally made from lower alloy tools steels of grade B O1 or BD series hardened & tempered only, but then latterly, nitride surface hardened in combination with process lubrication were the main enabling technology to assist volume manufacture. Today, advanced HIPIMS PVD coating/duplex treatments is the preferred tool surface protection for many metal sheet forming applications. So the technology conditions of the 1940's in contrast to those 75 years on has a seismic improvement in tooling technology. These improvements have made possible a transformation in the capability of practice and science of sheet metal forming.

I have tried to focus, as space permits, on two or three state-of-the-art forming and stamping technologies. The theme being: tooling, lubrication; surface coating, including work stock material and metallurgical heat treatment using vacuum and plasma techniques. To illustrate how sheet forming has developed to the level of 2021viz tool coatings, lubrication (no specific detail on process lubrication will be referenced in the instalment, this will be featured in a later issue) and metallurgical treatments. The following examples should serve to demonstrate how the industry has moved forward to meet the advanced needs of market demands, sustainability and economics. Some case histories and interesting examples of sheet metal applications of tooling used to produce quality parts for the food, beverage, and automotive markets.

Surface finishing of tools pre & post coating... as an illustration: steel & aluminium food & beverage packaging can tools.

Fig 4. The TiN PVD coating on this soda tab punch helps to prevent material pickup and premature tool wear. This shows a typical application of the use of tools with coatings for forming of aluminium, easy-open food and beverage cans. The use of metal based food containers is now a preferred route instead of polymer based to reduce environmental impact. This illustration shows one of the coated tooling elements used to deliver high volume production… Aluminium grade 1050-H24, canning light weight recyclable specification.

Tool steel: cold work grade D-series powder metallurgical, with a PVD top layer PVD nitride family with optimised food approved composition.

Surface Preparation.

Surface preparation is critical in any tooling application, and especially in stamping applications. Any marks on the surface of a stamping tool will work as a nucleation site for adhesive wear. The workpiece material will flow into the microscopic imperfections on the tool surface and stay there. During further forming operations, more material will build up on these areas, causing galling.

Galling is a common problem in metal forming and stamping operations. It results in increased roughness on the part resulting in premature tool wear. Therefore, improving the finish of the working surfaces is a very important part of the tool preparation.

The recommended surface finish is 8 micro inches or more; a high polish, if possible, often is best. After polishing, the tool must be inspected for surface quality. If machining or grinding marks are still visible, then the die needs to be re-polished. Stoning before polishing will produce a uniform surface. It is extremely important that the last polishing steps be performed in the direction of the metal flow.

Beverage and food can manufacture.
The example in fig 4, illustrates this where boundary lubricant cannot fully provide separation of workpiece and tool during ultra-high surface stress patterns; that is where the sticking and abrasion problems are the most prevalent mode of tool surface failure. So in these examples tools are coated with low friction ceramic PVD coatings which have been produced using High Impulse Magnetron Sputtering (HIPIMS) method to provide hard smooth thin film coating which exactly follows the working tool surface to ensure surface wear protection at high contact stress forming. For sustained production rate throughput, digital manufacturing can now be used to monitor process control and part quality. In the second case illustrated below for food can manufacture, tools are coated with multilayer chemical vapour deposition (CVD) coating: Titanium Carbide/Titanium Carbonitride/ Titanium Nitride (TiC, TiCN, TiN). It should be noted, however, that the choice of coating and coating method depends very much on the work stock sheet material, and the grade of tool steel used for the tools. Heat treatment using vacuum furnaces for hardening tools also plays a vital role in the success of tool surface wear protection…

Figs 4 a, b, c of beverage cans, CVD a Coated WC tooling and aluminium coil sheet for producing food and Beverage Containers (Cans)

Seaming Rolls Chemical Vapour Deposition coated with 8µ thick layers of TiC/TiCN/TiN

Finished packaging food cans after high volume seam forming. The size and surface finish of the corrugated can form is controlled by the tool coating by maintaining the surface integrity of the tool during high volume manufacture.

Example of tool coatings for advanced sheet forming of aluminium (Automotive)

The application of aluminium alloys in automotive and aerospace industries has been growing significantly in the last 20 years. Due to their high specific strength, aluminium became a strong alternative for steel particularly at automotive manufacturing. However, to deform a complex panel part from aluminium is quite challenging especially at ambient forming condition in which the formability index is relatively quite low. Many attempts have been made to improve the formability of the aluminium alloy such warm forming, hot forming, superplastic forming and Hot Form Quenching (HFQ) processes. HFQ presents the best practical and proven way forward. There are many advantages and still some drawbacks for this method, but if forming in the correct T4 solution treated condition (SHT) and post T6 cold form to final size hot assisted forming is the better route due to formability limitations of, say, 6xxx Al- grades. HFQ has now been commercialised and taking full advantage of 'low spring-back' forming challenges with ever increasing demand by automotive and aerospace industry. There are other familiar forming technologies in use and still being developed (Superplastic and Isothermal forming etc.). Significant further benefits can be gained using tools super finish coated with ultra-hard low friction surfaces to both aid uniform metal flow and provide anti-galling/wear surfaces. Tool coatings play a crucial role in the efficiency and process economics of the forming process.

So HFQ technology with aided PVD chromium nitride coated tools is now being used in Europe for 6xxx Al-alloy series sheet to achieve uniform metal distribution and mechanical properties via the tooling system is now regular use for producing automotive body panel parts.

As previously discussed, tool coatings used for aluminium forming tools can help further optimize the forming process and to increase the working life of the tooling system. The main properties required are the reduction of surface friction and reduction of both abrasive/adhesive wear. Furthermore, the bonding strength of the coating to the tool surface must be high to prevent detachment of the coating. Thin film Diamond like Coatings (DLCs) has shown good results when forming aluminium. However, tools should be cooled to keep an optimum die temperature not to exceed 200 DegC. Typical DLCs WC/C PVD deposited show good results and excellent performance can be further achieved combination of PVD Chromium Nitride tool coating and/or with thermochemical plasma nitriding used as a support substrate when tool interfacial stresses are high. However, it must be stated that PVD CrN or Thermochemical plasma nitriding is only effective for this process if BDH series tool steels hardened & tempered is used, or similar steel with a tempering temperature in excess of 500 DegC. Surface Quench heat transfer must first be assessed to take account of the 'part quench index'.

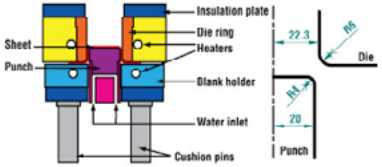


Fig 5 a & b: Schematic arrangement of tool steel and Hot Forming of Al-heat treatment heat treatment graphic.

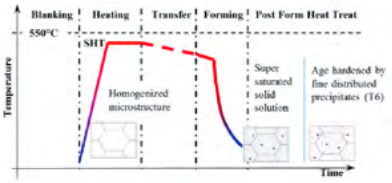
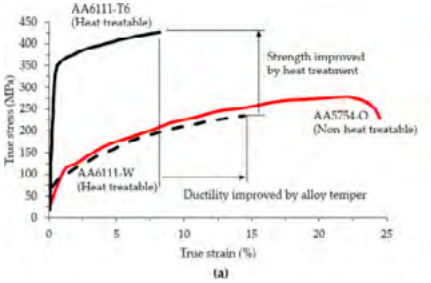
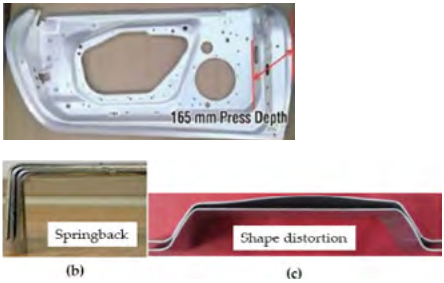


Fig 6: Hot Form Quench Process to achieve complex formed shape and optimised metallurgical properties with zero spring back in most cases. Condition of the part after age hardening… see illustration graph below. And distortion/spring back b & c.





Challenges of aluminium and steel: sticking & abrasive wear.

Sticking. There are two primary challenges with forming aluminium alloys. The first is sticking of the aluminium to the surface of the tool. Sticking of aluminium looks similar to galling of steel, but the mechanism that creates the sticking is different. When steel material picks up on or galls the surface of a tool, it is the result of dynamic friction between the two surfaces. The level of galling can be managed by minimizing the amount of dynamic friction present.

Aluminium sticks to the surface of tooling when it is being formed because of localized melting of the material caused by the heat generated during plastic deformation. To prevent the aluminium from sticking, an effective boundary lubricant that stays in place when the die closes and pressure is exerted must be present. Alternatively, a tool coating that exhibits excellent static friction properties must be applied.

Traditional ceramic coatings like titanium nitride (TiN), titanium carbonitride (TiCN), titanium aluminium nitride (TiAlN), and chromium nitride (CrN) do not provide enough static friction resistance, so their use without an effective boundary lubricant will result in substantial aluminium sticking.

Abrasion.in addition to sticking of aluminium alloys—particularly so-called military-grade materials—bring challenges. Abrasion most likely results from two sources: the presence of aluminium oxide on the surface, and the silicon contained in the alloy to strengthen it. Silicon's abrasiveness is of particular concern in tool functions that are working through the cross section of the material.

The industry is taking steps to address the sticking problem by using effective boundary lubrication on the draw stations. In secondary stations such as trimming, piercing it serves supplemental role with tool coatings. An example of this is in forming operations such as tube forming.

Tool coatings for Stamping & Flow Forming of aluminium alloys:

As there is a forward need to support ever lighter and energy efficient sheet engineering structures, aluminium and is sister light alloys are gaining more importance in automotive and aerospace part supply. In particular, electric vehicles (EV's) and aero propulsion systems are pushing the limits of materials development to achieve lower cost transport systems. There are other important drivers which are now entering the manufacturing and materials cycle such as sustainable manufacturing and environmental 'net gain' goals. Tool coatings are playing a significant role in helping to achieve these aims by using sophisticated coating technologies such as PVD DLC and its other family of metal carbides and nitrides with duplex properties to withstand/reduce higher friction forces between tool and work stock sheet. Aluminium alloys for aerospace and automotive body structures are a prime example…

The examples below illustrates the range of advanced industrialised tool coatings that are now readily available for sheet metal stamping and flow forming:

Carbon Coatings - Application illustration of multi-layer:

Fig 7. forming tools DLC family composite Top section tool, Chromium Nitride (CrN) + DLC, Bottom section tool, Tungsten Carbon

For aluminium applications in which sticking and abrasion occur, "diamond-like" carbon (DLC) coatings have been developed to provide protection that traditional ceramic PVD CrN coatings cannot. DLC is the name given to a family of coatings produced either by PVD or plasma-assisted chemical vapour deposition (PACVD) processes that can exhibit a range of properties.

However, these very hard coatings often lack the ductility required for some forming tool applications except in low stress forming of unalloyed light metals where high adhesive wear metal transfer is to be avoided.

The value of DLC coatings lies in their low coefficient of friction and their anti-sticking properties. The most commonly used DLC coatings are multi-layered.

New development thin film coatings:

Because of the demand for high duty performance tools with lower surface friction with anti-wear properties at room, or elevated service temperatures, a new family of commercial coatings has been developed. This new family comprises several designed to cater for forming a range of sheet materials from steels through to aluminium automotive grades. Moreover, there are significant challenges in the forming of both sheet and bulk Ni/Cr alloys (Inconel trade name). The chemistry of these advanced coatings is based on superlattice structured TiAlCrN/TiAlYN and CrAlYN/CrN thin film layers (up to 4µm thickness). This family is currently referred by its generic chemical formulae. There will be a commercial product name given this family in the near future. It is now commercially possible to deposit these coatings on to hardened tool steel dies as well as tungsten carbide materials. Development work is now being under taken by IHI IonBond Group in the UK who now offers a combination of 'Duplex layer 'tool coating system using plasma nitriding as a base substrate case hardened layer. First indications are that these duplex systems are very stable and provide wear protection up to 1000 DegC. Further details can be obtained via NHTC, Sheffield Hallam University, and IonBond UK.

References:

A full version this article can be found via ISME website: **isme.org.uk**, & LinkedIn **www.linkedin.com/institute-of-sheet-metal-engineering.**

John Yarnall

EUR ING John Yarnall CEng, CEnv, MISME, FIMMM / ISME Media & Surface Innovations Consultancy, UK

Tightening the fastener choice for sheet metal

Sven Brehler, Engineering Project Manager, TR Fastenings

There are as many joining methods as there are sheet metal applications. Selecting the best fastener for an application might not be the best fastener for assembly or disassembly. In most cases fasteners are selected based on a range of factors including physical performance, designers experience with a technology, used installation methods within the manufacturing environment, available sizes and lengths as well as piece price and overall cost.

The most recognizable method of joining two parts together would be with bolt and nut connections. Bolt-nut connections are generally used for detachable mounting of components and sheet metal parts. A nut is retained based on creating sufficient friction within the thread and between the interfaces of the fastener and sheet metal. The preload is created by stretching the bolt during tightening up. A relatively longer bolt can stretch more than a short bolt and is therefore better capable in retaining a nut by friction alone. Because of this, standard nuts and bolts are not always the best solution for joining sheet metal.

There are multiple methods to improving the retention of nuts onto bolts, such as the application of polymeric patches on the screw, which fills the cavities between the two mating threads. Similarly, a nylon ring attached to the nut will provide a light interference between the thread and the polymer. Other options can be mechanical deformation of the nut or thread to increase pressure within the thread.

The retention does not address the function of the joint. Most bolted joints are designed to be friction-grip joints: the preload in the bolt presses the sheet metal components together with such a magnitude that the friction between the components is enough to withstand forces along the sheet metal. If the forces along the metal sheets exceed the friction forces, the joint will slip, and the bolted joint will be subjected to shear forces. Henceforth the joint becoming practically a shear joint.

Accurate tightening and creating of pre-load functions better with longer than with shorter bolts and is therefore more suited in heavy laden dynamic applications with components with greater thickness.

Lockbolts can be a permanent solution if joints are not subject to maintenance. A metal ring is squeezed around a pin with helical or annular grooves, thereby providing a continuous pre-load. The fasteners do however need access from both sides.

Single sided access can improve assembly efficiency or even might be a requirement due to difficulty to reach both sides of the application.

Blind rivets have been specifically designed to allow single sided access. Most designs are based

on applying tension to an integrated or reusable mandrel, which increases the body diameter on the blind side by splitting, bulbing or expansion. Compared to nut and bolt joints, blind rivets provide a lower pre-load. Therefore, blind rivets are mainly used as shear joints. Some blind rivets have the additional benefit of being hole filling, increasing joint integrity.

Blind rivet nuts and studs can be used as a hybrid solution, whereby the rivet part either fits in a single-layer component or joins multiple layers together. The addition of a metric thread, either as stud or nut, enables further metal sheets or components to be joined with respectively a nut or screw.

The concept of blind rivets can be found in the use of solid rivets, where one side of the fastener is deformed using an anvil or die when the fastener has been placed in the hole. Solid rivets do therefore need access from both sides and through-holes in the sheet metal.

Self-piercing rivets are a variant on this subject, where a cup shaped, hardened rivet is pushed into the metal. The hardened rivet deforms the layers of sheet metal and forms an interference joint. Generally, a die is used on the blind side to create a mating profile. In certain materials, such as aluminum, it is possible to set the fasteners without the use of a blind side die. The benefit of this method is the possibility to automate assembly without the need of preparing the joints with holes to fit the fasteners.

Developing products for a 'circular economy' finds its fundamentals in developing products with an extended economic life span and are then suitable for re-use, repurpose or recycling at minimum cost and maximum efficiency and retention of value. This does place again emphasis on the use of reversible threaded fasteners, allowing reuse of parts during repair and maintenance and easy recovery of individual parts when the application is dismantled.

As was earlier established the use of bolts and nuts have the benefit of being removable, but require access from both sides, unless either part has a pre-fitted nut or male threaded part. **Cage nuts** and **captive screws** are well-known examples. The nuts can be clipped into square holes and are often used to compensate for some misalignment in joints.

One option is to attach the male threaded part to one of the components. This can be done either by welding or clinching. **Weld studs** can be manually or fully automatically placed and have an aesthetic benefit of being (nearly) invisible from the blind side, because no part will protrude. A downside is that parts have to be welded before coating or painting and generally the stud and component material have to be similar to allow welding.

If double sided access is possible before assembly, studs could be fitted to the component by clinching. **Self-clinching studs** do require a pre-punched hole, but the stud to be of a dissimilar material to the component material. All parts can also be pre-painted or coated.

Instead of fitting a male fastener part to the component, it is possible to pre-fit a nut. This can also be done using self-clinching products such as the **K-Series® nut.** Alternatively, **self-piercing nuts** or **weld nuts** are an option.

Eventually, it might be possible to remove the nut completely and fit a screw directly into the sheet material. With a preference for isometric threads, it can be possible to cut, punch or laser a hole or deep drawn a collar, which can then be tapped with a thread. Doing this requires additional operations during the manufacturing of the individual components adding to cost.

The use of **thread forming** or cutting screws removes the need of creating a screw thread in the counter parts, reducing number of operations, part numbers and overall cost. Some methods require a pilot hole, where other types of screws can be installed directly into the sheet metal without the need of a hole.

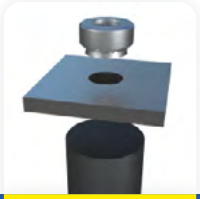
Self-drilling screws are equipped with a drill bit shaped point which creates a hole into which the thread is formed. Even though not requiring a hole for installation is attractive, formation of swarf limits the use in mass production environments.

> **In most cases fasteners are selected based on a range of factors including physical performance, designers experience with a technology, used installation methods within the manufacturing environment, available sizes and lengths as well as piece price and overall cost.**

Flow drilling and flow forming screws are also equipped with a special tip, but instead of drilling, it is designed to melt the material locally to allow the sheet material to flow and a mating thread to be formed by the screw. The joint will be resilient against vibrational loosening due to intimate mating of the threads. Flow drilling screws do require robotic installation and high installation speeds, whereas flow forming, such as the **TR EPW screws** can be installed manually.

Equipping parts with pilot holes or pre-extruded holes, thread forming screws can be used. These can either be fitted with a thread forming tip or have a trilobular design, which aids thread rolling. These types of fasteners are used extensively in automotive and other high-volume assembly lines. The benefit of this type of screws is the adherence to a metric thread form, allowing the fastener to be replaced by a standard metric screw in case of repair and maintenance.

TR Clinch Nut Installation:



Step One

Step Two

Step Three

Step Four

Program Requirements

An important point to consider when selecting a fastener are the features and benefits versus the limitations of the various systems. It is also useful to consider what assembly methods are already used on the assembly and production lines to be able to utilize existing tools and equipment without the need for capital investment.

Key points to consider with any joint:

- Materials and thickness to be joined – is it possible to standardize?
- Strength of the connection and type of joint – torque tightening or shear joint?
- Corrosion resistance – do materials suit together or is there chance of galvanic corrosion?
- Accessibility – can the joint be reached from both sides or would single sided access be required or beneficial?
- Automation – are the fasteners to be installed automatically to cope with high volumes?
- Takt time – not every fastener installs at the same speed.
- Poka-yoke – ensure that the correct fastener is used in the correct joint.

At TR we believe within the product design stage, early joining considerations can save substantial costs when detailing the application, or later when the products go into serial production. Our engineers have a wide experience of fastening technologies in a variety of industries and are available to support you with your next product development.

Useful links:

1. TR Sheet Metal Fasteners Product Range:

Scan Here

2. TR Sheet Metal Fasteners – Choosing the right fastener:

Scan Here

High-speed Bruderer press investment delivers major reshoring contract for HV Wooding

Investment in a refurbished precision high-speed press is helping a Kent-based sub-contract manufacturing specialist deliver a significant aerospace contract that has been reshored from Spain.

HV Wooding, which offers laser cutting, wire erosion, busbars, motor laminations and presswork to customers all over the world, has invested over £120,000 into new tooling and the installation of a Bruderer BSTA 25H to produce more than 28 million precision parts every year.

The contract will utilise the press' repeatable bottom dead centre accuracy and 1500 strokes per minute capability, with the industry-leading RAM Guidance System ensuring unparalleled stability and longer tool life.

Components will be used in a number of tamper-proof products for the airline sector and should account for 60% of the machine's capacity, leaving the other 40% for new opportunities in electrification and green energy.

"This is the second Bruderer we've installed, after inheriting our first when an electrical client outsourced its press shop," explained Paul Allen, Sales Director at HV Wooding.

"There are few machines in the world that can offer the speed and accuracy in such high volumes and this is going to make a major difference to our ability to meet the requirement of our aerospace customer."

He continued: "The material we are using is really thin gauge and tolerances are within microns - that's why we decided on the BSTA 25H. The RAM Guidance System eliminates the possibility of movement during the stamping process, prolonging the tool life and giving us consistent repeatable quality, something the customer wasn't getting overseas.

> "There are few machines in the world that can offer the speed and accuracy in such high volumes"

Paul Allen (Sales Director) and Simon Stewart (Technical Manager)

"It was a real partnership approach, with the Bruderer experts working with us to identify the right machine and then planning the timeline so that we could manage the install without disrupting production. This meant running the initial parts off at its Luton factory whilst we were putting the machine in place."

HV Wooding, which exports 30% of its £10m turnover overseas, has also invested in a Unidor Multi-Sensor in die tool protection system and a Unidor Press Force Monitor.

Both additions to the machine are designed to ensure the tool safety at both low and high speeds and provides protection against overload and potential damage to the tool and press.

Simon Stewart, Technical Manager at HV Wooding, went on to add: "We have been really impressed with the performance of the BSTA 25H and are already looking at ways where we can standardise the set-up process to move other projects on to it.

"There is also the potential to target new opportunities, with the 1500 strokes per minute speed giving us plenty of capacity to take on high volume electrical, lamination and motor orders."

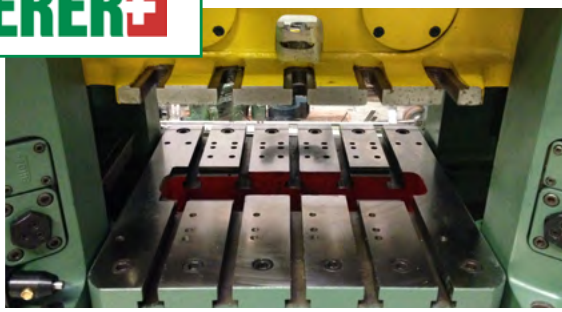
Bruderer UK has remained operational throughout the Covid-19 pandemic and, despite the difficulties, has posted an impressive last twelve months with increasing demand for new and refurbished presses and its Zani range of stamping presses.

A lot of this has been driven by clients supplying into the medical and automotive sector, who all require precision parts in high volumes.

Adrian Haller, Managing Director of Bruderer UK, concluded: "This is a perfect example of our partnership approach, working with the production team at HV Wooding to identify a solution that fulfils both immediate and future manufacturing needs.

"The BSTA 25H is a fantastic high-speed press and capable of easily meeting the 28 million parts per annum demanded by the aerospace contract. Importantly, it has also opened up new opportunities for the client to go after orders that they previously wouldn't have been able to compete for."

For further information, please visit www.bruderer.co.uk or follow Bruderer UK on LinkedIn. More details on HV Wooding can be found here www.hvwooding.co.uk.



Bruderer BSTA 25H press

Stamping European Springs & Pressings' Authority On The Metal Forming Stage

What's in a name? European Springs & Pressings (ESP), dates back to the 70s, when the UK joined Europe. If only the owners then knew what we know now!

Springs might lead the brand but it's pressings that is the final piece in the name jigsaw and it's this element, where the service, technology and qualifications of the experienced engineers in the Kent factory, are second to none.

With over 70 years of pressing heritage, ESPs wealth of knowledge, investment in technology and infrastructure positions the company as one of the largest metal stamping companies in the UK.

Lesjofors, the parent company, has continually invested in facilities allowing ESP to offer the very best in bespoke stampings and pressings.

Stuart McSheehy, Managing Director of the Kent factory says: "The phrase from 'cradle to grave' is my mission statement and one we're deeply proud of and live by. Successful innovations have started here and achieved huge market success as a direct consequence of our 360 degree approach that delivers above and beyond expectation."

What is design support? ESP's engineers advise on design, material and the surface treatment of chosen pressings or stampings. Ensuring a product is designed and fit for function, achieving all technical and quality requirements, whilst taking into account the products working environment, the repeatability of manufacture including tolerances, product life, ease of production and the most economic route of manufacture.

Every product goes through a rigorous selection process, taking into account:

- Material selection – technical requirements, price and availability
- Manufacture method, identifying high-speed pressing for high volumes to single operation stamping for low volume
- Capital investment for tooling
- Finishing requirements – heat treatment plating, coating, packaging
- Assembly requirements – automated or hand assembly
- Repeatability

EUROPEAN
SPRINGS & PRESSINGS

With the latest WEDM machines and in-house 3D CAD, ESP designs and manufactures progression, multi-slide, single operation and assembly tooling.

Tooling, which has a guaranteed tool life and often out last the products life, is purposefully designed to take tight tolerance requirements, capable of stamping a variety of materials from 0.05mm to 6mm thick. ESPs free tooling storage facility also adds another layer of customer simplicity and confidence to the product journey. In addition, if the customer already has tooling then ESP offers a free appraisal and transfer service.

"Our engineering and production facility is fully equipped to supply one off prototypes or low volume parts for testing", says McSheehy.

"Our engagement with the customer on their product development journey is key to their and our success. Offering rapid prototyping and by producing a number of prototypes, several materials can be selected for testing until the perfect material and finish is proven."

Facilities include an ever-expanding production area, fully equipped with the latest technology. From single operation presses to assembly and high-speed presses, ESP's 130 tonne presses from Bruderer and Mabu sit alongside Finzer and Latour multi-slides, Wafios coilers, laser cutters, welding, tapping, grinding and barrelling functionalities as well as heat treatment ovens.

McSheehy concludes: "In a period where Covid and Brexit have added unforeseen challenges, our resolve and commitment to being the best at what we do hasn't faltered. We pride ourselves on our ability to offer a fully finished solution from design concept to fully assembled product, delivering on our 'cradle to grave' mission, every time."

If you'd like to go behind the scenes at European Springs & Pressings, get in touch at sales@europeansprings.com and as a ISME member, you'll get an exclusive tour.

CHANGE OF DATE!

Institute of Sheet Metal Engineering

Metalforming Machinery Makers' Association

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METAL BASHERS BALL

FRIDAY 15TH OCTOBER 2021

COPTHORNE HOTEL

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BLACK TIE EVENT

6.30pm Welcome drink on arrival
7.30pm Three course meal with coffee and mints
8.30pm After dinner speaker 'Eddie the Eagle Edwards'
9.30pm Fantastic band 'Solid Groove Foundation'
Midnight Finish

Tickets £65 each

Further information

ISME Members & Guests please contact: Adrian Nicklin T. 07774 260126
E. adriannicklin@btinternet.com

MMMA Members & Guests please contact: Bill Neal T. 07725 277590
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DECADE

The Metalforming Machinery Makers Association

MAKE uk
The Manufacturers' Organisation

MMMA HAVE PARTNERED WITH MAKE UK

We are delighted to inform you that we have partnered with Make UK, the manufactures' organisation. Make UK is the largest force backing UK manufacturing and has been helping the sector to compete, innovate and grow for more than 120 years.

In this unprecedented time Make UK are in regular contact with Government and are working hard to support the sector. The latest Covid 19 related updates and resources, including some very useful FAQs are available here:
https://www.makeuk.org/coronavirus

As part of the agreement we'll be in regular contact with Make UK's policy and lobbing teams, and we'll be helping them understand our sector and the challenges we face, so please keep an eye out for Make UK surveys, and a few communications providing details of resources and benefits they will be sharing with us.

The partnership also entitles you to Affiliate Membership of Make UK. This will provide you with a range of benefits to complement your MMMA membership:

- Industry reports, publications and insight
- Member events, webinars, podcasts and briefings
- A range of discounted products and services
- Preferential rates on the Brexit Toolkit and Pay benchmarking reports

If you have any queries, you are welcome to contact Make UK directly: **affiliates@makeuk.org**

MEMBER NEWS

WANHUA IS EXPANDING ITS BUSINESS WITH TWO TURNKEY PRESS HARDENING LINES FROM AP&T

Wanhua Machinery in Wuxi outside Shanghai is a rising star of press hardened parts on the Chinese market. Founded in 2000, the family company currently has about 240 employees and has long been an established supplier of cold pressed parts to many world-leading car manufacturers who operate in China, such as Volkswagen.

Recently, they decided to expand their business and invest strongly in the latest press hardening technology. Increasing customer demand for lighter, stronger parts that can contribute to lowering vehicle weight and thereby, energy consumption and emissions, is what lies behind the investment. The result is two new manufacturing facilities in Wuxi, one of which is entirely dedicated to manufacturing press hardened structural parts.

NKC SWEDEN IS LOOKING TOWARD THE FUTURE BY INVESTING IN AP&T'S PRESS LINE FOR PRODUCING ROLLER BEARING CAGES

One of the main business areas of NKC Manufacturing Sweden in Gothenburg is the manufacturing of pressed, stamped and machine molded products for industrial companies. With its approximately 140 employees, the company is the European branch of the Japanese industrial group NKC (Nakanishi Metal Works), which operates around the world. Early in 2020, they invested in a new, fully automatic press line from AP&T to replace old machines and to ensure their production. But the relationship between the companies stretches back much further than that.

"The first AP&T machines were installed here in the mid 1980s when we were part of SKF. Since then, the equipment has been regularly expanded, updated and added to while service, maintenance and repairs have been made by AP&T on an ongoing basis," says Charles Wallin, Project Manager of Process Development at NKC Manufacturing Sweden.

The Metalforming Machinery Makers Association

MACH 4-8 April NEC Birmingham UK 2022

MACH 2022 IS THE UK'S BIGGEST EVENT FOR INSPIRING, INNOVATING AND CONNECTING MANUFACTURING.

MACH is a fantastic event for both exhibitors and visitors. Showcasing live, digital production systems in one space, under one roof, hundreds of millions of pounds worth of business is discussed, secured and completed at the event.

Attracting 25,000 visitors and in excess of 600 exhibitors, MACH is the platform to connect UK manufacturing engineers, decision makers, buyers and specifiers with suppliers of new technology, equipment, services and processes.

MACH is organised by The Manufacturing Technologies Association, the voice for the manufacturing technologies industry, committed to driving innovation, creating value and helping UK manufacturing to thrive.

Exhibitions remain the number one means of getting your products and services the attention they deserve in front of potential customers – and with the largest number of high-quality visitors, MACH delivers for its exhibitors.

MACH is not just a five-day exhibition but rather creates a large pipeline of high-quality leads and opportunities that will keep your sales team busy for a very long time after the show has ended.

MACH 2018 exhibitors report that their expectations were exceeded and the show was a resounding success, raising their company profile, creating tender opportunities and in-market sales leads.

A FEW OF OUR MEMBERS EXHIBITING IN 2022:

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WP WORCESTER PRESSES

THE MMMA METALWORKING VILLAGE IS OFFICIALLY OPEN FOR SPACES, NOW HAVING THE LARGEST AREA THE ASSOCIATION HAS EVER TAKEN AT MACH!

The Metalworking Village covers 650 square metres, one of the largest areas of any exhibitor at MACH. Demonstrating technologies, services and products from across many sectors of UK Manufacturing industries. We are very proud to boast that over 25 individual companies are exhibiting from the MMMA.

The association goes from strength to strength, over the last two years many changes have been implemented. These include, upgrades on the website, increasing focus on social media platforms and new member benefits – The membership remains positive and trending upwards as we currently, with 44 members, covering many manufacturing sectors within UK Manufacturing.

MMMA hosting our specialist Metalworking exhibition within MACH 2022 provides a fantastic opportunity for our members to show off their skills, services and Technologies to visitors across manufacturing UK. Within the Village, visitors will be welcomed to call on each member stand, to discuss and see, what is available, how it could help them in improving production, winning more orders and increasing profitability.

Momentum increases as we move closer to MACH 2022, visitor registrations are at an all time high as overall exhibitor numbers are up. You can see the revised layout, brand new zones and see who is already planning to be a part of MACH 2022 by scanning the QR code below.

Scan here to see the MACH Floorplan

Five-axis laser system supports car panel manufacture at QFS

The TRUMPF TruLaser Cell 5030 is the perfect entry-level solution for flexible 2D and 3D laser cutting. With its low machine-hour rate, the TruLaser Cell 5030 is ideally suited to small and medium batch sizes, and for applications where components are frequently changed.

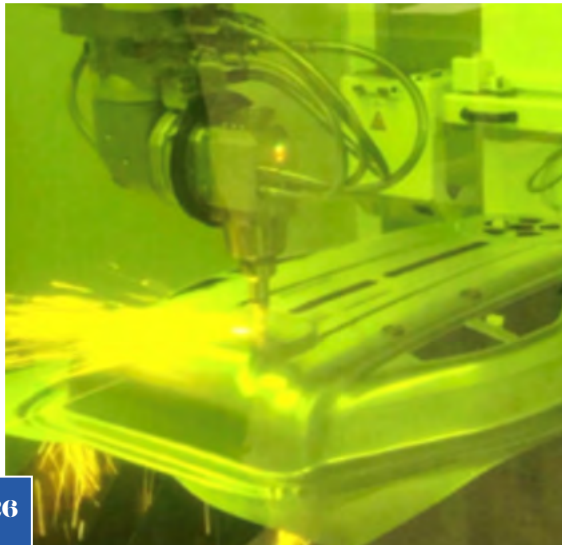
QFS Technologies, a specialist supplier of body-in-white (BIW) parts to the automotive industry has invested in a new TRUMPF TruLaser Cell 5030 five-axis (3D) laser cutter. Although the company has an older TRUMPF five-axis machine that has given many years of reliable service, QFS knew that investing in the higher performance and richer feature set of the TruLaser Cell 5030 would provide a number of competitive advantages, particularly in relation to new project work for a major customer.

Founded in 1997, Birmingham-based QFS provides the automotive industry with quick-turnaround metal-panel prototyping and low-to-medium volume production parts. Such has been its success that QFS has today become the first choice in its field for most UK automotive OEMs and tier-one suppliers, as well as yellow goods manufacturers. Current turnover at the 60-employee company is circa £7 million.

QFS develops and manufactures prototypes from single panels to complete assemblies' for BIW, concept and show vehicles. Customers often continue to use the company's unique blend of skills right through the initial prototype and manufacturing process, into mass production.

"As we supply panels in batch quantities of 25-150 through various prototype build phases, we already have some of the tooling in place, we're increasingly being asked to support OEM customers with production volumes – often running into thousands of parts," explains Managing Director Neil Holloway. "Maybe the pandemic situation where major production suppliers of panels being shut down during lockdown has contributed to production dies being delayed, but of course the OEM's still need to meet their build schedules to sell vehicles. We've found ourselves in a position to provide the necessary support."

When Mr Holloway recently put forward a business case for a new project with a major automotive customer, he realised that a new five-axis laser cutter would be required. Fortunately, he knew exactly where to turn.



"Once the investment decision had been made, it was always going to be a TRUMPF machine," he states. "I've worked with other laser cutters in the past, but TRUMPF machines are a lot more reliable. When you think about the curvature and complex shapes of a car panel, it's easy to imagine the essential role of a 3D laser cutter at QFS. We cannot afford to run an unreliable machine."

The TRUMPF TruLaser Cell 5030 is the perfect entry-level solution for flexible 2D and 3D laser cutting. With its low machine-hour rate, the TruLaser Cell 5030 is ideally suited to small and medium batch sizes, and for applications where components are frequently changed. Furthermore, TruTops Cell Basic software enables users to make quick adjustments to programs directly at the machine.

Supplied with an energy-efficient, low-maintenance TruDisk solid-state laser, the machine offers a wealth of functions from the tried-and-tested TruLaser Cell product groups, including dynamic and precise flying optics. Notably for QFS, it is easy to run-in components with the help of the teachbox and touchscreen.

Installed in August 2020, the machine's arrival has coincided nicely with an uptick in business after a recent suppression following the UK's full lockdown in March. Mr Holloway describes the current market conditions as "getting there", with the new laser already heavily utilised.

BIW parts produced on the new TruLaser Cell 5030 are mostly made from aluminium, although some are cut from high-strength steel, typically 1-3 mm thick.

"Our guys became accustomed with the machine really quickly," says Mr Holloway. "The controls on the TruLaser Cell 5030 are notably easier than our much older five-axis model. In addition, we were already familiar with the TruTops offline programming software, so our learning curve has been pretty shallow. We're now in the process of migrating programs over to the new machine."

The TruLaser Cell 5030 is located within the company's dedicated laser shop, in a total space of 34,000 sq ft.

"More speed is an obvious advantage with the new machine, while quality has also been enhanced," states Mr Holloway.

Clearly, investing in the latest equipment and facilities allows QFS to maintain the high-quality services expected by its customers. Capital expenditure at the company in recent years has extended beyond the five-axis laser cutter to include CNC machining centres, hydraulic and mechanical presses, and optical scanning inspection technology.

"Alongside this investment strategy, our can-do attitude is also a clear market differentiator," concludes Mr Holloway. "No matter the complexity or lead time, we'll always go the extra mile to meet customer requirements."

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