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PRESIDENT'S NOTES

Hello all,

It's a great pleasure to welcome you to the special 75th Anniversary Issue of Oracle.

I can't miss this opportunity to thank the many contributors of articles, and also the organisations who have helped with advertising. This issue really is packed with a terrific selection of up to the minute extracts from technical papers, the selection and compilation of which has taken a lot of time and effort by Council Officers – so a big thank you there too!

ISME really has the feel of an organisation that is embracing current technologies to the full, not only in the subject matter of the technical information imparted here, but also in the strides we have made with social media initiatives and the like.

For those of us engaged in production and manufacturing, we live in challenging times. Increasing Energy costs coupled with shortages of materials and labour are having a serious impact across the whole sector, so the intelligent implementation of technologies which can optimise resource usage are very much the order of the day

I hope you enjoy the content of this special issue of Oracle, and would add my encouragement to you to submit any items which you feel might be of interest to members, either for incorporation in future Oracle issues or indeed via LinkedIn, Twitter or the ISME YouTube channel.

Alan Shaw - President

CHAIRMAN'S COMMENTS

Just looking at the automotive sector have you noticed that the availability of new cars is currently really limited and the price of used cars have risen staidly during this year.

This limited availability in new cars is a result of the shortage in microchips / semiconductors that are the brains that control the functions of electronic devices that we find in these vehicles. This is one of the main reasons why some sheet metal sub-contractors are seeing reduced requirements from some of the automotive manufacturing companies.

There are some automotive manufacturing companies that are saying that they could be producing as many as 1,000,000, to 1,500,000 less vehicles during this year due to the microchip shortage.

Because these microchips play such a vital part in the way that they function on our everyday lives, we have come to rely on them some much.

The shortage of these items is a result of bad decisions by the automotive industry compounded the global issue of COVID 19 and many automotive companies cancelled their orders for microchips. Therefore, microchip companies switched to making microchips for other customers products in attempting to meet the explosive demand caused by this pandemic.

They're tiny technological marvels, hosting billions of transistors within them, though the size of the chip can vary. Their construction involves multiple steps to manufacture these chips. In some chip packs there can be as many as 50 billion transistors into a two nanometre, fingernail-sized space.

These microchips are the lifeblood of modern society and the loin share of the production of these items comes from Taiwan & Korea and the demand for these microchips is only going to get greater.

This shortage is predicted to continue for a further six to twelve months and at some point, during this we all could be seeing that because of this massive demand for these microchips the price is most likely going to increase in the future and this will naturally filter down to the end consumers.

Barry Smith - ISME Chairman

ISME MEMBERSHIPS

If you want to learn more about sheet metal and meet like minded people why not become an ISME member.

OUR MAIN AIMS:

- To promote the science and working of sheet metal.
- To provide opportunities for people to exchange ideas and information.
- To encourage the development of members.

CURRENT ANNUAL MEMBERSHIP SUBSCRIPTIONS ARE:

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Full details and membership application forms are available on our website **www.isme.org.uk**
Or contact the ISME secretary at **ismesec@gmail.com**

SECRETARY'S NOTES - AUTUMN 2021

BILL PINFOLD
ISME HON SECRETARY

To celebrate ISME's 75th Anniversary year we have produced this special A4 bumper edition of our Oracle magazine. A huge thank you is due to our members and associates who have provided such a wide range of articles relevant to the Sheet Metal Industry and to our advertisers who have made the Anniversary edition possible. We have articles ranging from the history of one of our member companies starting up in post war Britain with a hand press in the garden shed to becoming a leading presswork supplier to articles on the latest technology and technics from Imperial College and the WMG. There's even a contribution on BIW industrial engineering from Brazil.

The ISME AGM was held by Zoom in May with 12 members attending. The reduced activities in 2020 lead to a surplus of £3,800 although this figure included some prepayments for the postponed Dinner Dance. Reserves stood at £25k.

The ISME Council has started to return to physical meetings albeit on a hybrid basis with some attending by Zoom. It was good to get together again and exchange information over a cup of coffee. We are delighted to welcome Dr. Mohamed Mohamed of ITL who has been co-opted to the Council and he is keen to contribute to our future.

Getting back to normal with running our events is proving more difficult as although much of normal life has returned, many of us are still avoiding large events, particularly in indoor settings. This may have contributed to the low bookings received for the MBB which has led to the October event being postponed to 2022. However, the Gold Medal Dinner and presentation without the crowded bar and dance floor will be going ahead in November where Professor Jianguo Lin will receive the ISME Gold Medal and Dave Gilbert the Davy Udal Award. Both these gentlemen have made major contributions to the science of sheet metal working and the sheet metal industry. Please support them by attending the Dinner. Full details are elsewhere in the Oracle or available from Adrian Nicklin.

A number of exciting works visits are lined up for the new year as soon as companies are comfortable accepting visitors again and we can share knowledge and experience in a real environment again.

Congratulations are due to our member Stephen Hall who has just published a book covering steel grades, including sheet steels, which are utilised in construction and building structures with the aim of improving designers' understanding of steel grade designations and differences in material characteristics.

ISME DEVELOPMENTS DURING 2021 SOCIAL MEDIA CHANNEL – AUTUMN REVIEW

It's almost a year now since ISME launched a second social media channel 'LinkedIn' adding to its existing Twitter Blogging Service. Development of LinkedIn is a continuous process, and I am pleased to report that our first year milestone is breaking the 160 followers' line after a slow start in November 2020. The Covid pandemic has probably had some influence on the growth... The objectives remained unchanged this year so as to capture a wider interest in sheet metal forming, and target new members to join the institute. Our strategy of increasing the channel's visual impact using a selected range of sheet metal forming video clips, advertising and educational postings will further help increase awareness of metal forming technology and services. Networking, with the prospect for attracting quality sales leads is now a prime objective of most individuals & organisations, but it also establishes public image on a global scale as a reputable and trustworthy organization.

I am pleased to announce that as of July 2021 LinkedIn has a new feature to enable its followers to link directly to the ISME website to capture new members and to view Oracle magazine advertising rates and registration. This is in addition to synchronising latest news of social events and skills training announcements. Some of the latest ISME posts include: ISME Page Live; Skills Competition; ISME 75 Anniversary; Gold Medal Awards 2021; Warwick Manufacturing Group- Digital Manufacturing; Bruderer UK-A Call To Engineers... These are a few examples of the 15 plus main posts and videos/ YouTube clips. All these posts can be viewed via LinkedIn pages https://www.linkedin.com/company/institute-of-sheet-metal-engineering. As a further illustration of how the ISME LinkedIn platform is reaching out to both UK and international sheet metal forming communities ISME has received interested followers from Asia and South America. One follower, located in Brazil working at a large automotive OEM involved in BIW sheet forming, has joined ISME and agreed to provide a technical article for the 75 Anniversary autumn issue of Oracle.

Future plans to develop LinkedIn will be to post YouTube training videos in sheet metal skills, Toolmaking and advanced metal forming materials. The Media Editor and his team would welcome ISME member ideas and suggestions to enlarge the range and scope of technical posts and company profiles.

We would be pleased to receive news posts from all ISME members for posting the week prior to going to live press. These can be sent to ismemedia@gmail.com, or ismesec@gmail.com

In my next LinkedIn review early 2022, I plan to report a set of analytics with graphs to show how the growth and demographics of followers is progressing. There should also be data available on the effectiveness of LinkedIn platform has been in attracting membership enquiries and advertising using the new ISME Website live link facility set up by Eleven10creative web management services.

John Yarnall & Dan Cox,
ISME Media

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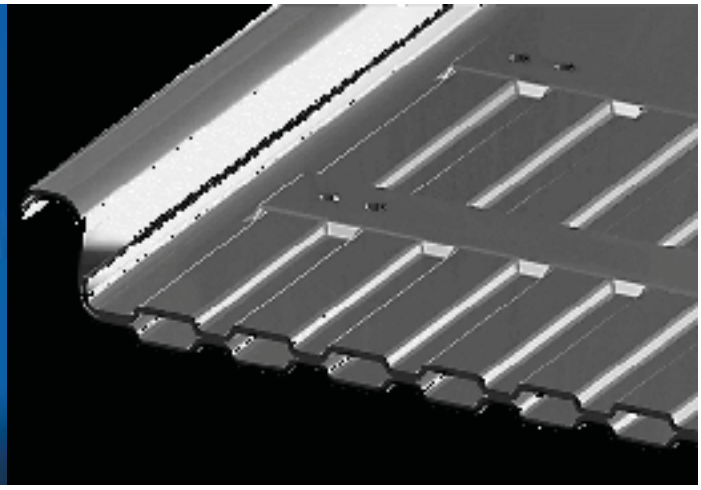
Sustainable light-weighting HFQ Technology for low carbon transportation



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DR MOHAMED MOHAMED, DR ALISTAIR FOSTER, DR DAMIAN SZEGDA
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Vehicle weight reduction has been identified as one of the most effective ways of achieving the reduction of energy consumption and CO2 emissions in the automotive industry. Aluminium has been used as a lightweight replacement to sheet steel in the automotive industry for many years.

The formability of high strength Aluminium alloys increases significantly at elevated temperatures. HFQ® is a modern hot forming process that combines high formability with virtually no springback for (ultra) high strength aluminium alloys. HFQ was developed at Imperial College London by Professor Jianguo Lin and is licensed to manufacturing tiers by Impression Technologies Ltd (ITL).

Typically, HFQ® consists of: i) heating an Al-alloy blank sheet to its Solution Heat Treatment (SHT) temperature in order to produce a homogeneous solid solution that has very high ductility and hence provides good formability; ii) Transferring the hot blank to the press where a high forming speed is set to take advantage of the strain rate hardening of the material; iii) Holding the formed part in the tool for a few seconds to quench so as to avoid the formation of precipitates in the microstructure; and, for full strength, iv) transferring to an aging oven where precipitation hardening is performed.

In HFQ® technology, the sheet forming and in-die quenching are performed in a single press stroke which reduces production steps and facilitates the production of high strength, high precision, and complex-shaped lightweight Al-alloy panels efficiently and cost-effectively. The process schematics together with temperature and micromechanics evolution is shown in Figure 1.

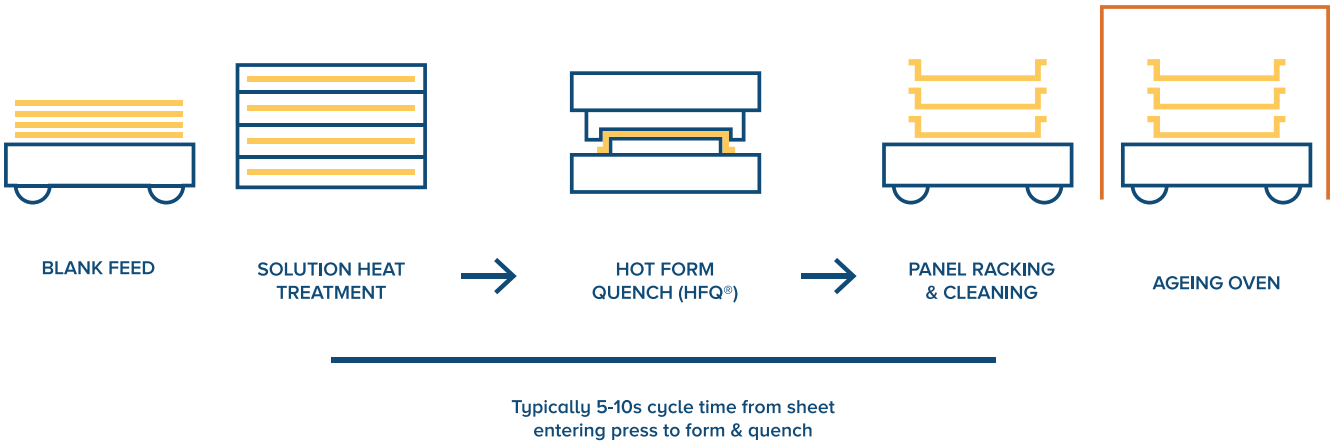

Figure 1: HFQ® Manufacturing Process

The process is successfully applied in different aluminium alloy grades such as AA6xxx and AA7xxx series to produce complex shaped high strength aluminium automotive components such as crossbeams and B-pillars. A Lotus Door Inner panel (Figure 2a) was the first example to be chosen to showcase a complex shape with a high draw (200mm) which could be manufactured in one step.

HFQ has been shown to produce complex shaped high strength aluminium automotive components such as such as the AA7075 B-pillar shown in Figure 2(b).

Additional weight reduction is achieved through a combination of HFQ and Friction Stir Welding (FSW) technology, in which multi-thickness blanks are created by welding together sheets of different thicknesses, forming a Tailor Welded Blank (TWB). Weight reduction is accomplished by part integration, the deletion of joining flanges and the

Figure 2: HFQ automotive components
a) AA6082 Lotus Door Inner

b) AA7075 CRF B-Pillar

optimisation of thicknesses across a single pressing. An example of HFQ® weight reduction capabilities is the complex cross member panel. The original concept baseline part was manufacturing from cold formings and assembling from 11 parts (Figure 3). Using a TWB (3mm-2mm-3mm), the 11 parts was reduced to 8, 5 formed together in a single HFQ® step. Weight was reduced by 32% and overall cost was reduced by 37%.

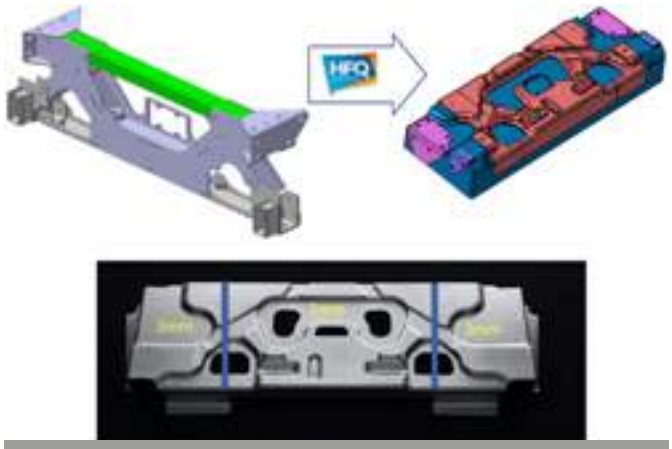

Figure 3: Part Integration and cost reduction by HFQ and FSW Technologies.

For all HFQ components, the following criteria are each considered when developing a part for production (i) Blank handling, transfer speeds, heating rate, cooling rate during transfer, temperature drop during the quench, (ii) Formability of the alloy, (iii) Forming speed, temperature, forming force and blank holder force, (iv) lubrication, application and cleaning of lubricant, (vii) Tool performance, wear and temperature control, (viii) Blank location on tools, (viii) Data acquisition methods.

It could be said that HFQ® is a complex forming process, in which the strain rate and temperature change dynamically. Therefore, the accurate modelling of material behaviour during HFQ is crucial. Recently, the HFQ Material Mechanical Model has been developed to account for the effect of stress-state on damage accumulation and failure for AA7XXX series alloys. The stress-based HFQ Material Mechanical Model has the capability to predict the shape of the forming limit diagram (FLDs) at any different combination of temperatures and strain rates. The model was implemented via user-defined subroutine into PAM-STAMP, a commercial FE software package from ESI Group. This enables the capability to predict the formability of sheet metal components through the use of FE simulation. The underlying viscoplastic model equations, which take the mechanisms of dislocation-driven evolution processes such as hardening, dynamic and static recovery into account are presented below.

$$\tilde{\sigma}_{ij} = \frac{\sigma_{ij}}{(1-\omega)} = D_{ijkl}\varepsilon^{e}_{kl} \qquad (1)$$

$$\dot{\varepsilon}^{p}_{ij} = \dot{p}\frac{3}{2f}s_{ij} \qquad (2)$$

$$\dot{p} = \left(\frac{2}{3}\dot{\varepsilon}^{p}_{ij}\,\dot{\varepsilon}^{p}_{ij}\right)^{1/2} \qquad (3)$$

$$R = B\,\rho^{n_1} \qquad (4)$$

$$\dot{\rho} = A(1-\rho)\dot{p} - C\,\rho^{n_2} \qquad (5)$$

$$X(\sigma) = \frac{\alpha_1 J_0(\sigma)+\alpha_2 J_1(\sigma)+\alpha_3 J_2(\sigma)}{(\alpha_1+\alpha_2+\alpha_3)J_2(\sigma)} \qquad (6)$$

$$\dot{\omega} = \Delta\, X^{\varphi}\eta_1 \dot{p}^{\eta_2}\frac{1}{(1-\omega)^{\eta_3}} \qquad (7)$$

Where p is the equivalent viscoplastic strain, which could be also written ε^{vp}_{eq}, f is the equivalent Von Mises stress, (also written as σ_e), $_{sij}$ is the deviatoric stress tensor. ω is damage variable, D_{ijkl} is elasticity tensor in which Young's Modulus is assumed to depend on temperature. The evolution of dislocation density ρ is related to the equivalent viscoplastic strain rate, it includes the dynamic recovery and the static recovery which appear at high temperature. Parameters A, B, C, K, n are functions of temperature. The damage criterion is a combination of the three invariants of the stress tensor $J_0(\sigma)$, $J_1(\sigma)$, $J_2(\sigma)$,

which are respectively the maximum principle stress: $J_0(\sigma) = \sigma_1$, the first invariant: $J_1(\sigma) = tr(\sigma) = 3\sigma_H$, the second invariant: equivalent stress $J_2(\sigma) = f = \sigma_e$. The parameters α1 is temperature dependent α2 is strain rate dependent and α3 is constant. The three invariants together enable the representation of two different damage mechanisms, namely grain boundary damage and ductile damage. The parameters η1, η2 are functions of temperature and parameters η3, ϕ, Δ are temperature independent. The damage parameter defined in Equation (7) is assumed to be equal to 0 at the initial state of the deformation. When the damage level reaches 0.7, it is assumed that failure takes place in the material. Due to the exponential nature of the damage accumulation, as the damage increases from 0.7 to 1.0, the strain increment is negligible and can be omitted.

Recently, ITL has collaborated with ESI group, Pamstamp software partner to release the new integrated model into commercially available software. Meanwhile, an example of the model performance is shown below for AA7075 B-Pillar. Two pressings were carried out. One with a non-optimised blank to induce splitting in different locations for model validation. The second pressing was carried out with an optimised blank to achieve a successful part.

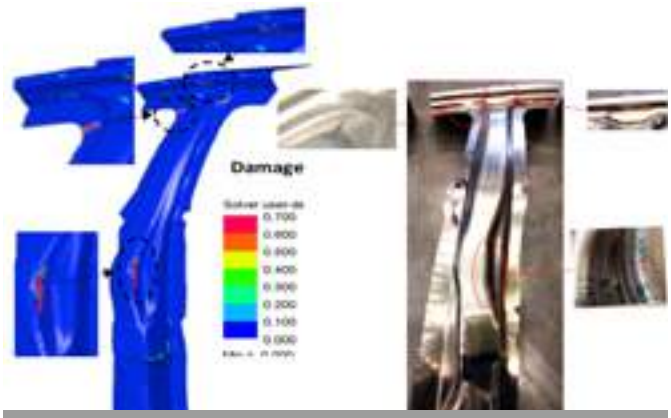

Figure 4: AA7075 HFQ B-pillar – formed with non-optimised blank pressing– a) damage distribution showing splitting, and b) actual HFQ B pillar part formed, indicating the splitting in different locations.

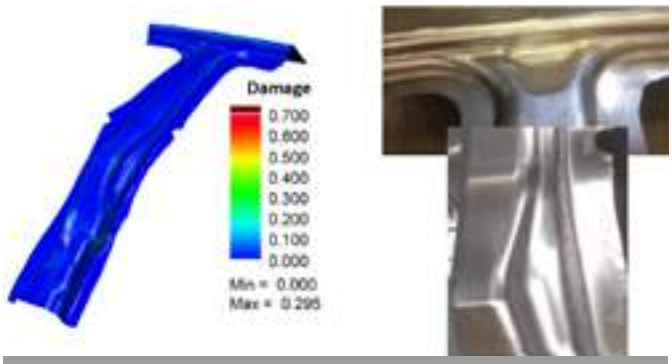

Figure 5: HFQ Material Mechanical Model simulation for AA7075 B-pillar for the second pressing a) Damage distribution showing no splitting and b) Successful physical part.

A GUIDE TO ROLL FORMING FROM START TO FINISH

WHO INVENTED ROLL FORMING?

Roll forming to most people is still novel, when in fact it goes back many years. I have read that Roll forming was used as early as 600 BC in South Asia and the Middle East. The formers were basic but in principle similar to a rolling mill. However, more streamlined mills, closer to what we use today were created across Europe and Britain. The design for these supposedly came from a drawing by Leonardo da Vinci, I'm not sure of the exact dates but I have read they can be traced back to the 1910's, when the first continuous roll forming lines were manufactured. Yet even after all this time, many still don't know what roll forming really is. It is commonplace in certain sectors like, aerospace, automotive, and the building industries, but to many, the century-old metal forming technology remains a 'black art'.

WHY ROLL FORMING?

The technology employed in Roll Forming production machines is continually evolving, even those involved in roll forming are amazed by the possibilities. Integrated into other manufacturing processes extremely complex shapes to include non-continuous cross sections, like swages, tapers, formed tabs and even drawn/formed indents/shapes can be produced.

However continuous sections/profiles still play a major part, it could be a simple 'C' or 'U' section, the profile could be curved, twisted like a helix, or extremely complex with multiple bends, either pre-cut or post cut to length.

Conventional roll forming line with pre punching and pre cut to length

Roll forming is a method of producing high quantities of product in a shorter space of time compared to other manufacturing methods. Also, the sections can be longer in length compared to sections produced on say a press brake machine.

THE PROCESS OF FORMING

The Basic principle of Roll Forming is the correct material taken from a coil or blanks and fed accurately into a pair or series of driven forming rolls. The rolls are mounted on shafts and in turn supported by stands with bearing housings. On many machines the housings also have a facility where the gaps i.e., the pressure, can be adjusted between the rolls. Depending on the complexity of the shape this will determine the number of forming passes required. The most common way to describe the forming process throughout the different stages is a flower pattern, (if you illustrate each stage on paper on top of each other, it looks like a flower in a fashion "open to closed")

As the material is fed through each pass of the roll tooling, the section progressively forms the desired shape, which is accurately machined into the forming rolls. Without going into the detail too much, careful consideration of metal thickness, grade, material yield and tensile strength, to include many other variables, need to be taken into account. For instance, certain materials may require more forming work than others to achieve the desired outcome. Attempting to form a section with an insufficient number of passes can result in twist, bow and many other issues in the product.

DIES

Also included in many Roll forming lines are Dies for cutting, whether it be, a pre-cut, flat shear blade for producing a cut length (some Roll formers produce from pre-cut hand fed blanks also), or post cut profiled single shear blades, to even double cut shear blades, these remove a slug of material and finishes the product to a final size and even end shape.

In some products it is necessary to use punching dies for holes, shapes and notches, these can be applied using a mechanical press or hydraulic/pneumatic press and even

Duplex roll former forming from flat blanks forming face panels

Rotary punching units on some products. This can be done at various points of the process i.e., start, middle or the end as a few examples.

Punching and Notching dies can be fixed or situated on a flying punch unit, which is fixed to a track mounted to the base and servo controlled. The entire hydraulic or pneumatic press assembly moves back and forth on rails accurately, this uses a closed loop measuring system. Flying dies generally increase a line's speed and productivity.

Some lines have forming embossments, i.e., slots, tabs, louvers, and other features. A rotary die can also be used, as the die rotates, the forms are embossed into the material and this is generally faster than using a press.

WIDTH AND LENGTH

Generally speaking, roll formers can produce very long sections, the difficulty arises in handling such products, however, some solutions have been developed to solve this issue, for example where standing seam roof panels of 40m plus are produced on site. I believe some machines also roll straight onto the roof as well.

Coil widths are the main restriction for the width of a rolled product, roll formers come in a wide range of sizes and include duplex edge forming machines, which can open and close to suit varying products.

CHANGEOVER CONSIDERATIONS

With lots of options available for product change, from cassette type stand set up, (some companies call them rafts), these usually have a bank of passes that lift off the base and save hours of manually swapping rolls. Jobbing mills are generally slower to change as you have to set each pass individually, but you can sometimes speed things up with horseshoe spacers and split tooling options. Another type of machine is the duplex mill which are adjusted in and out to a set width. A typical example being a shelving panel, where widths vary but uses the same edge details.

Dual mills are another type, this is where two roll formers are in the same production line but only one is operational, while the other is being changed for the next product. To changeover a dual mill, the bed of the machine moves on rails into position and the other half becomes free to work on. You can also have a single edge forming machine, where the material is hand fed and for instance, forms a 90 degree bend on one side, these are the main types of machines with the odd few other variations. Changeover of punched hole centres and part lengths can be set / altered utilising programmable software. It usually only takes minutes to make alterations of this kind.

At Formit, we have the perfect facilities for manufacturing reliable Roll forming production lines, to suit the customer's needs. We use the most up to date software to aid with tooling and machinery design. We offer the personal touch and put pride into providing good reliable solutions. Our many years of experience combined with using high quality components, ensures we provide top quality equipment, which is built to last **From start to finish.**

Jamie Potts - Engineering Director- Formit Ltd.
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AFFORDABLE DIGITALISATION FOR SMARTER FACTORIES

Tipping of the digitalisation scale

Gigantic organisations have traditionally been in the forefront of technological development and adoption of advanced manufacturing and digital capabilities gaining huge productivity benefits with some progressing on to become benchmarks for digitalisation titled as 'Lighthouse facility'. Well before the announcement of the fourth Industrial revolution in 2011 called Industry 4.0, ground-breaking technological advancements have been the privilege of mid-cap and larger organisations due to their adoption barriers of high cost for implementation, maintenance, and skills development. However, the sheer size, colossal workforce, multinational presence, routine rigidity and deeply engrained cultures of bigger organisations have sometimes acted as organisational inertia to overcome for successfully embedding digitalisation.

In contrast the more supple Small and Medium Sized Enterprises (SME) which represent more than 99% of UK businesses (5.7 million) although slow in adopting technologies have now got the biggest opportunity to adopt digital tools. The Made Smarter review suggest that within a decade industrial digitalisation could boost UK manufacturing by £455bn and create a net gain of 175,000 jobs. There are several financial and technical support initiatives available, including Digital Innovation for Manufacturing (DI4M) managed by WMG, and Made Smarter, which is led by The Coventry and Warwickshire Local Enterprise Partnership (CWLEP) Growth Hub with its fellow West Midlands Growth Hubs on behalf of the West Midlands Combined Authority and the Department for Business, Energy and Industrial Strategy. Both schemes are designed to assist manufacturing SMEs with the quick adoption of digitalisation, and data lead decision making and analysis. During the recent times of adversity came the biggest opportunity for manufacturers. Easy digital access became the order of the day following the recent workforce and supply chain disruption due to Covid, Brexit and other economic events coupled with the changing face of offices and mobility restrictions. These have led to a surge in the uptake of digital tools and technologies by the C-Suite in at least some part of their business mainly for business continuity. For manufacturers it is critical to move rapidly from traditional manufacturing practices to 'Digital Manufacturing' which encompasses the use of computer-based data driven systems, tools and technologies that span across the entire product or service lifecycle from design to disposal or recycling.

Digital transformation is usually impractical and too big a leap for smaller companies which is why smaller bite sized Digitalisation pilots with fail fast mentality provide the highest traction. The paradoxical situation of lack of suitable data to improve and a desire to improve availability of data has always been a stumbling block for SMEs in taking the plunge. Whilst the high cost of ownership has been one of the biggest considerations for SMEs, the latest scientific developments, online marketplaces and globalisation have made the digital tools more affordable and readily accessible than ever before.

This article further explores the various tools and technologies which have broken the traditional company size barriers acting as easy pilots for digital adoption to move your traditional factory into the new age data driven Smart Factory. They raise the bar for manufacturing productivity but lower the accessibility barrier and could be implemented with a minimal capital outlay.

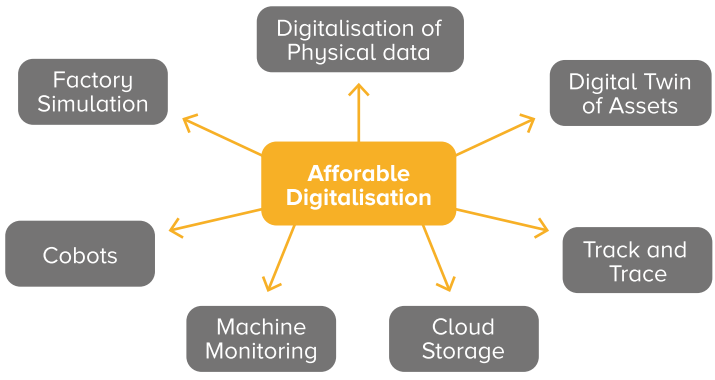


Figure 1 Affordable Digital Tools and Technologies for SMEs

Digitisation of paper-based data

"You can't improve what you don't measure" attributed to the famous quality guru Peter Drucker has the most relevance in the digital age. Most of the factories still work on paper-based information including drawing and quality check sheets stored in hard files. The start of the digitalisation journey happens with converting handwritten paper-based data into a digital format. For manufacturers the typical examples would be digitising aspects of the Purchase order, Quality certificates,

Drawings, Process and Quality Inspection cards from manual paper-based format to a digital format. There are several 'Scan to cloud' solutions available for scanning documents directly to metered cloud storage for further processing using their wide array of services. Optical Character Recognition (OCR) tools are readily available for converting handwritten and ink printed documents into editable digital formats. This would be the starting point towards creating a data-driven culture within your organisation to constantly challenge and improve the status quo, assist critical decision support systems and to predict future events based on historic data.

Digital representation of your critical assets

It is estimated that around 75% of the global industrial data is still in written or 2D formats. This inhibits use of modelling and simulation capabilities for further product development, Computer Aided Process Planning (CAPP), CapEx introduction, layout optimisation, predictive simulation and other improvement activities. The traditional approach would be to build bottom-up 3D models using a modelling software generated by reviewing existing physical spaces and their 2D layouts. However, with the recent development in laser scanners they could be carried out in a reverse manner by scanning the factory space first to directly obtain point cloud data which can then be used to generate very accurate and representative 3D models of your factory. Similar capability can well be applied to remanufacture products as well by scanning the product using Lidar or CT scanning capabilities and then converting them into 3D models using their point cloud data. Most Lidar scanners also provide a Google Street view type 360-degree walkthrough of your factory spaces which could be effectively used in remote working. There are numerous low-cost solutions for capturing the point cloud data using Lidar Scanners ranging from a phone scanner like in the iPhone 12 to dedicated handheld Lidar scanners.

'Track and Trace' of products or services

Information at your fingertips is a key competitive advantage in times of adversity however it shouldn't cost an arm and a leg. With rising digital access, knowing the real-time status of manufactured products or services is key for increasing flexibility and speed eventually impacting profitability. There are numerous open-source platforms available such as runtime JavaScript (Node.js), Python, TensorFlow, etc which builds the backbone of the latest technologies. This coupled with simple local networking HTTP/S application of Internet-of-Things (IoT) would provide a huge impact to SMEs on a shoestring budget. Further low-cost processors such as Raspberry Pi costing approximately £50 can be successfully deployed for applications in a local network or as a middleware to cloud platforms. The typical 'Track and Trace' range of application can be from inspection forms on a handheld device, Near Field Communication (NFC) or Radio Frequency Identification (RFID) based status monitoring, Work In Progress (WIP) tracking, Asset management/ambient condition monitoring etc.

On-demand metered cloud storage

"See you at the top" was one of the accurately delivered sermons evident with the rising popularity of the cloud platform. Their attractive running cost benefits outweigh the traditional capital intensive in-house server setups. A typical application deployed on cloud range around £50/month with no expensive onsite infrastructure to maintain or elaborate IT administration workforce. The advancement in internet-based cloud technology for having serverless application provides an additional advantage of commissioning & using the infrastructure on the fly hence reducing the Operational cost further. The flexibility of scaling the application horizontally and vertically on-demand makes such technology suitable for SMEs.

Real-time machine monitoring

Borderless operations on the go will be a strong distinguishing factor for companies that survive and thrive beyond the pandemic. Ability to monitor and proactively manage your factory using mobile devices from any corner of the world has been one of the key motivators for most SMEs considering Asset Performance Management capabilities. The other stimuli are a more effective workforce and reliable critical assets. What was always a monopoly of bigger technology players is now offered by many smaller organisations. WMG's Manufacturing Information Platform (MIP) offer a budget starter platform to organisations to retrofit affordable instrumentation to critical legacy assets capturing availability and quality data using an economical Raspberry Pi controller to aggregate data onto a dashboard with real time alarms and status details for critical assets to ensure business continuity and higher throughput.

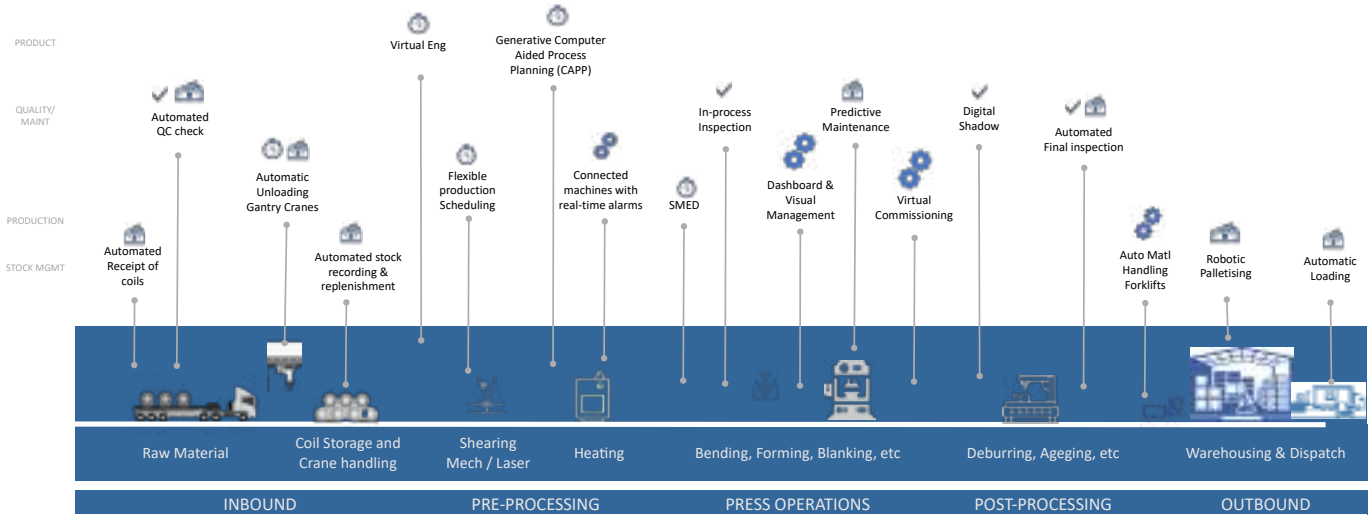
Augmentation of Human workforce with Cobots

'Rise of Machines' has been rampant in the recent years with increase in loss of highly skilled labour, rising complexity of processes, need for 24/7 operations, prevalent occupational hazards and a quest for higher productivity. Traditionally robots have been expensive and time consuming to implement with huge space, safety and skills requirement. However, with the advent of the humble Collaborative Robots (Cobots), humans can effectively work alongside cobots replacing or assisting with task around machine tending, pick and place, inspection, part changeover, processing and assembly. With the entry level cobots starting at just over £8k these are much more accessible for automation pilots within an SME.

Scenario planning through Predictive Simulation

Take the guesswork out of your planning through the powerful ability of Digital Twin Predictive Simulation which can be conducted at a product, process, Line, Factory or Supply chain level. The simulation-based technologies constitute a focal point of digital manufacturing solutions since they allow for the experimentation and validation of the different product, process, and manufacturing system configurations in the virtual world without disrupting actual production. With licences of

Figure 2 Smart Press Shop



SMART PRESS SHOP

under £10k these simulations can be used for visualisation of new factories, optioneering for capital equipment validating the business case and returns and for optimisation of existing assets, lines or layouts to improve their performance.

Smart Factory Vision

Manufacturers must aspire towards a Smart factory vision to improve the overall operational performance and organisational resilience. The digital tools can be deployed horizontally along the whole end to end value chain of the factory and could be split down vertically right from design through to production function as shown in figure 2 enabling a highly productive lights out factory.

Co-authored
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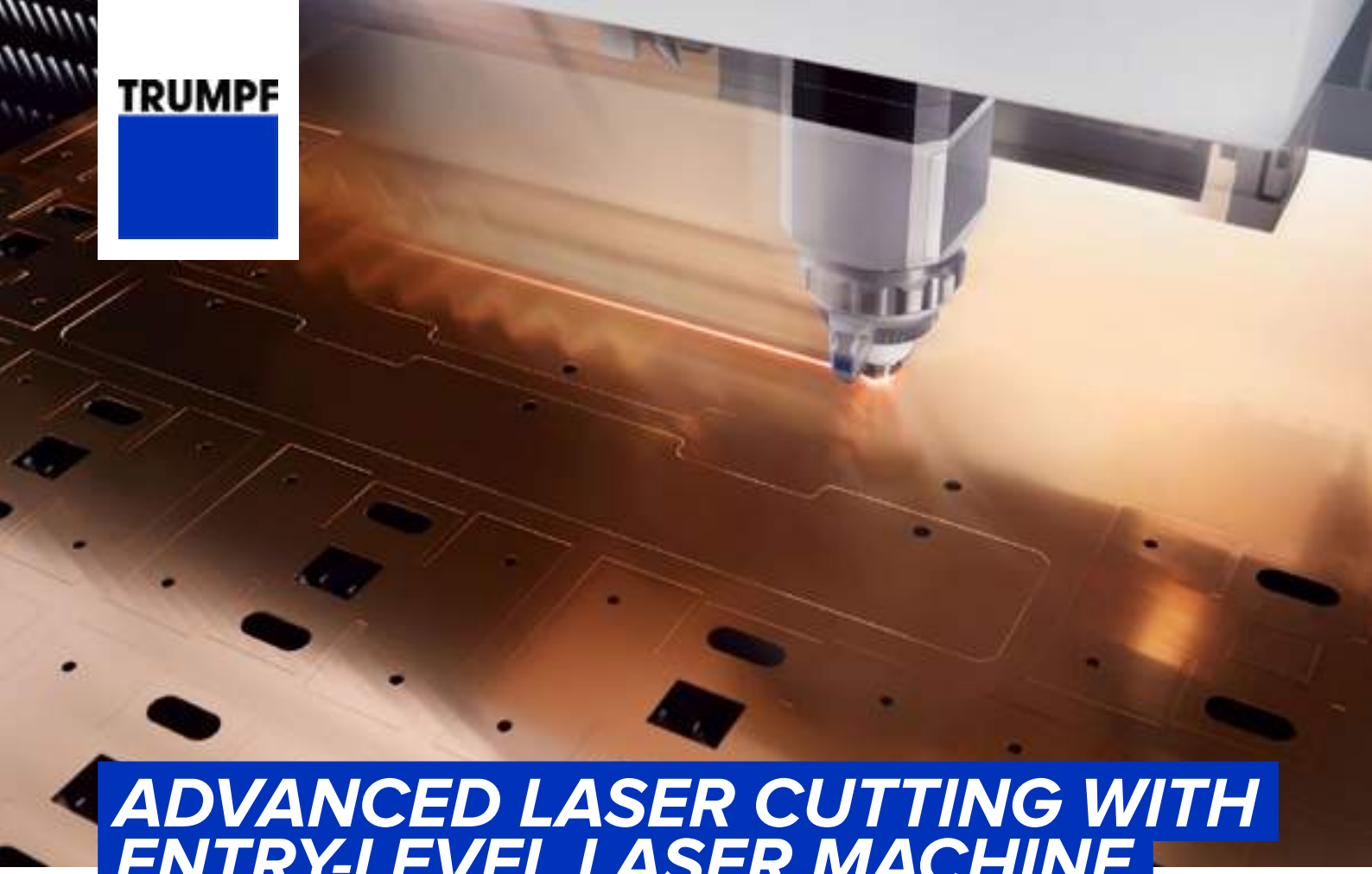

ADVANCED LASER CUTTING WITH ENTRY-LEVEL LASER MACHINE FROM TRUMPF

BIZ Engineering, a long-established company with a comprehensive knowledge of the sheet metal industry, has invested in a 3kW TruLaser 1030 fiber laser cutter to meet growing demand and replace previous CO2-based technology. This increasingly popular entry-level machine is proving that TRUMPF offers laser cutting solutions to suit all budgets, while providing high levels of capability, productivity and quality across the sector, as BIZ Engineering can now confirm.

BIZ Engineering is remarkable in that its history is traceable back to 1816, when it began trading initially as a builders' merchant from the Commercial Road in Shoreditch, East London.

Although the company remains a family-run business, a lot has changed in the subsequent two centuries. Today, the 23-employee subcontract fabrication specialist is part of BIZ Group Holdings, also comprising BIZ Karts and BIZ Power Tools, operating from premises in Enfield, North London. Industries served by the company include food, construction, aircraft, materials handling, electrical and retail, to list but a few. Notable recent projects - such as packaging conveyor systems, cycle parking systems, high-rise balconies, building cladding cassette systems and retail checkout barriers - indicate the diverse nature of products supplied.

Of course, serving so many different types of customer across the UK demands investment in the latest manufacturing technologies to ensure the highest quality and widest specification of product.

"We are currently growing year-on-year, which is testament to our investment programme, ongoing diversification and commitment to customers – existing and new," explains Paul Jones, who joined the company in 2017 as managing director following over 30 years of experience in precision sheet metal and other engineering sectors.

Whilst BIZ Engineering offers a range of subcontract manufacturing services, including CNC punching, routing, bending, welding and shot blasting, the company's latest investment drive has centred on laser cutting. Two new fibre-laser machines have arrived in the past 18 months, the most recent of which is an entry-level TRUMPF TruLaser 1030 fiber – one of the most cost-efficient and economical laser machines from the TRUMPF TruLaser portfolio.

"When I arrived, we had two small TRUMPF CO2 lasers which were 18 and 20 years old respectively and, although still operational, we took the decision to replace them with fibre-based machines," explains Mr Jones. "In comparison with our CO2 machines we knew fibre would be around five times faster, provide more capability and cut running costs by two-thirds."

The first laser cutter to arrive was a low-cost model from a non-European supplier. However, when inviting quotations from various suppliers for a second machine, BIZ Engineering was surprised to learn that the price differential to an entry-level TRUMPF laser cutter was smaller than expected, despite the higher productivity, better build quality and extensive functionality.

"We installed the TruLaser 1030 fiber in November 2020, and since then it has become a great asset to our business,"

states Mr Jones. “We sent four of our operatives on the TRUMPF training course, where they discovered that the machine’s Touchpoint control is very user-friendly.”

On a daily basis the company is using its recent arrival to process aluminium up to 12mm thick and stainless steel up to 15mm, as well as many different gauges of mild steel.

The 3kW TruDisk laser supplied with BIZ Engineering’s TruLaser 1030 fiber allows users to cut all common type of sheet metal, quickly and to a high standard. Despite its classification as an entry-level model, the TruLaser 1030 offers a number of advanced features, such as collision protection, touch display with intuitive menu navigation and a Central Link function for digital connectivity. The machine is available in lengths up to 6m, and laser power up to 6kW.

The TruLaser 1030 at BIZ Engineering produces parts in batch sizes from 1-off to 300-off, 12 hours a day, with plans afoot to extend the current single-shift working pattern.

“The speed and part quality offered by the machine is fantastic, while we are also making savings thanks to the elimination of CO2,” concludes Mr Jones. “Machine usability is also very important. We had been using our previous machines for the past 15-20, so there is always a degree of apprehension in the face of change. But our operators have really taken to the TruLaser 1030 fiber, which is great because our key market differentiator is high-end quality, so the TRUMPF adds real value in that respect. We are the main supplier to a lot of our customers and they rely on us and our manufacturing capabilities to deliver right-first-time components in accordance with tight delivery schedules. There is very little margin for failure in this industry, which is why we believe investing in a TRUMPF laser cutter represents an astute business decision.”

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CONTINUOUSLY EXPANDING SERVICE TO INDUSTRY

For nearly 40 years Midland Power Press Services Limited (MPPS) has been supporting press users with an increasing range of services. Over the years the company has grown from a one man operation into the company that UK industry calls when presses develop a fault. As the nature and demands of manufacturing industry has changed so has MPPS with continuous investment in people, facilities, machinery and equipment.

Well known as the company to call when presses develop a fault the MPPS emergency power press repair service guarantees a rapid response with an engineer on site the same day. However, the move to Lean Manufacturing in recent years means that OEM manufacturers have minimised production stock and require "Just in Time" deliveries which in turn puts the pressure on suppliers to maintain production and deliveries that can be costly when unexpected breakdowns occur. To minimise unplanned machine downtime MPPS offers press users an annual contract service for **Planned Preventive Maintenance**

Preventive Maintenance, provides a proactive maintenance strategy that involves regular and routine servicing of presses and equipment to reduce the likelihood of failure leading to unplanned downtime. Repairs to machines can then be planned well in advance enabling users to plan and schedule their production capacities.

MPPS has developed **Planned Maintenance Programmes** to check and inspect all mechanical, electrical, pneumatic and hydraulic equipment for correct operation and function. Where possible, MPPS service engineers will make adjustments to correct any minor faults during their visit.

A detailed report will advise on the condition of the machine, detail the repair work required (if any) and the actions required to maintaining continued production. This service is available for power presses, hydraulic presses, forging machines and auxiliary equipment

The advantages of a Planned Maintenance contract with MPPS include:

- Reduced unplanned downtime
- Fewer breakdowns of presses and machines that are essential for production
- Improved reliability of presses and equipment
- Fewer expensive corrective and emergency repairs

The frequency of the scheduled Planned Maintenance inspections, either 6 monthly or 12 monthly, is dependent on the machine use – single or double shift – and will be agreed with the customer as part of an annual service contract.

For more information contact:
Rob Friberg – Email: rob@mpps.co.uk or
Ruth Harper – Email: ruth@mpps.co.uk

SUB-CONTRACT MACHINING

An essential element of the MPPS service has always been the in-house machine shop for the manufacture of spare parts and the re-machining of components. In recent years MPPS has invested in additional manufacturing space enabling the original machine shop to be expanded. Conventional Lathes and Vertical Boring Machines are still in use but the move to CNC machining has been rapid. This investment has enabled MPPS to decrease lead times on critical spares and re-machined components.

This has freed up capacity to enable MPPS to offer a Sub-contract Machining service. Small batch specialist CNC machining has already undertaken for an existing press customer. The target market is small to medium batch sizes or even a "one off".

The three CNC Milling machines have up to 2500 x 800 x 950mm cube capacity and up to 5000kg component weight. The CNC Long Bed Lathe 3000 mm between centres with 710mm maximum turning diameter. The Vertical Machining Centre has a 1000 x 450 x 535mm cube capacity.

Our latest investment is a large Elga-Mill Miller giving us capacity to machine parts up to 7 metres in length.

MPPS has full in-house programming capability with CMM measuring equipment for inspection and ISO 9001 accreditation. We pride ourselves on having the ability to reverse engineer from broken samples with no drawings available.

For details of the MPPS machining capability and the full range of conventional and CNC machinery contacting: **Ruth Harper** - ruth@mpps.co.uk

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Flangecombe, a MPPS sister company, specialises in the servicing and repair of Single and Dual Safety Valves including ROSS, Schrader and many other well-known brands. We ensure that all repairs and servicing are carried out to the manufacturers standards and fully tested on our in-house dedicated test rig before delivery to the customer. Full documentation on the work carried out and a test report are all part of the service.

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To learn more about Flangecombe pneumatic repair service contact: **sales@flangecombe.co.uk**

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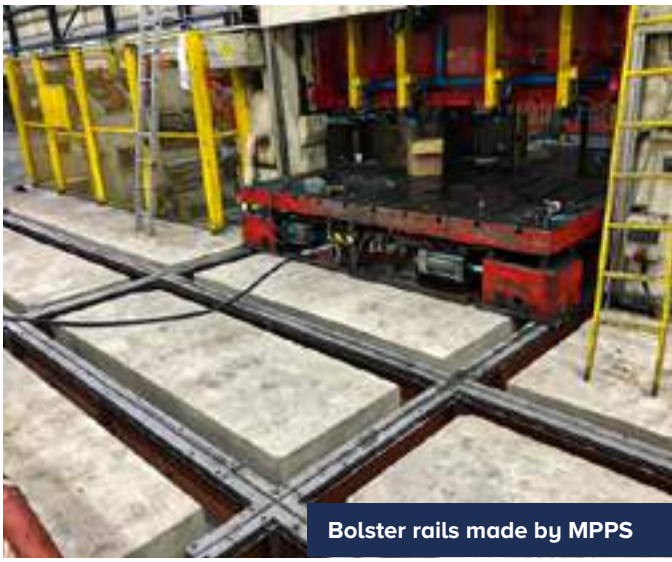
Sachmann Machine in Action



Bolster rails made by MPPS

Hydraulic Press refurb

Hydraulic Press refurb

SHEET METAL FORMING TOOLS: PART 3 OF SERIES 2.

ADVANCED SURFACE COATINGS & TREATMENTS FOR PROTECTING TOOLS AGAINST WEAR

Introduction:

I am delighted to present this next instalment as part three in this 75th anniversary year for ISME. The Institute can trace its formation to 1946 as a learned body of individuals and corporate members. Skills and technological advancement in sheet metal forming technology has remained the hallmark of ISME's mission to the sheet metal forming community, and is rapidly developing its reach within the UK and to an international audience. Not least the Institute recognises the prime importance of advanced tooling development and enabling technologies such as surface engineering, sustainable processing & environmental considerations being crucial components of sheet metal forming towards the drive to 2050 in an increasing digital manufacturing economy. In this series I have tried to link sheet metal forming manufacture to one of the most critical elements of tooling and its protection in service by the use of surface coatings and Laser cladding with advanced metallurgical heat treatment processing. This link is a crucial part of tooling design philosophy for the manufacture of high volume, high quality, and precision parts to the market utilising energy sources at lowest economic cost available. It is worth noting that to achieve these objectives in a world of light-weighting within a 'reduced carbon footprint', surface coatings and treatments have a major contribution to make to the overall success of 'smart tooling' surfaces for reducing sheet forming costs. Advance additive manufacturing by Laser Metal Deposition, (LMD) and plasma thermochemical treatments together with surface coatings and lubrication have made possible considerable progress in protecting tools surfaces. These surfaces assist metal forming of light alloys based on aluminium, high yield strength and carbon steel alloys. A newer aspect of tooling economy now features other environmental and economic benefits which are now prime consideration for the reclaiming and reuse of tools to help fit the circular economy model of the future with its associated cost reductions and lower energy use. All this helps to aid our manufacturing communities and their need to reduce burdens on society in a sustainable way.

In this instalment I will focus on tooling surface modifications and coatings which are now commercially available to achieve best practice sheet metal forming of a selection of sheet metal alloys which comprise the vast majority of sheet structural parts being made. The largest sectors of 'white goods', automotive, aerospace and general engineering products will only be indirectly cited as examples, as more specific reference has/will feature in my other series of articles. Space limits my coverage of some of the novel sheet manufactured tooling now being produced for high temperature applications, medical devices, space applications and composite sheet materials. I plan to present details of these new application area in a future series article.

Laser Deposition (LDC) and additive manufacture of tool and die surfaces.

Laser Deposition Welding is a surfacing technology used to produce a surface cladding on to dies and tools to provide a metallurgically bonded wear resistant layer up to several millimetres thick for some applications. This process is particularly favoured for tool surface repair and for applications where a thick anti-wear layer is required for severe sheet and bulk metal forming applications. There is considerable scope to apply a selection of cladded layer alloy deposits to tooling surfaces. The choice of cladding alloy can be selected to provide the best wear and corrosion resistance for a specific tooling application. These range from Ni/Cr layers or hard wear resistant steel alloys, or in combination to form a duplex surface with PVD/CVD for low friction characteristics, or plasma nitriding thermochemical treatments.

Laser Cladding is a welding process which uses a precisely focused laser beam to generate a melt pool on a component surface under inert flux conditions. A metallic feed material is simultaneously injected into the melt pool and fully melted to build up a deposit.

- The Feed material usually takes the form of a metallic powder but can also be a wire.
- The precise nature of the process allows the quality of the coating to be accurately controlled.
- The Key to successful laser cladding is controlling the heat input into the base material, which can be minimized whilst maintaining a high strength metallurgical bond.
- The very fast cooling rate associated with laser cladding has the effect of producing fine high strength microstructures with minimal effect on the mechanical properties of the base material

Processs:

- MMA
- MIG
- TIG

Benefits:

- Consistency of product- new and repair tooling
- High-level quality integrity across the cladded deposit
- Can be applied to both large tools, including chassis members and' body in white' automotive panels for example.
- Scope to produce thick layers up to several mm with high metallurgical quality
- Able to produce complex shapes to most tooling exterior designs. Some examples illustrating LCD additive process:

Typical family of alloys used in LDC:

- Nickel Alloys

Fig 1 Laser Welding Deposition

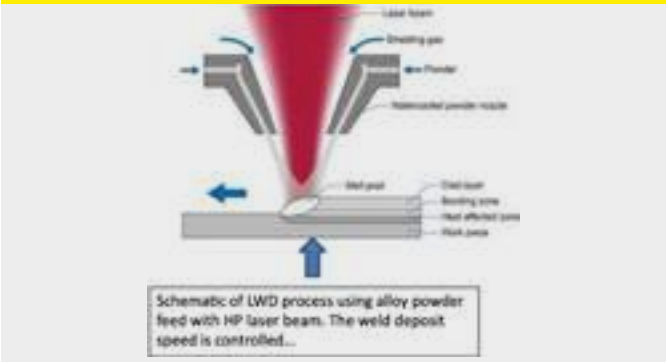


Fig 2 Back of die wall showing weld deposit

- Cobalt Alloys
- Tungsten Carbide
- Ceramics

Smart forming tooling systems for sheet forming tools- Surface engineering integration.

Surface engineering can now be added to the design and tooling process system via digital menu system. The advantage of this approach is to pre- design- in the best tooling surface for the process functionality of the parts to be produced. With this facility tooling material, heat treatment surface finish can all be 'dialled- in' to form a process route and a digital twin made from the initial tool manufacture to redesign and recycle/reuse. The economic advantage being that a predicted reproducible tool life and process performance can be made. This further helps the manufacture and their customer to help with costings and JIT requirements under real time supply conditions. The following graphic illustrates the circular nature of integration of the tooling system parameters:

Fig 7.1 to 7.4 illustrating the smart tooling cycle. This concept can be expanded to include surface and heat treatment modelling via digital interface. This will become an important feature in OEM/supplier business relationships over the next years as factory 4.0 is introduced.

The benefits of tool surface texturing for forming of light alloy, steels and other sheet material alloys:

As today's manufacturing industry has to cope with increasing demands for lightweight design, especially in the transport industry .The extensive use of lightweight materials, including aluminium, magnesium and titanium alloys, is emerging .Aluminium alloys provide several advantages, including high strength to mass ratio and high corrosion resistance, and thus attracts large attention in engineering applications such as automotive and packaging. Sheet metal forming covers a broad range of processes, all designed to mechanically deform sheet material into a shape without material removal. Among them, deep-drawing is one of the most commonly used forming processes in automotive and packaging applications, since it allows cost-effective mass production of sheet components. Tribological phenomena between tool and workpiece can significantly influence metal forming processes. Friction at the sheet metal–die interface, at the heart of it, affects the material flow in the manufacturing process, and wear on the tool surfaces could lead to changes in the boundary conditions of the process, greatly influencing productivity and product quality. The forming of aluminium sheets presents a significant challenge due to the low formability compared to steel and the materials' vulnerability to undergo galling with the forming tools' Galling' is a severe adhesive wear mechanism, often seen in sheet metal formed parts and parent tooling.

Controlled texturing of the surface of tooling has considerable proven benefits as a means of controlling friction and wear with its subsequent tool and part quality failures. The following cites the main benefits. This can be a complex topic, but it's a surfacing technology which is in regular commercial use by sheet metal forming manufactures which augments the tool process lubrication and surface coating of tool surface. It does not replace these.

- Friction is reduced as the texture degree is increased. This effect is probably attributable to the greater ability to retain lubricant in the pockets. Some of the related observations:
- Low initial friction is not a guarantee for good galling prevention.
- Present studies underline the key role of die topography and the potential of die surface functionalization for galling prevention. The generation of stratified surfaces with high polish degrees on the bearing surface combined with retention pockets are key to reducing galling and wear.

Many practical assessments on working tools in press shops are on-going. Further reporting on the benefits and mechanism will feature in a future tooling series.

Tool and die vacuum heat treatment for stamping and forming tool steel grades and dies.

A high quality tool steel tool is a prerequisite to successful sheet metal forming tool performance. There are a number of generic and proprietary grade now available. A number of standard grades, namely, high Chromium, high carbon such as BSI 'BD' series steels are often chosen, but there are also grades specifically designed to meet the high requirements now placed on much cold work tooling such as powder

metallurgical (PM) tool steels with high toughness and chipping resistance. The tool user has to make an informed choice of grade and vacuum heat treatment available. To choose the 'right' tool steel for the application it is crucial for many reasons not least for the optimal application of tooling surface treatment selection.

The obvious reasons being:

- The tool must have sufficient wear resistance.
- The tool must perform reliably and not fail due to premature chipping, cracking or plastic deformation. An optimal tooling economy—the lowest possible tooling cost (including maintenance) per part produced—can only be achieved if the correct tool steel for the application in question is used.
- Can the tool steel grade be surface treated or coated?
- Is the grade suited to cold forming the material being formed in its pre H/T and rolled condition?
- Can the tool steel be recycled and reworked.

Some basics of tool heat treatment using vacuum H/T technology:

The heat treatment of tool steels (and any other steel heat-treatment procedure) relies on a given set of metallurgical principles. For example, the formation of martensite relies on:

- The carbon content of the steel
- The alloying elements contained in the steel
- The appropriate austenitizing temperature
- The appropriate rate of cooling
- Environmental considerations

It does not matter if one heats the tool or steel by an oxy-acetylene gas torch or a vacuum furnace or a fluid-bed furnace, the steel will respond if all of the above parameters are met. The principles of metallurgy suggest that steel does not care from where it receives the temperature, it will respond to the temperature and cooling rate if there is sufficient carbon present to form martensite. However, to guarantee the optimum metallurgical control to prevent cracking, surface oxidation, temperature uniformity of the tool being treated, microprocessor controlled vacuum methods are to be preferred. Moreover, vacuum H/T places a much lower burden on the environment!

The method of vacuum heat treatment has been with us for many years, but only in the past 25-30 years has the heat-treatment industry has seen a significant growth in the use of vacuum-processing technology, particularly with the ability to capture and store data as a result of the growth of PC/PLC technology.

When one considers process technology and its growth as a result of vacuum H/T, it supports a learned paper written for first ASM European conference, held in The Netherlands in 1991. The writer forecast that the future of the heat-treatment industry was to "make a silk purse from a sow's ear" (using low-alloy materials to enhance the surface characteristics as well as the core properties). Consider the following processes that are now conducted under low-pressure (vacuum) conditions:

- Low-pressure nitriding
- Plasma nitriding
- Low-pressure carbonitriding
- Low-pressure carburizing
- High-temperature/low-pressure carburizing
- Tool-steel heat treatment with high-pressure gas quenching
- Quench technology utilizing blended gases of nitrogen/ hydrogen or nitrogen/helium
- Thin-film hard coating
- And many others now being developed for specific purposes

For tool-steel heat treatment, however, vacuum offers a distinct advantage: there can be no surface oxide attack at the surface of the steel (provided that the oxygen source is not already present or has been carried into the process chamber). This means that there can be no intergranular surface oxidation (IGO). It also means that, provided the appropriate stress relieving steps have been considered and there has not been any abusive machining practice, the distortion will be kept to a minimum with only a minimum grind-stock allowance needing to be made. This is one of the technical illustrations now being practiced by many heat treatment shops, and serves to demonstrate how far advanced the importance of 'best practice' tool heat treatment has become over the past 25 years.

Some basic elements of Tool H/T practice:

H/T involves the transformation from austenite to martensite and through to the appropriate tempering, normalising and annealing processes which must be used to ensure optimum functionality of performance of both the bulk and surface of the tool in service. These properties are dependent upon selecting the appropriate rate of heating, cooling and final temperature of treatment. There is a prescribed thermal treatment regimens used for each tool steel grade by most heat treatment service contractors. H/T contractors will advise at the time of ordering. But as a general guide figure 3 provides a set of sequences for heating and cooling of tool steel grades in vacuum. A full feature article will be presented on vacuum heat treatment theory and practice in a future series.

Fig 3 Heating and cooling cycle vs treatment time in vacuum furnace.

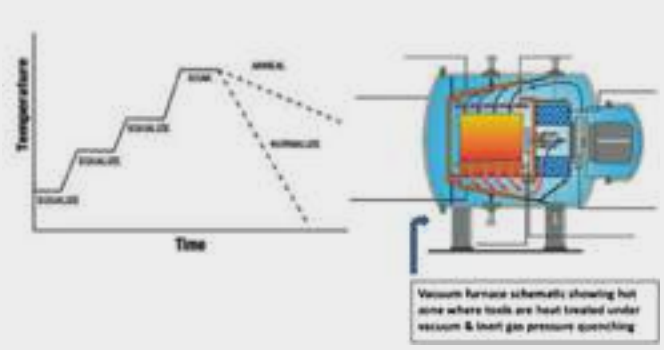


Fig 4 List of tool Coatings for sheet metal forming of common sheet materials grades

This list of tool surface treatments is but a condensed overview. The choice of tool surface and tool steel grade and post machining process is a complex set of interacting parameters. It I recommended that a full surface engineering design survey be carried out prior to specification of tooling

Fig 4

COATING/ TREATMENT	THICKNESS/DEPTH MICROMETRES	MAX SERVICE TEMP.DEG. C	HARDNESS VPN	COATING TECH	APPLICATION	RATING - FORMING ALLOY
TiCN PVD	2-4	300	2,800	PVD Arc	Forming dies/ punches	High hardness ferrous alloys
TiN	2-4	450	2,800	PVD Arc	Forming tools	Medium duty
AlTiCrN	3-8	850	3,200	PVDArc/HIPIMS	Forming Tools	Non-ferr. alloys
AlCrN	2-4	1050	3,000	PVDArc HIPIMS	Forming Tools	Various Alloys Ψ
CrN	4-6	700	2,300	PVDArc HIPIMS	Dies/punches	Various Alloys Ψ
a-C:H:W (DLC)	4-6	300	2000+	PVDubm PACVD	Dies/Tools	Non-ferr. alloys
TiC	6-10	400	3,200	CVD. 1000 Deg.C	Dies/tools	Open tolerance ф
TiN-TiC-TiN	6-10	500	2,500	CVD. 1000 Deg.C	Dies/Tools	Open Tolerance ф
TiC+MoS2	8-10	500	3,200+2000	CVD low friction	Dies/Tools	Open Tolerance ф
Boron Nitride	10-25	500	3,000	PCVD	Dies/Tools	Open Tolerance ф
Plasma Nitriding	Case depth ~0.2mm	350	1,200	Ion Plasma	Dies/Tools	Hardened Tools #
Duplex PVD+PN	Various	350	1,200+2,500	PVD + Ion nitride	Dies/Tools	Hardened S.Tools#

Key:

TiCN - Titanium Carbonitride
TiN - Titanium Nitride
AlTiCrN - Aluminium Titanium Chromium Nitride
AlCrN - Aluminium Chromium Nitride
CrN - Chromium Nitride
TiC - Titanium Carbide
a-C:H:W - Metal carbon DLC (diamond like coating). (Low Friction properties)
TiN-TiC-TiN - Titanium Carbonitride, Multi- layer.
TiC+MoS2 - Titanium carbide + Molybdenum Disulphide
Ψ Non-Ferrous .i.e. High strength Aluminium alloys/HSLA steels
ф - Open tolerance: heat treatments after coating

surface required to meet the production system requirements. It is pleasing to note that with tool coating data now available via various specialist sources, the task of tool selection at the design stage can now be realised with less risk than it was 25 years ago. Tool life Certainty will always be a challenge, but with Digital Manufacturing systems now available and developing the future of sustainable tooling is upon us.

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Credits:

Dr Chris Constable, IonBond Group UK.
Profs P Hovsepian and A Ehiasarian, NHTC, Sheffield Hallam University.
Uddeholm Steels, Oldbury UK (A division of Voestalpine Metals UK Ltd

Next Instalment: topics for Part 4 in Series.

1. *Case histories and developments of tool coatings and treatments for PM Tool steels used for high volume sheet metal forming*
2. *Hybrid & Duplex anti-wear coatings for sheet metal forming- automotive & engineering structures*
3. *Multi-material tools and 3D additive manufactured tool surfaces*

EUR ING John Yarnall CEng,CEnv,FIMMM, MISME

DAVE GILBERT: MANAGING DIRECTOR OF DG FABS LTD AND SKILLCRAFT PRODUCTS LTD.

In 2015 we set up DG fabs Ltd with a plan to service and provide equipment, mainly small to medium sheet metal and structural fabrications to the military sector through a previous colleague and his company Ban-Air. After a stumbling start DG fabs ltd began to gain momentum and from a humble start of 3k square feet with a cheap guillotine, Plasma cutter, old Amada punching machine and a cheap Pressbrake and Just myself , my son Ben, daughter Stacy and two other lads I worked with previously, but quickly, we began to find our feet and did some great work with the help of a local air handling company and a steady supply of military work from Ban-Air the company went from strength to strength, doing our in-house design and manufacturing and subcontracting any overspill work.

After 35 or so years I had lots of varied experience in different methods of design and hands on manufacturing in sheet metal work fabrication, and we had a very small but very skilled team. My daughter was the fastest Punchpress setter operator I had ever seen, my son was the best Pressbrake setter I have ever seen, 2 of the best assets you could have when starting a Sheet metal business, skilled 'happy' staff, good man management, the 'correct' choices when upgrading machinery and good customer relationships as well as keeping everything lean with minimum waste has worked well for us.

Today DG fabs turnover grows 30-50 % on year, it has a workforce of 35 people which include 30 production staff, so is a very lean operation. It has 45000 sq ft on its Bilston site occupying 5 units and has all the latest equipment, we recently achieved BS EN 1090 class 2 status and employs some of the best Fabricators and Welders in our locality.

Skillcraft Products ltd was created in 2017 as a personal distraction to the hard 24/7 toll of DG fabs and born from a hobby, and with the help of my wife Liza, turned into a fledgling but profitable business initially making woodfired ovens. We had a slow start; selling to the public is a hard game, word of mouth takes time, advertising costs money, we were not sales or marketing experts and although we tried paid advertising and mail shots and even door to door leaflets the response was poor. But gradually it was becoming evident that word of mouth is the most important sales medium out there for this type of work, so using our 2 youngest daughters and getting them involved in Skillcraft we created social media sites such as 'Backyard pizzas uk' on Facebook, and a few others letting owners and other enthusiasts dictate the conversations and topics where we listened to their product improvements and recommendations, and we had expanded from 1 oven size to a dozen or so variants we have today. We also manufacture pizza trailers, Catering horsebox style trailers, Smokers, Firepits, and lots of other products will be available in 2022. Currently we outsell all other UK manufacturers of woodfired ovens of the like for like type and are gaining ground on the imported ones as well. We also allow the customers to buy direct from the factory where they

can visit and we can show them true UK manufacturing and Sheet metal fabrication.

One of the biggest advantages for us was a wealth of transferable skills from DG fabs to Skillcraft Products enabling us to make good progress on prototyping and first off production runs, every prototype we made -we sold, we had no wasted efforts. As a company we don't have a long list of rules but we are diligent where efficiency is concerned yet maintain a family and mostly fun atmosphere where everyone works with me rather than for me. Products are designed with 'minimum waste 'ideology' at the forefront, waste is also time inclusive, we have been graced with a lot of luck and knowledge and we tend to get it right first time.

I do most of the CAD work and developing still using old skills like triangulation, radial line and Parallel line methods when making first offs also using AutoCAD 2d mainly putting bend allowances and reliefs as I go based on my machine tooling and capabilities, this is a moot point as the old school Sheet metal workers will draw it out on a sheet of steel and the modern guys will use Inventor or Solid works, we can do both ways but having the knowledge to switch back to old skills when Inventor can't figure it out is quite satisfying. Our guys learn many shop floor skills before they go onto cad, again this not only makes them better Cad operators it gives them an understanding of why things actually work and what to do when they don't.

Skillcraft has moved on a little bit and we now make products for the Building Services industry, Acoustic Industry, Air handling industry and Traffic Products, rather than being a Subcontractor we will reverse engineer or design and manufacture new products in their entirety.

Lastly, we are blessed to work in the Black Country, we have an abundance of material suppliers and have not really struggled with recruitment or had any staff turnover, we also have been supported well by Amada and although we look carefully at spending any money, Amada always seems to win the business through service and quality.

2022 will see us moving on to other areas with American style Hot Dog trailers, Patio Heaters, High End bbq's, Thermal hand-wash stations for industry and commerce, Traffic light boxes, Acoustic Enclosures, Roof Hatches..... and lots more maybe!

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Pablo Gutierrez, Technical Director at Source Engineering, with the new Bruderer machine

DEVON MANUFACTURER SOURCES NEW BRUDERER PRESS LINE WITH £100,000 INVESTMENT

LATEST NEWS FROM SOURCE ENGINEERING

A specialist in precision pressed parts and machined components has invested more than £100,000 into the installation of a new high-speed press line to boost capacity ahead of a raft of new opportunities.

Source Engineering, which employs 32 people across its two divisions in Plympton, has tapped into the expertise of Bruderer UK to purchase a machine that can do the work of four conventional HME power presses.

The BSTA 200M 20 tonne stamping press was identified as the ideal solution and is now up and running at its Langage Business Park facility, achieving 300 strokes per minute which represents a 200% increase in production output across a range of products destined for the automotive, electrical wholesale and oil and gas markets.

Engineers at the firm have freed up an additional 500 sq ft of production space to use for the introduction of new projects and to help them cope with an increase in demand for its range of automation solutions.

Andy Dunkerley, Chairman at Source Engineering, commented: “Buying a Bruderer is like buying the Swiss watch of machines...you get unrivalled precision, speed and repeatable quality, all wrapped up in a relatively small footprint.

“We already had one in another part of the factory and were fully aware of its capabilities, so when it came to looking at how we optimised the factory floor space by replacing four machines with one high-speed line we called in its technical experts to review the options.”

He continued: “They really understood what we were looking to achieve in space utilisation without giving up the versatility and the volumes, which basically meant we needed one machine to do the work of four.”

The Bruderer BSTA 200M high precision, high performance stamping press was identified as the preferred option and was fitted with a high-speed Servo Feeder and Pallet Decoiler to help achieve ultimate precision control of material de-coiling and pinpoint pitch control through the progression press tool.

Specified with a tool area of 510 x 400mm, the machine can deliver up to 1800 strokes per minute and is capable of handling a maximum material thickness of up to 2mm and material width of 100mm

It has also been equipped with Press Force Monitor, which ensures protection of the press from overload and limit damages to the tool if any stray material is pulled back up into the process - stopping the machine within 1 stroke, even at high speed.

Pablo Gutierrez, Technical Director at Source Engineering, went on to add: “Sales are now back to pre-pandemic levels and we are looking to grow, with our ability to provide design, tooling and manufacturing all in one place driving the need for more production space.

“Our long-standing relationship with Bruderer UK has been pivotal in giving us a faster more flexible machine, whilst also delivering capacity to install different types of presses or a dedicated assembly area to support bespoke automation work.

“There are lots of new opportunities domestically and overseas and we are hoping to turn some of the potential into contracts that will see turnover rise by 20% over the next twelve months.”

Adrian Haller, Managing Director of Bruderer UK, continued: “This is a perfect example of how the technical expertise of our team and the power of our presses can be combined to find a solution that does the work of four machines in one.

“Tolerances of manufactured process speed have improved significantly, whilst the ability to achieve fast changeover of press tools has been achieved due to the inbuilt Bruderer application of SMED (Single-Minute Exchange of Dies).

“We’ve been working with Andy and Pablo for nearly a decade and have got an excellent relationship with its technical team. This was a project that really excited us as we could use our technology to provide an immediate operational solution and, importantly, a way of supporting the company with its ambitious expansion plans.”

Source Engineering, which is approaching 30 years in business, has developed new control boxes that help monitor the part as it goes through production.

It has already supplied a number of models to Bruderer UK for installation on its machines and is looking to expand its offer further over the next twelve months.

For further information, please visit www.s-eng.co.uk. More details on Bruderer UK, can be found at www.bruderer.co.uk or @brudereruk on twitter.

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LATEST NEWS FROM BRUDERER UK

NEW BRUDERER PRESS IS JEWEL IN THE CROWN OF EUROPEAN SPRINGS & PRESSINGS £700,000 PRESS SHOP REDEVELOPMENT

One of the UK's leading manufacturers of precision springs, wire forms, pressings and assemblies has completed the relocation of its new press shop with the addition of a new, high-speed precision Bruderer press.

European Springs & Pressings Ltd, which supplies customers in the automotive, aerospace, building products, medical and nuclear sectors, has installed a BSTA 410-110B2 and high precision servo feeder to help it increase capacity and target more than £1m of new opportunities.

Fitted with the latest press and tool monitoring technology, the machine's expansive 1100 mm bed, production speeds of up to 1600 strokes per minute and fully adjustable stroke between 16 and 47mm, makes it an ideal addition for the Beckenham-based firm and means it can be used for pretty much every product it makes.

Continuing its policy of long-term investment in cutting-edge, innovative technologies, the acquisition is the final stage of a dynamic £700,000 project that has involved the construction of a dedicated 6000 sq ft press shop, which is set to deliver 20% efficiency gains and more streamlined production cells.

Stuart McSheehy, Managing Director of European Springs & Pressings, commented: "Our relationship with Bruderer UK goes back more than 15 years and this will be our third new machine we've taken from Adrian Haller and his team.

"The Swiss stamping technology is the best in the world when it comes to precision, achieving tolerances and delivering flexibility, and this new BSTA 410-110B2 will be the real jewel in the crown of our new press shop."

He continued: "A long press bed is ideal for satisfying the increasing demand from customers for longer press tools that accommodate more progressions and more complex shapes. We also required a machine capable of giving us versatility when it comes to strip width and material thickness.

> ***"EUROPEAN SPRINGS & PRESSINGS IS ON COURSE FOR A RECORD £11M SALES IN 2021.***

"Working with the Bruderer team, we made the decision to spec the machine up with a state-of-the-art servo feeder to help us automate some of the jobs and a high-end multi-head MicroCoat lubrication system for greater performance, whilst tool protection technology, press force monitoring and acoustic booths were also added."

European Springs & Pressings remained operational throughout Covid-19, diversifying its product range to produce components that went into surgical masks, other medical devices and the power generation supply chain.

Due to the diverse nature of its markets, the company has enjoyed rapid growth since the easing of lockdown and is on course for a record £11m sales in 2021, which should create more than ten jobs.

The new press shop was critical to this expansion and the business was again assisted by Bruderer's centre of engineering excellence in the UK in the relocation of presses, ensuring that production was still able to meet day-to-day targets.

Stuart went on to add: "This project was two years in the making and highlights the strong partnerships we have with our suppliers, especially Bruderer UK, who we asked to provide engineering services for the decommissioning, relocation and recommissioning of two of its high-speed presses and one, 160-tonne Zani machine.

"The latter was an especially complex move and had to be taken from its existing position on its side and then erected into its new location in the machine shop. Having a company with such a strong product knowledge meant we were confident that this process would not affect the press in the long-term and the relocation was completed with only one machine ever out of action at any time."

Adrian Haller, Managing Director at Bruderer UK, concluded: "We have built a strategic relationship with European Springs & Pressings, and this is reflected in the trust it placed in us to support its press shop relocation.

"The installation of the BSTA 410-110B2 is a clear indication of the precision markets the company is going after. In particular, the control technology added to the press provides

automatic ram shut height adjustment while the machine is under acceleration and deceleration loads, giving it guaranteed process stability and pinpoint repeatability.

"What is a really pleasing element of this partnership is how apprentices are being trained on the latest high-speed presses, future proofing their careers for years to come."

For further information, please visit **www.europeansprings.com** or **www.bruderer.co.uk.** You can also find out more on high-speed presses by following **@brudereruk** on twitter.

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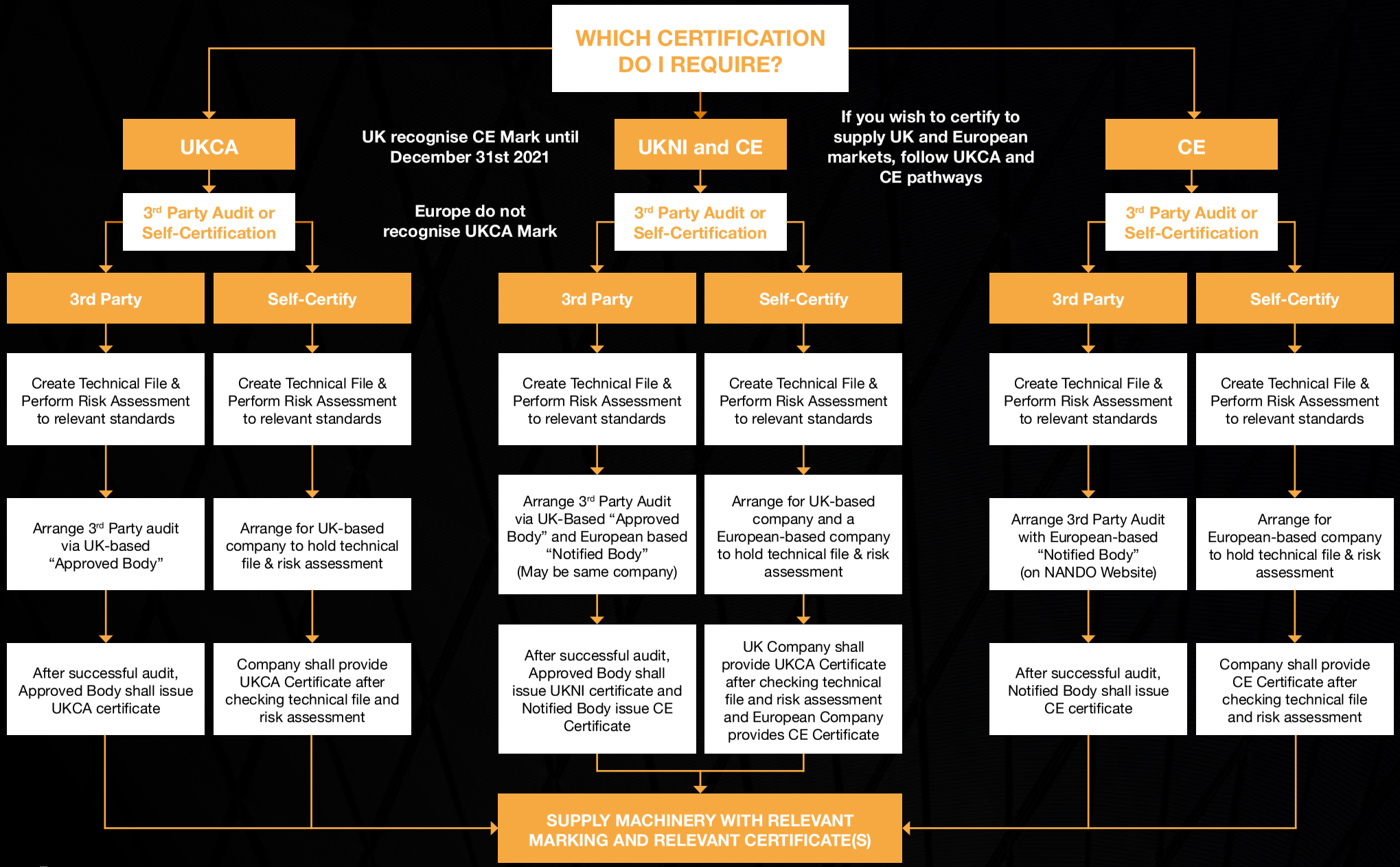

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A few members have asked questions regarding certifications and which ones they require due to the confusion in the marketplace and our sector. As a result, the MMMA have put together a working party to discuss the topic and have produced the above 'Decision Making Tree' to help advise members. **Source - Ray Pearson**

LATEST NEWS FROM KALLER

INTRODUCING: THE NEW DIGITAL KALLER CATALOG VOL.2

In the KALLER Catalog Vol.2, you will find general information about what to expect when choosing KALLER Gas springs, our innovative solutions for a safer working environment as well as Delayed Return Units and other KALLER product systems that you won't be able to find in the KALLER Gas Springs and Standard Mounts catalog.

In the digital version of the KALLER Catalog Vol.2 you will be able to access all the detailed information you need to determine which KALLER product will be the perfect match for your business.

If you have any questions about the catalog or the products included, contact your local KALLER Team.

SCAN HERE TO SEE THE FULL CATALOG

DIRTY ENVIRONMENTS & GAS SPRINGS

Hot Stamping (press hardening or hot press forming) higher strength steels has been somewhat of a trend with benefits like potentially reducing the weight of pressed parts and can be seen in OEM Standards. It has been a viable solution to protect battery packs in Electric Vehicles, or EVs.

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LATEST NEWS FROM ROEMHELD

MOVE DIES OR MOULDS SAFELY AND EFFORTLESSLY

Different rack types can be assembled to the desired size. The dies or moulds are transported from the warehouse to the press with changing carts manually or electrically powered by battery. They can be easily inserted into the machine via manually or electrically driven consoles. Roller and ball bars integrated into storage floors, transport and machine tables, ensure that even heavy dies or moulds can be moved effortlessly by hand over surfaces.

A uniform docking system fitted to all racks, transport carts and consoles ensures safe handling throughout the entire process chain. Thus, dies and moulds can only be moved once the components are firmly connected.

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ABOUT ROEMHELD:

Whether for aircraft, automobiles, machine tools, or cases for smartphones: ROEMHELD technologies and products have been used to manufacture numerous industrial commodities and goods for end users for more than 60 years.

Innovative and smart clamping technology solutions for workpieces, as well as for dies in forming technology and plastics processing, form the core of our ever-increasing portfolio. This is supplemented with components and systems for assembly and handling technology, drive technology and automation, and locking mechanisms for rotors on wind energy systems.

In addition to a constantly growing range of more than 30,000 catalogue items, ROEMHELD also specialises in developing and realising customised solutions and is internationally regarded as one of the market and quality leaders.

Innovation through tradition: ROEMHELD was established in 1707 with a foundry in Friedrichshütte, which still belongs to the ROEMHELD Group today and counts as one of Germany's oldest active industrial businesses.

The owner-managed group of companies employs approximately 560 workers at the three locations Laubach, Hilchenbach and Rankweil/Austria and is represented in over 50 countries by service and sales organizations. With customers from the mechanical engineering sector, and the automobile, aviation, and agricultural industries, ROEMHELD generates an annual turnover of more than 100 million Euro.

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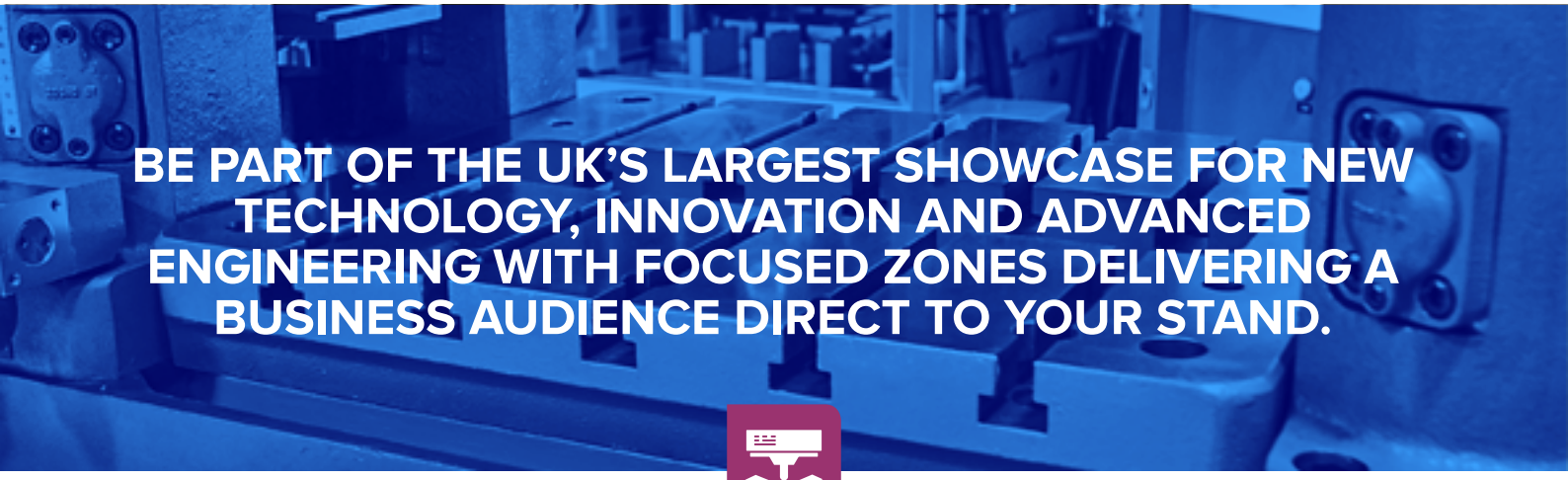

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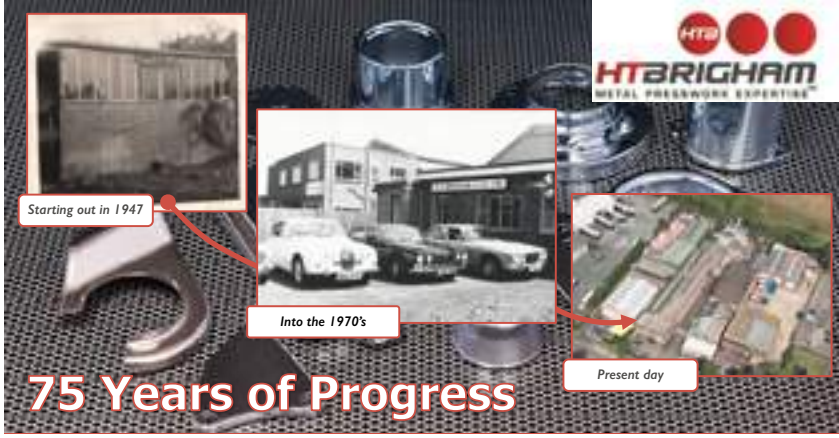
FROM HUMBLE BEGINNINGS... 75 YEARS OF MOVING FORWARD



Just like the Institute of Sheet Metal Engineers (ISME), H T Brigham is also celebrating 75 years in business very soon. The presswork company was established in 1947 by husband and wife team Hugh and Margaret Brigham, who operated a single hand-press from their garden shed in Birmingham, delivering components locally using their motorcycle and sidecar.

Over the decades, H T Brigham has grown from a small, local manufacturing business to what it is today; a key global supplier, specialising in the production of high-volume metal pressings, utilised across numerous industries, with business from exports making up 75% of turnover.

As a member of ISME for over 20 years, H T Brigham has enjoyed a long and successful relationship with the organisation. During this time, ISME has provided practical support, shared industry knowledge and presented various networking and promotional opportunities to the company, and many other metal working businesses, across the UK and beyond.

Much has changed over the years, but H T Brigham's founding principles of high quality, excellent customer service and value for money still remain integral to the core business ethos.

As we all know, there is little need to point out what a challenging period the last 18 months have been. It is evident that whatever the industry, we are all likely to have suffered to some degree as a result of the Covid pandemic. Following the dramatic overnight issues of slashed orders, a drastically depleted supply chain and the need to navigate through a hastily developed furlough scheme, came the longer-term issues which are still having a major impact on the business; including dipped automotive market demands, unprecedented material delays and relentless cost increases.

At this point, it seemed that the bad news was coming all at once. Covid crisis worries were simultaneously further compounded by the post Brexit fallout and associated logistical challenges. This made for one of the most challenging times in HT Brigham's long history.

However, we have been through difficult times before and bounced back stronger. In spite of the obvious challenges, H T Brigham is committed to investing in the future and to keep moving forward. Working closely with expert consultancies, a tailored improvement programme has been formulated and is now in the process of being rolled out, with significant investment planned in technology and processes.

The company has also continued with its commitment to its apprenticeship programme, which was introduced in 2014. With previous apprentices successfully completing their 4-year training programme and becoming integral members of the team, the scheme has a proven track record of encouraging and nurturing the young talent needed to take the company forward. This year H T Brigham has welcomed two further apprentices, one into the Tool room and another into the Quality department.

The company has also been keen to promote the value-added aspect of its capabilities. Providing a 'one stop shop' solution, a wide range of post-production services are available to meet customer requirements. A dedicated facility is geared up to supply finished products directly to customers, on time, on budget and to customer specification. Various welding operations can be performed in line with customer requirements, including spot, mig and projection methods. Other post press operations can also be provided by a range of additional techniques, including riveting, crimping, drilling and tapping; all traditional practices carried out in Coleshill.

From a market perspective, having grown its business from supplying the original Hardy Spicer car plants with axle parts, to cementing strong relationships with GKN group and other key automotive companies worldwide, today H T Brigham continues to command a strong reputation in the automotive sector.

H T Brigham is currently busy working on some exciting contracts within the automotive sector for metal pressings required for both the production of EV motors and their cooling systems. Additionally, work is being carried out on the metal casings required to house and secure EV battery cells. As "Perpetual Change" ensues within the automotive sector, Brigham is heavily involved in exploring the potential of pressings within the rapidly expanding electric vehicle market and the new horizons of hydrogen power.

The remainder of H T Brigham's customer base is drawn from key non-automotive market sectors, with dependable customers rapidly re-expanding due to post Brexit calming and the need to invest in the stability of local supply chains; as opposed to the "long distance run-around" and escalating import costs now playing out from the Far East. "Reshoring" is now becoming the key phrase and future implementation plan for many UK companies from the construction, medical, rail and leisure sectors.

As the company looks forward to celebrating its 75th year, much has changed and many challenges have been overcome since the motorcycle delivery days. H T Brigham will always try to improve and adapt in order to remain competitive and build the business further. Reasons for optimism, in the areas of diversification and emerging markets, are on the horizon, and H T Brigham plans to continue maximising potential future growth, particularly with the continued support of ISME. **Happy 75th!**

CONNECTING THE SHEET METAL WORLD WITH SOME TECHNIQUES FOR VEHICLE STRUCTURES.

Since I was invited to this "party", I thought a lot about what to write for this special publication. Well, it is not every year we celebrate our 75th anniversary, right? In fact, if we think about the birthday mate, I believe it is an early age for an Oracle, and hopefully I will be able to have a piece of cake for its 100th anniversary too. Congrats!

I'm pretty sure all the content of this publishing is amazing, a lot of technical info and news about upcoming technologies related to this lovely sheet metal world. So, instead of adding some tech-info I would like to leave some tips to who is now working or planning to work with sheet metal design, maily for vehicle structures. But don't worry, I promise you won't need to decrypt the message.

So, here we go. Get yourself comfortable, grab your popcorn bowl and enjoy the reading!

HOW TO DESIGN A SHEET METAL PART TO DELIVER A GOOD BODY STRUCTURES PERFORMANCE?

Well, if you are looking for a single and magical response, I'm afraid to tell you that this answer doesn't exist. But don't be scared, there are some design best practices that often help to achieve the expected body structures performance and avoid potential issues. Did you get the word "help" right?

No matter the vehicle architecture, there are always two "bad guys' ' following the design, stress and strain. Of course there are some more, but let's say that those are the bad ones, even more when we're working to deliver the main structural attributes.

The point is, some attributes issues we can manage by using different material grades and thickness, but the shape also plays an important role to achieve the target and should be also part of solution, even more when we are working to deliver durability and safety performance.

So, these are some of the key points to consider as design best practices to help you mitigate potential performance issues, avoiding stress risers and concentrators around your design:

- Always use the largest radius possible, including the bending radii. Don't forget the mating surfaces surrounding your parts.
- Don't use sharp corners in any square hole, notches or slots. Besides performance, the toolmakers will hunt you before rejecting your design.
- All design section transitions should be smooth, tangency and gradual. Avoid abrupt section changes if you don't want to end-up with cracks after durability runs.
- Do your best to not design multiple stress riser features in the same surface plane. I know, sometimes we have no much options due to other systems' interfaces.
- Adding beads and darts only when really required for stiffness or spring back control. Around these little features the bad guys are waiting for you to crack your part.
- The joints and spot welds distribution are also quite important to balance the tensile loads around the parts and systems. Always consider sharing the stress around the parts by improving the joints.

Escalope Flanges

Bear in mind that from virtual to real phases we always may have some correlation gaps, which means even that some issue wasn't found during virtual analysis doesn't mean won't appear during physical validations. That's why you need work in all ways to mitigate potential issues in your design.

The best way will always be to release the design considering stress concentration points avoidance, for all parts and joints. This will help you save money and timing, if thoughtful since the first sketch.

DESIGN EFFICIENCY, WHAT DOES IT MEAN WHEN WE'RE ENGINEERING THE BIW STRUCTURES?

Efficiency, guess this word is spread around for all companies whatever the market is, and for me it makes sense. Well, this is the best, if not, the only way to keep the business profitable and growing. In a simple way, being efficient means delivering high quality products in a short time and with low cost, in mass production obviously.

But, how can we deliver it? Looks simple, right? It's only three things. The point is, to deliver JUST these words (time, quality, cost) there is a long path to go...

So, from the body structures side it is about the same, but we consider a mix of engineering, manufacturing, vehicle performance, style and the main one, customer experience. Everything combined to those three words.

So here, is a short list resuming the overall view during engineering and manufacturing phases related body structures development work related efficiency:

- Regulatory and internal requirements
- Customer experience and expectations
- Appearance (styling and craftsmanship)
- Package and occupant interface
- Durability and reliability
- Vehicle dynamics (NVH, ride and handling)
- Manufacturing and assembly feasibility
- Costing, weight and financing
- Interface with other systems

Yes, we need work to balance all those inputs/outputs and constraints to deliver an efficiency design. Can we achieve 100% of the target for all these deliverables? Not always, but we always work hard to deliver the best profitable business case.

On top of all these deliverables, we also need to work upfront to manage the life of the vehicle, including maintenance, serviceability and repairability and its associated costs. We often consider a warranty of ten years forward or minimum 150,000 miles, considering several environment variations and customer usage conditions.

Besides all the above deliverables, these are the main functions expected by the vehicle body structure, divided by some groups:

- Defining shape and appearance
- Installation for other subsystems
- Protecting from the environment
- Managing energy during crash event

Bear in mind that, for each bullet point, we may have a couple of tasks, workload and interfaces to manage, being the architecture made in sheet metal or aluminium material. Now, tell me. Isn't it an amazing world?

PUNCH DIRECTION – ANOTHER DEFINITION THAT NEEDS ATTENTION SINCE INITIAL SHEET METAL PARTS DESIGN AND STAMPING PROCESS DEFINITION.

All the BIW parts have a couple of holes, each one with a specific function, the main ones:

- Locating
- Clipping
- Gun access
- Joint clearance
- Anti-rotation feature
- Weight relief

Flutes Design

But, I would like to point out the severity of clipping holes quality. Highlighting the interface with interior trim, exterior ornamentation and wiring systems.

After the stamping process, being more specific the piercing stages, the part gets some burrs around the holes. This is a normal and expected result, besides of inherent the process.

Basically, opposite of punch direction we always going to get burrs, and if it was not under quality control, will directly affect the clipping operation during assembly steps.

The best way to mitigate such issues is defining in your design the punch direction, keeping the punch and clipping installation direction in the same way. But, no never it is possible due to process constraints, and in this case the hole tolerances have to handle this achievement.

There is an acceptance criteria for burrs including cutting edges, and this is also part of quality inspection and BIW deliverables.

DESIGN TRIGGERS - A SIMPLE DESIGN STRATEGY BUT QUITE SENSITIVE FEATURE APPLIED TO MANAGE THE BODY STRUCTURES LOADS.

Not always increasing the parts strength improves the vehicle performance, the body system has to be balanced and developed to manage all load inputs. Sometimes, weakening some areas improves the overall structure's performance, and the triggers have important functions on this workload.

The main function of triggers is to drive the body system behaviour and support the complete vehicle structures, manage and absorb the load inputs - kind of fuses.

The front bumper beam assembly is a good application example. It's a quite complex system to develop, has to be strong enough to receive the frontal impact but also able to absorb and manage the load paths into oncoming vehicle structures.

Yes, a load path coming from frontal impact may affect the A Pillar performance for example, and that's why we need to work out to manage this path since the first input, the bumper beam. It's a very complex and sensitive engineering trading, and the triggers are key features to support this achievement.

But, just adding triggers doesn't mean we can easily manage the loads and deliver the expected results, there are many other inputs to be considered until we achieve the target, the triggers are only one.

DESIGN GAPS, A HELPFUL STRATEGY TO SUPPORT THE BIW MANUFACTURING PHASES.

Considering all geometric and process variations, one of the main challenges during BIW assembly steps is the parts marriage. Some constraints are already expected based on parts geometry and assembly tolerance stack-up previously identified at GD&T and virtual analysis, but the process variations are still complex to manage – in a physical environment – which means even doing the home work very well, we still may face some unexpected issues.

The last thing we want during manufacturing roll-out is face a BIW assembly issue with no option to handle by tuning the welding fixtures and parts locating. Yes, sometimes we have no option and/or no other parts quality to assemble and need to keep going until we find the root cause and improve the parts quality. This is real life on the shop floor!

So, based on design architecture we can predict and mitigate some potential issues during assembly steps adding some margins into design as possible fixes, that's why we often use this design gap strategy. The strategy is more about manufacturing lessons learned than math.

A simple example, a single part with over three mating surfaces to marriage, if you worked already with GD&T you may understand the potential concerns, on top of this add the shape complexity and sub-assembly interfaces. The point is, sometimes we had no option to design the interface in another way, so we need to ensure the part will fit properly during assembly steps considering the worst scenery, but still with proper quality and under control.

The design gaps application has some limits and parameters, and is part of manufacturing sign-off prior product release. It's not just a matter of creating clearance among the parts, once you still need to weld those surfaces without affecting the joint quality, besides appearance.

This is a simple example of product engineering working with eyes on the manufacturing process, and for me this is the best way to design parts, define processes and deliver proper manufacturing quality.

FLUTES DESIGN – A SIMPLE DESIGN STRATEGY TO SUPPORT BIW DELIVERABLES WITHOUT LOSING STRUCTURAL STIFFNESS.

Never forget, the BIW assembly is designed to support functions and attributes, every single hole, flange, forming, shape have a specific function to support the systems interfaces and complete vehicle deliverables. So, if you are working for body engineering you MUST know very well about your system, what it means, understand why, how and when each detail is added into every single part.

Back to flutes design, this is a simple design strategy basically considering in keep-off some surfaces among flanges to create gaps between mating surfaces, it's a good strategy once keeping the whole line flange increases the parts stiffness - the last thing we want to lose into BIW Structure.

We often use this design strategy to support few BIW deliverables, for example:

- E-coat ingress and regress: in a simple way, the flutes are used as drainage features, mainly into closed sections like x-members and beams, and most of the time are quite helpful to achieve the e-coat drainage target without affecting parts function.
- Squeak and rattles: one of the root causes of BIW squeak and rattles is the metal to metal contacts, so adding the flutes design among some flanges, mainly in areas when we have high torsional behaviour, might help to mitigate some rattles issues, for example in B Pillar flanges. But don't be so happy, squeak and rattles issues come from ghosts.
- Welding joint stuck-up: sometimes, to increase the structural stiffness performance we need to add extra welding joints, so we use the flutes design to create mating surfaces across flanges to be able to place the spot welds or rivets.

The main advantage of using flutes design strategy is that most of the time we can keep about the same part stiffness, once keeping the flanges with flutes instead of adding notches often don't create design triggers among the parts, weakening the systems.

So, whether you need to add some e-coat drainage feature, mitigate squeak and rattles or create a new welding joint, never forget to first try playing flutes, most of the time it works. BUT, never forget to check stamping feasibility too!

ESCALOPE FLANGES DESIGN – A SMART WAY TO DELIVER THE BIW WEIGHT TARGET KEEPING THE PARTS FUNCTION.

Weight is one of the most important vehicle deliverables, besides related to inertia class and emissions, affects the vehicle performance too and is also part of body engineering achievements. Yes, the design has a weight target and as you know, the BIW is the biggest vehicle system, which means more weight contribution.

No problem, something that every BIW engineer knows is that we're always facing troubles and challenges. Believe me, achieving the weight target is a complex task, even more, when we need to improve the structural performance by adding parts or increasing the sections or gages. It's A complex design trade with no option to fail, no matter how, the vehicle weight needs to be delivered.

To help with this achievement – considering the BIW is overweight - we often use a design strategy called escalope flanges to reduce weight. This strategy consists in simply reducing the final shape of parts by cutting off the material along the flanges not used for welding joints purpose. That's all.

Design Gaps

Look's simple but is not, before applying this design strategy some interfaces need considering, such as static sealing application, stamping feasibility, welding fusion area and the overall system performance. Removing material often means reducing part stiffness and adding the escalope also creates some triggers along the flanges, so this strategy often plays against the structural stiffness.

Sometimes, we also use this design strategy to improve the stamping feasibility by removing wrinkles or thinning areas from part design, this is not the best option, but sometimes is the only one we have.

The main focus always is the final part shape working on the overall BIW system.

Bear in mind that by using design escalope strategy, doing downgage or reducing parts section, the BIW weight target needs to be achieved, the same if the weight is under target.

SHARPEN EDGES – A VERY IMPORTANT DESIGN RULE WHO CAN'T BE FORGOTTEN DURING ENGINEERING PHASES, AND VIRTUAL MANUFACTURING SIGN-OFF.

Whether you're starting as a body structures engineer, one thing that you MUST know about the system is that all external edges of sheet metal parts are like a Samurai blade. Yes, anytime you need to grab a part with your hands, use proper gloves and always do it with high attention. Never forget this!

Even knowing that burrs are inherent to the cutting and piercing stamping process, we follow some acceptance criteria to control the burrs. It's not about hands injuring only, the burrs might affect parts marriage, systems installation and in the same case the attributes too.

Besides burr control, we also have some engineering rules related to sharpening edges considering manufacturing phases, mainly for final assembly steps with manual installation.

Basically, all open windows or slots at structures that we may need hand access during systems installation, we need to avoid direct contacts of sheet metal edges to hands and arms of operators. The burrs even under control don't avoid the sharpened edge condition, and this is a critical condition besides injuring risk for operators. Safety first, always!

So, to avoid risk of injuring, we simply flanged all hands access (slots) into BIW structure in a way to avoid direct edge touching conditions to the operator during assembly steps; all sheet metal parts edges with injuring risks to the operator MUST be avoided.

The good point is, flanging the slots often helps to improve the parts' stiffness. So, in a simple way, we mitigate the operator's hands injuring, reduce the BIW weight and keep system stiffness.

In other hands, always try to use the design challenges to bring up advantages for your systems. The vehicle requirements often don't change, so it's just a matter to find the best way to deliver. Keep it in mind.

LAST BUT NOT LEAST, ALWAYS ASK YOURSELF - DO I REALLY NEED TO ADD THESE FEATURES INTO DESIGN?

This simple question - on the right time - can save money and timing if you're engineering sheet metal parts.

Isn't rare to see sheet metal parts with oversized designs. Some beads, pockets, flanges or even holes added with no real need. I get it, really do! It's A normal "mistake" when we are designing new parts and use some existing design as references. Well, if someone added these features before, let's keep it right? WRONG!!!

I'm not saying that you won't need to add the same features in your new design too, I'm just saying that you need to understand the technical reasons very well BEFORE add any feature into your new design. Just because someone made this before, doesn't mean you'll need it too.

I know you're thinking, how do I know it? Well, I already redesigned a couple of sheet metal parts, not only for BIW architecture, and removed a plenty of features from previous design delivering a clean and cheaper design, BUT keeping the same system performance. Yes, it's possible, and I'm not Harry Potter.

The most used feature with no technical reasons are the beads across bending lines. We often use these beads to spring-back control besides stabilize and stiffen the side walls, but only in cases the system really requires it and we are facing spring issues in stamping simulations with no other option to control. Isn't required to add beads in every single bending line.

The point is, adding features into sheet metal design often increases the part and tooling costs. Yes, in a simple way, the more features, the more complex the die sets will be besides taking a long time to manufacture. Yes! Even a few beads across the bending line might increase the tooling and part costs. If you have some doubt, just imagine how to design the blank holder and dies interface with or without beads.

Another oversized design common to see is over thickness. Kind of - Well, not sure if we're going to meet a little bird or a big lion to cross this jungle, so let's carry a gun to protect ourselves from a T-Rex.

Thinnest sheet needs less stamping forces, smaller gas springers or springs, small punches and dies, and OFTEN means cheaper costs. Simple like this.

So, here is a tip for you: Always start a new design clean, simple and flat as possible. After starting the stamping simulations, attributes and function analysis then is the right time for adding features, never before! A clean and simple design doesn't mean it is not functional. Parts are designed to deliver functions, if there are no technical reasons to add some feature, don't do it!

I used to say that this is the main difference between knowledge and experience. It's not only about knowing the design techniques, but how and when to apply. I learned this someday, now I'm sharing for those who might think it's helpful.

WHO IS DANIEL PEREZ

Just a guy who loves the sheet metal world, mainly related to vehicle BIW Structures, always looking for new techniques, Software and processes that challenge the status-quo.

THE OPPORTUNITY FOR ARTIFICIAL INTELLIGENCE TO IMPROVE PRODUCT DEVELOPMENT FOR SHEET METAL FORMING TECHNOLOGIES

Advancements made in recent sheet metal forming research have introduced new hot stamping technologies that enable high-strength lightweighting solutions while offering improved component design freedom [1,2]. However, the uptake of new technology may be limited among industrial component designers due to the inherent unfamiliarity of designing for these processes and their process limits. Artificial Intelligence (AI) brings new opportunities for easing the component redesign efforts for new technologies and supporting the potential to achieve improved lightweighting designs and will be explored in this article.

New forming technologies may require the extensive use of Finite Element (FE) simulations to assess the feasibility of potential design candidates [3]. Since the simulator would need to be run by a process engineer with extensive forming technology knowledge each time a designer wishes to make a geometry change, this makes the design process slow and costly. A typical engineering approach might therefore be to only simulate a small set of potential design candidates, without an extensive search through the design space. This process can be further prolonged by improper initial designs which may require extensive design consultations to correct. Consequently, FE simulations may only be suited for final design validations, which typically happen near the late stages of a design process, when designs are near completion [4].

Researchers are currently investigating the use of AI to assist in the product development process and encouraging the uptake of new technologies among industrial designers. The advent of AI has introduced a new way to establish time efficient process models. Fundamentally, this application of AI can be thought of as a way to come up with a model that approximates a mapping from an input to a target state. As an example, an AI model was recently developed to rapidly predict the manufacturing feasibility of components to be formed through a hot stamping process, given a designed candidate geometry as its input [5]. Such a model provided an alternative approach to complicated and inefficient FE simulations during the early concept stages of product development.

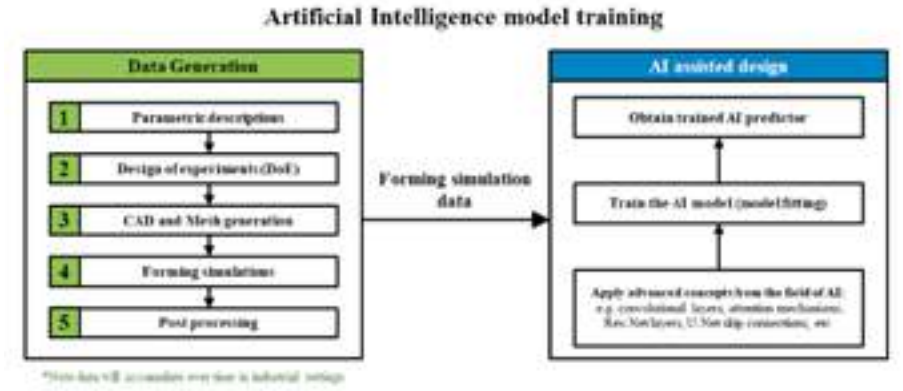


Figure 1 General Workflow for establishing an AI model to assist in design.

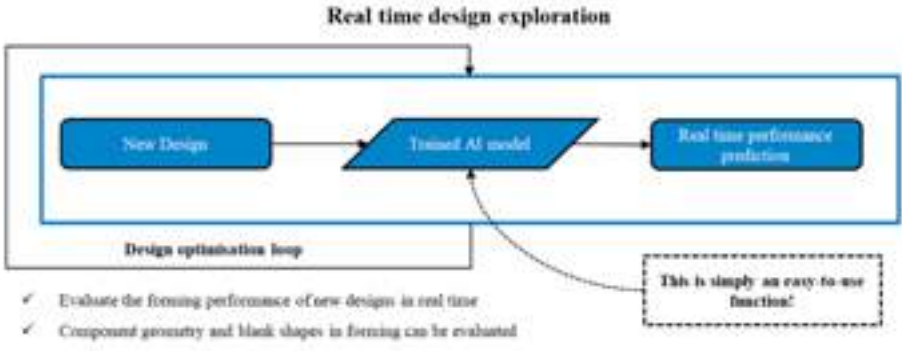


Figure 2 Employing a trained AI model to predict on an unseen design.

HOW DOES IT WORK?

AI approaches in essence consist of "learning" system dynamics from representative input-target data samples in a process known as training. Once training is complete, and a well-trained model has been obtained, it can be employed to infer system behaviour when presented with previously unseen inputs. This process is summarised in Figure 1 for a model to be trained on data collected from FE simulations.

The first step is to collect an initial dataset. The dataset must be well designed such that it captures key system behaviours to enable a proficient AI model to be obtained. For stamping processes, that might mean designing a dataset which includes samples with manufacturing defects such as excessive thinning and wrinkling [5], in order for these to be correctly predicted by the model and thus allow unsuitable designs to be identified early in a design process. It is also noteworthy that historical data from engineering companies could also be used in the dataset to improve model predictions, rather than being discarded. The trained

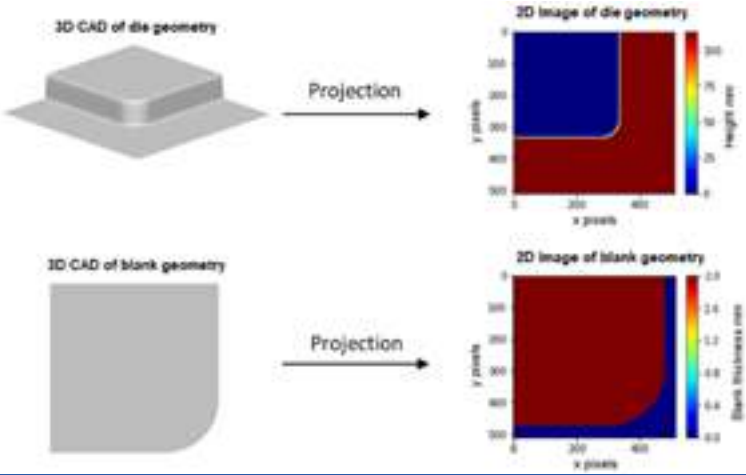


Figure 3 3D CAD geometries being projected onto 2D images to be used as inputs to image based AI models.

model can then be employed to make predictions on unseen data in real time, as shown in Figure 2.

The real time design exploration capability of AI models presents significant time saving opportunities for early stages of design, where design concepts are often very fluid. Total FE simulation run times on concepts can be reduced from weeks to minutes by using AI models. Once suitable solutions are found from the models, detailed component design can proceed, with only manufacture-intent geometries being reviewed by the FE simulator.

WHAT TYPE OF DATA WOULD BE NEEDED?

Depending on the problem to be modelled, data can take the form of simple scalars, through to image, point scans or mesh based. Scalar based models regress the performance landscape, given a low dimensional parameterisation. For example Attar, Li and Foster [4] simplified corner geometries into a combination of radii and height values, and established scalar based models as a means to construct intuitive design maps.

Image based models offer a richer data representation and are suitable for modelling complex shapes which may be described by many CAD features and dimensions. From a stamping perspective, an undercut-free geometry is a necessary requirement to avoid clashes with forming tools. Consequently, it is possible to perform a 2D projection from 3D CAD designs onto 2D images, shown in Figure 3. Apart a convenient 3D to 2D dimensionality reduction, this now enables access to a wide range of well-developed AI tools from the field of Deep Learning, such as Convolutional Neural Networks (CNNs), that can perform tasks such as feature recognition.

WHAT EXACTLY IS BEING "LEARNT" BY THE AI SYSTEM?

Unlike an iterative FE solver, an AI model consists of a series of matrix multiplications that are performed to transform the input to the target, thus enabling predictions in real time. During the training process, the system is learning these matrices, by updating their values iteratively to minimise an error function between the actual output from an FE solution (known as the ground truth), and the predicted model output. In this way, the model can learn a function that can map from an

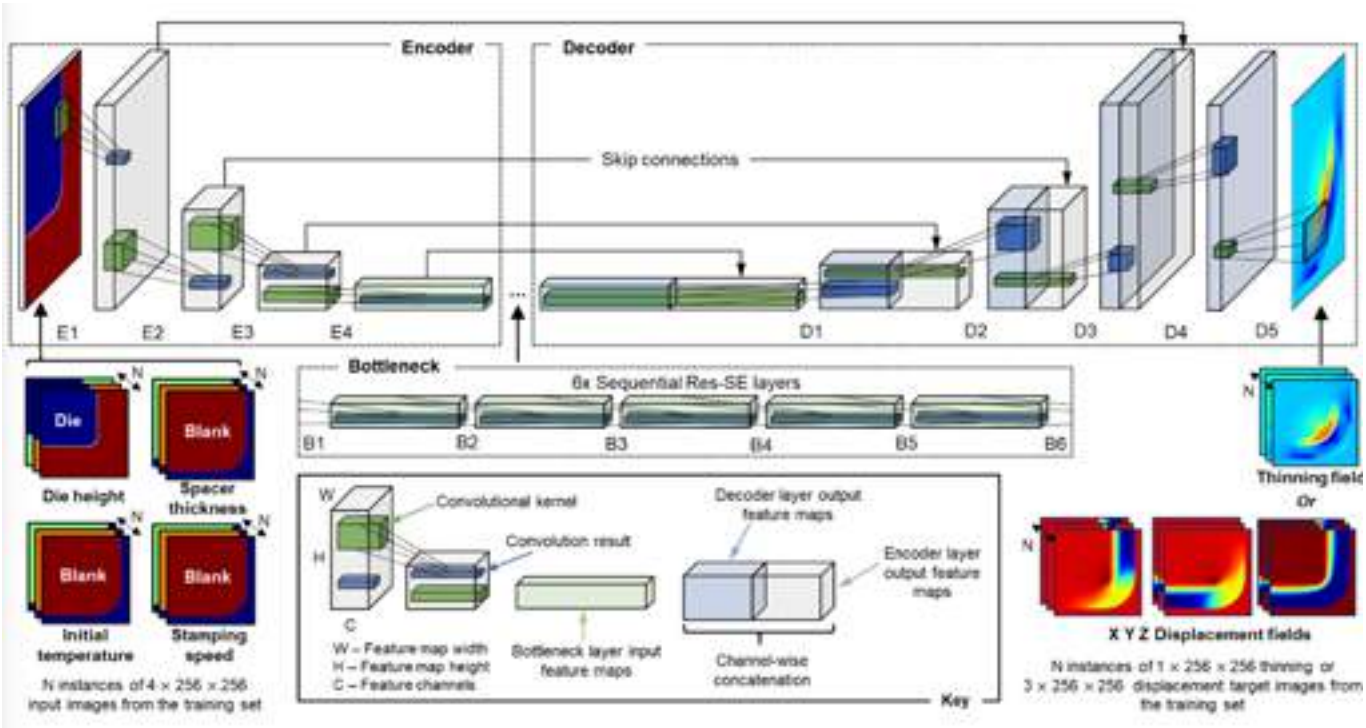


Figure 4 A convolutional neutral network AI model predicting thinning and displacement fields from images of dies and blanks [5]

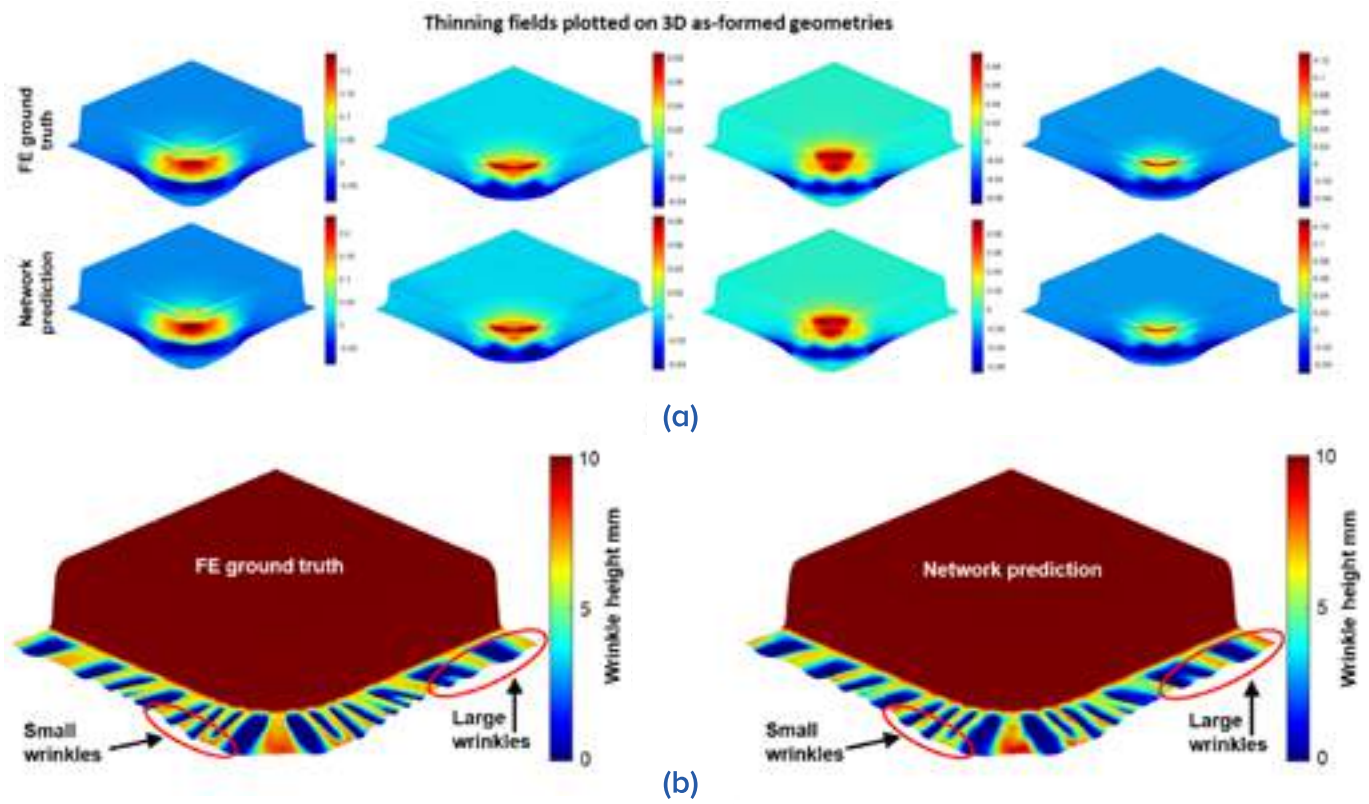


Figure 5 Real time neutral network predictions compared with predictions from an FE simulator for samples unseen during training (a) thinning fields and (b) wrinkle distribution [5].

unseen design to predict its manufacturing performance.

WHAT WOULD BE A SPECIFIC USE CASE?

A schematic of a learnt mapping is shown in Figure 4, showing an AI model predicting the hot stamping performance of with given component design, blank shape, and process parameters. The specific AI model employed here is known as a Convolutional Neural Network (CNN). By convolving learnable kernels across input images, CNNs hieratically detect and extract locational features. Important design features on a component geometry, such as tight radii are therefore automatically detected without human supervision [5]. The detected design features were then transformed by a series of learnt matrix multiplications into thinning and displacement fields, which were used to define the manufacturing performance.

Figure 5(a) shows thinning fields plotted on 3D as-formed shapes for four different corner geometries, varying in draw depth and radii combinations. The solutions obtained from the neural network model in Figure 4 can be seen to be indistinguishable from their FE simulation counterparts. The displacement fields which make up the 3D as-formed shape were also predicted by the neural network model. Intricate features in thinning fields, such as the change in location of maximum thinning from the corner sidewall to the punch radius from the first and fourth case are also well captured. The model was not explicitly embedded with these trends but was able to discover them through being hidden within the training data. Similarly, Figure 5(b) shows the prediction of wrinkles where wrinkle heights and ripple locations are correctly predicted with high accuracy.

CHALLENGES ON THE ROAD AHEAD

AI models have great potential to assist in the product development process of sheet metal forming technologies, and a rapid growth in the application of AI in sheet metal engineering is expected in the next few years. Although there is a promising road ahead, there lies some challenges that need to be addressed before AI becomes a common tool for the typical engineer.

One key challenge is the need to familiarise engineers with data science practices, for them to efficiently undergo data collection, model training and troubleshooting. There currently exists a wealth of online resources and freely available university courses in AI, for example [6], which need to be compiled and offered in company training programs in order to bridge this skill gap. Potentially, production engineers could handle the role of model construction and testing, and then deploy the models to design engineers as users, when a sufficiently suitable model is obtained.

Another challenge lies in the maintenance of data repositories and current industrial practices. Typically, data which does not meet design criteria (e.g., a FE simulation that predicts severe manufacturing defects, or physical defects seen on the production line) is discarded and considered as a failed run. To come up with proficient AI models, data from these cases should be included in the training data. Therefore, companies would need to update their data management practices, to map these data samples into a suitable form for model training. Further, data obtained under different conditions (e.g., different materials, temperatures, etc) should be collected, cleaned, and well organised into labelled repositories.

SUMMARY AND OUTLOOK

This article described an application of AI in supporting the design for new stamping processes, by coming up with a model that was able to predict the manufacturing feasibility of new designs in real time. Key challenges in the road ahead in the adoption of AI in industrial practice were also discussed.

The theme of learning models from supplied data is expected to be extended to other areas of the production cycle in the near future. Data from part scans could be used by an AI model to understand real physical process limitations. Examples could include complicated contact conditions and prediction of surface defects, as well as the optimisation of production line processing parameters to avoid on-line defects such as wrinkles or folds. In these cases, analytical solutions may be impractical, and FE simulations might not be accurate enough to capture complex physics, while AI solutions driven by collected physical data may be a good alternative.

Another potential application of AI could lie in improving the accuracy of FE simulations. 3D brick elements have the potential to accurately model bending physics and through thickness effects but are computationally impractical in practice, leading to the use of 2D shell elements. Solutions obtained from 2D elements could be mapped to their 3D equivalent counterparts using a custom AI model on the element scale, to potentially improve the predictive capability of shell element simulations.

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PERSONAL INFO

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AN INTERVIEW WITH MOHAMMED - A YOUNG MEMBER OF ISME

The Institute has a keen interest in promoting careers in the Sheet Metal Industry to young people. ISME Council Member, Dr. Alistair Foster interviewed Student Member, Mohammed for the Oracle

SO, CAN YOU TELL ME A LITTLE ABOUT YOURSELF?

I am Mohammed Ismaeel, 19 years old, and am an Apprentice Laboratory Technician working at the Materials Characterisation Centre within Impression Technologies Ltd.

COULD YOU TELL ME MORE ABOUT YOUR JOB?

I work in a small team, performing tensile and compression tests on sheet material. We test the material to characterise for finite element simulation to ensure new tools entering production on the shop floor work as expected with low scrap rates and efficient takt times.

HOW DID YOU FIND OUT ABOUT YOUR APPRENTICESHIP SCHEME?

My school told us about apprenticeship opportunities, and it seemed to fit with my interests. I signed up for the apprenticeship program as it felt the best way to prepare myself and gain a good amount of experience for industry. I applied with a CV and there was a short interview. The college then matched me with the most appropriate companies, and I chose Impression Technologies immediately after attending the interview here.

WHY DID YOU CHOOSE A TECHNICAL CAREER?

Since school I have been fascinated by engineering and its principles which is why I decided to get into it from the beginning of my career, I've always really liked tech and knowing how things work by taking things apart and putting them back together. It is best to go into a sector that you have passion for and want to thrive in as you feel a sense of achievement when you accomplish your targets.

I got into the role initially through college, then after having conversations with seniors and experienced people at work, I feel I have made the correct decision. I have found these conversations very helpful when starting off, as colleagues will have better ways of carrying out specific tasks, overall increasing the productivity of my work. Working here, I can also branch off and alter a few things here and there, making a better and improved way of carrying out a job.

Currently I am gaining skills and experience and getting ready to move onto the next big steps of my career. The technical aspects I find interesting are how data is processed and how the physical testing is converted into data sets and then into pressed parts. I also like the management activities, but at this stage I still feel like I need to know more about different roles. I often want to ask people "what do you do in your job?" because I want to learn more about how colleagues' responsibilities fit together within the company.

HAS HAVING A JOB WITH A WAGE RATHER THAN TAKING A STUDENT LOAN BEEN AN ADVANTAGE?

Whilst people may think that I'll miss out on higher salary positions due to not being a graduate, I would rather have a hands-on position at the start of my career and gain practical experience (as well as a salary!) and work my way up. I also don't like the idea of being heavily in debt. There will always be an opportunity to take a degree course later in life through the Open University if I change my mind.

ARE YOU CONTINUING WITH EDUCATION ALONGSIDE THE JOB AND IF SO, WHAT QUALIFICATION ARE YOU AIMING FOR?

I am currently taking an EAL Level 3 Diploma in Advanced Manufacturing and Engineering - Technical Support Technician. I have also recently completed an English language course as I was not satisfied with my school grade.

HOW CAN ISME HELP YOU AND OTHER APPRENTICES DEVELOP YOUR CAREERS?

I would like to gain more of an idea of the wide variety of skills and applications involving sheet metal engineering, and I'm hoping that being a member of ISME will help me do this. Regarding my personal career, I am aiming to develop and broaden my current skills and pick up some best practices along the way. I hope to continue my apprenticeship as a Lab Technician, learning more about the detail behind the testing, how raw sensor data is processed to develop the test outputs and how this relates to press trials. Further down the road I will hopefully be looking at process technology roles.

THE INSTITUTE IS CONSIDERING SETTING UP A YOUNG MEMBERS SECTION. WHAT SORT OF ACTIVITIES WOULD YOU LIKE TO SEE IT PROVIDE?

I believe that social media is a good way of putting across information about sheet metal engineering. I feel that drip feeding information in short videos/explanations is a good way gaining an interest from young people and then including something that directs you to where you can find a more in-depth explanation of the video.

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UNIQUE METAL FORMING APPRENTICESHIP READY TO RECRUIT – WITH DEGREE AND HNC OPTIONS

THE LEVEL 6 TOOL PROCESS DESIGN ENGINEER APPRENTICESHIP WAS SPECIFICALLY CREATED FOR THE METAL FORMING SECTOR IN RECOGNITION OF INCREASING SKILLS SHORTAGES.

The Tool Process Design Engineer apprenticeship and end point assessment have been developed by the CBM and member organisations. It is the only Apprenticeship that recognises the unique and specialist skills for this senior technical role. Organisations of all sizes can access government funds towards the cost of the apprenticeship. The Apprentice may be an existing employee wishing to formalise their qualifications or for a new recruit. The apprenticeship can lead to Incorporated Engineer status with the Institute of Mechanical Engineers.

Employers can choose their preferred training provider including Universities as the apprenticeship has 3 optional routes.

Option 1 Level 6 Tool Process Design Engineer Apprenticeship. The learner undertakes practical and theoretical training on a block release basis. (Typically, 88 days over 2 years). Then an assessor visits the workplace every 2 months to continue the training and assessment. Once the training is finished the apprentice must complete an independent end point assessment conducted by the CBM. The funding value assigned to this option usually covers the full cost of both the training delivery and end point assessment

Option 2 Level 6 Tool Process Design Engineer Apprenticeship with HNC units. As option 1 above but provides the additional opportunity for the Apprentice to complete a HNC in Mechanical Engineering. This option incurs an additional cost in order to complete the full Higher National Certificate.

Option 3 There is the possibility of a degree option for suitable candidates. This option requires collaboration between the university and training provider. Again, this option incurs an additional cost to complete the full Degree. The collaborating partners use the Degree's engineering curriculum to provide some of the under pinning knowledge required in the Apprenticeship standard.

These options allow greater flexibility during these difficult times and ensures this Apprenticeship meets the needs of your business and your workforce.

In response to CBM member feedback this level 6 Apprenticeship (degree level) programme was developed by the CBMs Trailblazer group in collaboration with the Institute of Apprenticeships and technical education. Previously no Tool Process design apprenticeship existed at this level and many employers were dissatisfied with generic qualifications.

In this new apprenticeship, skills knowledge and behaviours are specific to our members needs and the employing organisation can choose which university/training provider they work with to achieve the standard. There is the opportunity for the apprentice to work on industry standard training equipment. This equipment was specified by the CBM on behalf of members and procured by the University of Wolverhampton and the Black Country Local Economic Partnership.

The CBM will be the independent end point assessment organisation. This will allow industry specialists, trained in

CBM CONFEDERATION OF BRITISH METALFORMING

assessment techniques, to become part of the assessment panel. The panel will ensure the apprentice has achieved the required level of knowledge skills and behaviours necessary to meet the needs of modern manufacturing.

We are asking members to become actively involved to ensure this standard adds real value to our sector by encouraging existing and new members of staff to become professionally qualified via this apprenticeship.

The first step is to undertake a demographic and skills analysis of the Tool Process Design capability in your organisation. Using the analysis consider whether to recruit new talent who can undertake this apprenticeship, or whether to up skill your existing workforce as a means of staff retention and to ensure business continuity.

For further information please contact Geraldine Bolton at the CBM - Geraldine.bolton@thecbm.co.uk.

75TH ANNIVERSARY GOLD MEDAL DINNER

FRIDAY 19TH NOVEMBER 2021

The Fairlawns Hotel & Spa
Little Aston Road
Aldridge WS9 0NU
5 Course Dinner followed by the presentations

2021 ISME GOLD MEDAL AWARD TO PROFESSOR JIANGUO LIN, IMPERIAL COLLEGE FOR A MAJOR CONTRIBUTION TO THE UK SHEET METAL INDUSTRY.

FOLLOWED BY THE PRESENTATION OF THE DAVY UDAL AWARD TO DAVE GILBERT, SKILLCRAFT PRODUCTS LTD. FOR SERVICES TO THE SHEET METAL INDUSTRY

Reception Drinks 7:00pm | Ticket Price £49
Tables of 8 or 10 available for single or company groups
Please reserve your places by emailing **adriannicklin@btinternet.com**
Please dress smartly for the occasion with gentleman lounge suits and ties
Overnight accommodation is available to guests, with discounted rooms starting at £119.05 based on 2 people sharing a room on a B&B basis.

It is hoped by then that the Government restrictions will have loosened to enable an excellent evening. All monies received will be returned if we have to cancel due to Government restrictions.

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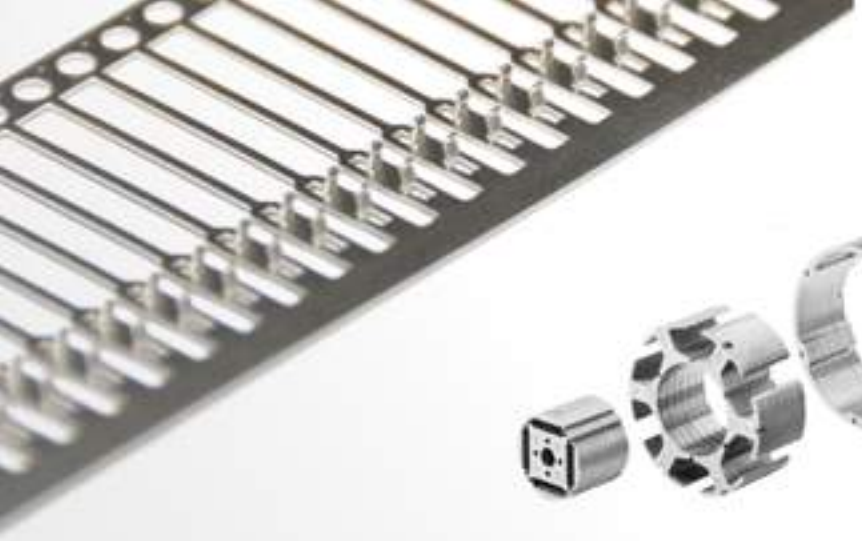

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