

TAGMA TIMES


NEWSLETTER

(Technical Info. on Die, Moulds & Toolroom)

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Simulation: Streamlining Manufacturing

TECH FOCUS
ADVANCEMENTS IN
INJECTION MOULDING
TECHNOLOGY

TOOL TALK
MR. RAMESH K. S.
Sr. Vice President - Engineering &
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NISHANT KASHYAP

Editor

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Dear Readers,

In the November edition of TAGMA Times, we delve deep into simulation technology for the tooling industry and the latest advancements in injection moulding. As we navigate the ever-evolving manufacturing landscape, these two pillars stand out as transformative forces shaping the future of toolmaking.

The 'In Focus' article spotlights the transformative power of simulation technology in the tooling industry. From virtual prototyping to process optimisation, simulation tools are revolutionising the way toolmakers design and validate their products. The piece not only explores the current state of simulation technology, but also delves into its future potential, offering insights into how it can enhance efficiency, reduce costs, and bring about unparalleled precision in tool manufacturing.

The 'Tech Focus' section explores injection moulding. We bring you a comprehensive overview of the latest trends and innovations in this critical aspect of toolmaking. As injection moulding continues to be a cornerstone of manufacturing processes, we examine the breakthroughs that are driving efficiency, sustainability, and product quality. This article aims to equip you with the knowledge you need to stay at the forefront of this dynamic field.

We also have another interesting read for you — our exclusive interview with Mr. Ramesh K. S., Senior Vice President of Engineering at Ather Energy in our 'Tool Talk' section. Here, Mr. Ramesh sheds light on the expectations from toolmakers in the rapidly evolving electric vehicle (EV) sector. He shares his valuable experiences working with both Indian and overseas toolmakers, emphasising the critical role they play in shaping the future of EVs. In this insightful conversation, he talks about the opportunities that lie ahead for toolmakers in the exciting realm of electric mobility.

This edition of TAGMA Times also features an in-depth report on SMEs in India and an interesting case study on measuring systems. As we navigate through the articles, reports, and interview, our goal is to empower you, our esteemed readers, with knowledge that will not only enrich your understanding of the industry but will also inspire innovation in your own endeavours.

I wish you an enlightening and insightful read.

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India poised to become 3rd largest economy by 2030: S&P report

While global economic growth faced stagnation for the second consecutive month in September, India continued to shine as a beacon of economic resilience, expanding at one of the strongest rates in nearly 13 years.

According to a report by S&P Global Market Intelligence, this comes as the private sector output in developed markets, including manufacturing and services, faced a mild contraction.

According to the Asia Credit Outlook 2023 released by S&P Global Market Intelligence, the Indian economy will be 3rd largest economy by 2030. The Indian economy is growing and will give huge opportunities for medium to long-term.

If the projected trajectory holds, India will supersede Japan and Germany to become the world's third-largest economy by 2030. As per the S&P Outlook India's GDP is poised to touch USD 7.3 trillion by 2030.

Currently, India is the 5th largest economy in the world at USD 3.7 trillion worth of GDP in 2023-24. It replaced the U.K. as the 5th largest economy in 2022.

As per S&P Global Market

Intelligence report, the strength of India's economy shone brightly as it continued to lead among major emerging economies, displaying exceptional growth momentum.

India was the only one among these economies to accelerate its growth from August, with output expanding at one of the strongest rates in just under 13 years. As per the report, Indian economy has shown sustained growth during the 2023 calendar year.

India's robust expansion was bolstered by a substantial increase in new business, supported by favourable demand conditions and positive market dynamics.

Both manufacturing output and services activity in India contributed to its impressive growth trajectory.

In contrast, Russia and China experienced more modest expansions, with both seeing a slowdown in growth from August.

Price pressures eased slightly for emerging market firms due to softer service sector cost inflation, although solid demand growth enabled businesses to pass on higher costs at an accelerated rate.

Consequently, emerging market selling price inflation reached its



Image used for representation only. Courtesy: Envato Elements.

highest level in 14 months, offering optimism for firms' profits.

Developed market profit margins faced pressure from a faster rate of input cost increases while selling price inflation dipped in September.

However, developed market selling prices continued to rise at a rate well above the long-run average, despite the challenge of higher prices on clients' demand in an environment of high-interest rates and softening global economic conditions.

As India sustains its growth, the contrast between emerging and developed markets highlights the challenges and opportunities presented by the ever-evolving global economic landscape. ♦

Courtesy: ANI/ Deccan Chronicle

Google bets on India with Pixel smartphone manufacturing

Alphabet Inc's Google will start manufacturing smartphones in India and its flagship Pixel 8 will be available next year, an executive recently said, as the tech giant joins global companies setting up facilities in the South Asian nation.

At a Google for India event, Rick Osterloh, Senior Vice President of Devices and Services, said Google will partner with international and domestic manufacturers to produce the smartphones locally.

"India is a priority market for Pixel



smartphones, and we're committed to bringing the best of our hardware and underlying built-in software capabilities to people across the country," Osterloh said.

No details on how many smartphones will be manufactured or where factories will be located were immediately available. ♦

Courtesy: Reuters

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Paramount to increase global armoured vehicle development and production through India-based manufacturing hub

Paramount, the leading global aerospace and technology company headquartered in the UAE, recently announced a broadening of its development and manufacturing partnership with Indian industrial conglomerate, Bharat Forge Ltd. and Kalyani Strategic Systems, to produce a wider range of armoured vehicles in India for Paramount's global customers.

The existing industrial partnership between Paramount and India-based engineering and technology conglomerate Bharat Forge Ltd. and its subsidiary, Kalyani Strategic Systems, has to date resulted in the successful development and production of large volumes of the locally-made KM4 armoured vehicles for the Indian Army.

Announced at the London-based Defence and Security Equipment International Conference (DSEI 2023), the companies are looking to leverage the strong industrial capabilities and engineering excellence of the Kalyani Strategic Systems to develop and manufacture armoured vehicles for Paramount's global customers, in step with Paramount's continued global expansion and production strategy.



Paramount Global CEO Steve Griessel stated, "The global armoured vehicle market is undergoing a monumental shift and within such a dynamic environment, our partnership with Kalyani Strategic Systems has become ever more strategic. We are excited to broaden our partnership to include the development and production of 4x4 and 6x6 Infantry Combat Vehicles for customers around the world. We are very proud that our partnership is growing from strength to strength."

Neelesh Tungar, President - Defence, Bharat Forge Ltd., expressed,

"We, at Kalyani Strategic Systems, have come a long way in developing and scaling up our manufacturing of world-class defence platforms and reliable specialist vehicle platforms with our deep technical and industrialization expertise. This continuing and growing partnership with Paramount substantiates the fact that the world considers India being ready to be "the manufacturing capital" for the global defence industry. We are committed to take this successful partnership to further greater heights, supporting the ability of Paramount to serve its global customers." ♦

Tesla considering \$1.9 billion component sourcing from India: Piyush Goyal



Piyush Goyal

US-based electric vehicle maker Tesla is looking to source components worth around USD 1.9 billion this year

against USD 1 billion last year, Commerce and Industry Minister Piyush Goyal informed.

The minister said that going forward, demand for electric vehicles will increase and it will help in pushing the growth of the sector. "Tesla already last year bought one billion dollars of components from I think all of you sitting here.... I have the list of companies who supply to Tesla. This year, their target is nearly USD 1.7 billion or USD 1.9 billion what they mentioned," he said at an event of auto component makers in New Delhi.

He added that the demand gap between electric vehicles and other

vehicles has reduced and "narrowed quite significantly".

Earlier, the government had stated that it is not looking to frame a separate policy for providing incentives to Tesla, and the company can apply to avail support measures under existing schemes like PLI for auto and advanced chemistry cells.

The government has rolled out the production-linked incentives (PLI) schemes for advanced chemistry cell (ACC) battery storage with an outlay of INR 18,100 crore and INR 26,058 crore PLI scheme for auto, auto-components and drone industries. ♦

Courtesy: PTI News
Image Courtesy: Press Information Bureau



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Raymond Group to acquire 59% stake in Maini Precision for INR 682 crore

Raymond Group recently announced the acquisition of 59.25% stake in Maini Precision Products (MPP) for INR 682 crore. The company will fund the deal through a mix of debt and internal accruals. "This acquisition is a strategic move to further strengthen Raymond's existing engineering business with a complementing business that has presence in sectors like aerospace, electric vehicles (EV) and defence," the company said in its release.

The acquisition will be concluded through Ring Plus Aqua, a subsidiary of JK Files and Engineering. Post the acquisition, Raymond will consolidate the businesses of JK Files, RPAL and MPP, and will form a subsidiary, Newco, where Raymond will hold 66.3%. Newco will focus on precision engineering products.

"With this acquisition, Raymond's engineering business will emerge as a large-scale provider of engineering, automotive, EV, aerospace and defence components," the company said.

"This acquisition will catapult the growth of our engineering business and will open new vistas to us for our foray into rapidly growing segments. Raymond Group has always believed in the 'Make-in-India' initiative and this acquisition will also provide an impetus to the China-plus-one strategy that has been benefiting



us. These are growing sectors with visible momentum presenting us with ample opportunities to leverage. I am pleased to welcome Gautam Maini, founder of MPP, to the leadership team of our engineering business, and we will significantly benefit from his domain expertise and his vast experience," said Gautam Hari Singhania, Chairman and Managing Director, Raymond. MPP has 11 manufacturing

facilities in India across two verticals – aerospace, which comprises precision products manufactured for aerospace and defence, and automotive and industrial, that comprises precision products for clean internal combustion engines, fuel injections and transmissions, EV components, hydraulics and industrial as well as agriculture.

Gautam Maini, Founder of MMP, said: "I am delighted to lead Raymond's consolidated engineering business. This strategic merger represents the harmonious integration of our diverse strengths. Leveraging our core competencies, this partnership will usher in myriad opportunities for rapid growth and expansion, affording us a competitive edge in both international and domestic markets." InCredMAPE, the investment banking arm of InCred Capital, acted as the exclusive M&A advisor on the transaction. ♦

Courtesy: Business Standard

CSIR-NIIST, HAL sign MoU to strengthen indigenisation in aerospace sector

Kerala-based CSIR-National Institute for Interdisciplinary Science and Technology (CSIR-NIIST) recently signed an MoU with Hindustan Aeronautics Ltd. (HAL), Bengaluru, for a collaboration in the nation's aerospace and defence sectors, NIIST said.

NIIST said that it would be collaborating with HAL on strengthening the indigenisation and import substitution programme for the nation's aerospace and defence sectors, as envisioned by the 'Aatmanirbhar Bharat' initiative.

The MoU, signed and exchanged in Bengaluru, involves the development of magnesium and aluminium alloy castings and deals with related areas for the aerospace and defence sectors, it said in the release. The Memorandum of Understanding (MoU) was signed in the presence of senior scientists and officials from both the organisations, the release said. "The MoU facilitates CSIR-NIIST to collaborate on human resource utilisation, facility utilisation, technology support services, consultancy services and



Image Courtesy: CSIR NIIST/ Facebook

collaborative research works in the field of light alloys, for the design and development of aerospace components and welding. The specific areas of collaboration include manufacturing of aeronautical grade magnesium alloy castings using low-pressure casting (LPC) process, design and development of filler materials for salvage welding of aluminium and magnesium alloy castings and other areas of research of mutual interest," it said. ♦

Courtesy: PTI News

Škoda Auto Volkswagen India inaugurates Parts Expedition Centre in Pune, to facilitate parts exports to ASEAN region

Škoda Auto Volkswagen India Private Limited (SAVWIPL) has inaugurated its Parts Expedition Centre (PEC) at the Volkswagen Group's Headquarters in Chakan, Pune. This 16,800-square metre facility is set to accelerate the company's export operations in the ASEAN region, starting with Vietnam from 2024. The made-in-India kits will be shipped from India to Vietnam for final production.

Andreas Dick, Škoda Auto Board Member for Production and Logistics, said: "With the opening of the Parts Expedition Centre, we are building a bridge between India and Vietnam and setting the stage to unleash significant synergies between these



Volkswagen India Private Limited, commented: "This year marked the 600,000th car export for Škoda Auto Volkswagen India Private Limited from India. We have been serving key international markets from India, which is a testament to our engineering capabilities. The establishment of the Parts Expedition Centre represents a strategic advancement in our export capabilities. This facility combines modern

two key markets. While Vietnam will be the first phase, the PEC is geared to serve several emerging markets in the ASEAN region in the future."

Piyush Arora, Managing Director & CEO of Škoda Auto

infrastructure and sustainability, allowing us to cater more effectively to emerging markets. At the same time, we will carry on with our vision of making sustainable, quality mobility accessible worldwide." ♦

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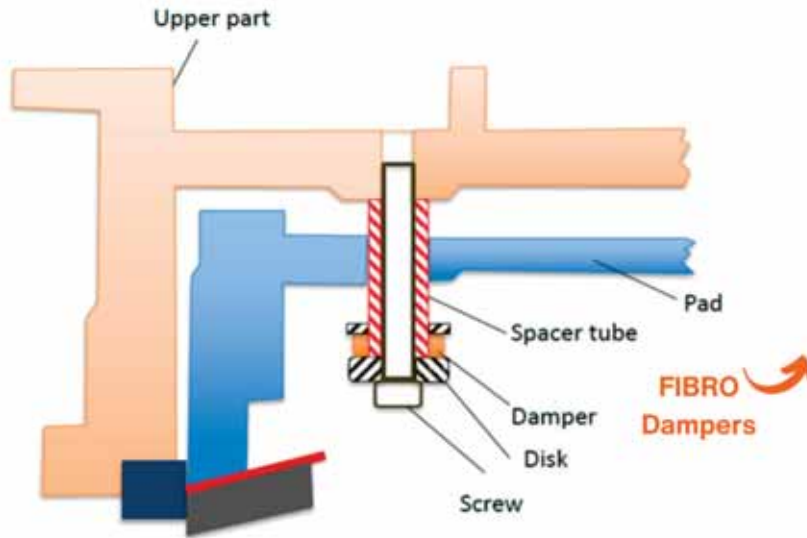
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Cimatron 2024 Integrates Sandvik Coromant CoroPlus® Tool Library Add-In

Cimatron, the leading CAD/CAM software supplier for the mould & die industry has announced the integration of the Sandvik Coromant CoroPlus® Tool Library for Cimatron 2024.

The integration of the CoroPlus® Tool Library allows users of Cimatron to define tool assemblies and the relevant cutting conditions and import the data directly into Cimatron 2024, providing a significant productivity boost for customers.

The CoroPlus® Tool Library unlocks the power of Sandvik Coromant and makes intelligent tool recommendations based on factors such as material, operation, and tool type. By utilising 3D tool models and recommended cutting data, users can optimise the machining process without running the risk of multiple manual data entries. The cloud-based nature of the tool library means that users of Cimatron 2024 can access



data from anywhere with an internet connection, making it invaluable for organisations implementing company standards, or users who work remotely or across multiple locations.

Tobias Unosson, Product Manager at Sandvik Coromant highlights the transformation this integration brings, stating, "Here, at Sandvik Coromant, we have access to the world's leading metal cutting know-how. By leveraging the power of CoroPlus Tool Library, we are making tooling selection and cutting data readily accessible, making life so much easier for users of Cimatron." ♦



HARVI IV requires no stops for tool changes, increasing productivity for customers

Kennametal Inc. recently announced that it has expanded its bestselling and best-performing line of HARVI™ Solid Carbide End Mills with a new 8-flute design option that requires zero stops for tool changes. The new HARVI™ IV 8-Flute End Mill is a high-performance and versatile solution for machinists in aerospace and defence, medical, energy and general engineering applications that require maximum output when cutting a range of difficult-to-machine materials.

"Our first 8-flute end mill will move customers from one challenging cut to the next without having to stop for tool changes," said Scott Etling, Vice President of Marketing, Global Product Management. "Machinists need to achieve

high productivity when working on tougher materials while remaining cost-effective. Our new HARVI IV 8-Flute End Mills deliver just that and were designed especially for roughing and finishing applications that requires a combination of flexibility and safe processing."

While similar products often work on one type of material, HARVI IV 8-Flute End Mills' innovative design provides versatility that supports cutting across difficult applications like high-temp alloys, stainless steels, steels and hardened materials. Its design also delivers higher metal removal rates and process stability with an internal coolant supply that clears away chips even in deep cavities.

The launch of the new HARVI IV 8-Flute End Mills coincides with Kennametal's newly announced stainless steel, titanium and other high-temp alloys end milling grade KCSM15A. This innovative coating technology provides extended tool life for users and the best wear resistance in Kennametal's history of solid carbide end milling. ♦

Mastercam announces new add-on for additive manufacturing



Mastercam, the world's leading CAD/CAM software, has announced a new add-on product, Mastercam APlus® by CAMufacturing Solutions, which was designed for Additive Manufacturing (AM). APlus can be used with Mastercam Mill, Lathe, or Router licences. Using the same interface Mastercam users are familiar with, APlus customers can program, backplot, and simulate their 3D printing scenarios just like they would with traditional toolpaths in Mastercam.

APlus uses Direct Energy Deposition (DED) and has toolpaths developed specifically to handle any geometry in AM, as well as features and utilities designed to remove uncertainty out of the process and to improve efficiency. Hybrid manufacturing provides users with the versatility to build parts from scratch, add features to an existing part, or to repair a worn or damaged part. APlus integrates seamlessly with Mastercam to allow users to generate AM toolpaths, as

well as visualise the additive and machining outcome.

Kenneth Fortier, Technical Product Manager, Mastercam, says: "APlus brings Additive Manufacturing to the Mastercam user in a form that is consistent with the workflow used for over 40 years. Direct Energy Deposition is making its way into many machine shops and being able to program hybrid machines or dedicated additive machines using Mastercam makes the transition seamless. With the hybrid process of alternating adding material and milling allows parts with internally machined features to be created that would have been impossible without additive."

Since Additive Manufacturing is not simply reversing machining toolpaths, all features and toolpaths are designed and developed to ensure users experience efficient and practical results for the additive and hybrid manufacturing process. ♦



In an increasingly competition-oriented industry, it is of major importance for companies to optimise their manufacturing processes and reduce bottlenecks.

It generally occurs in an injection moulding company, over the course of time, that the number of injection moulding tools builds up significantly and, after the production of a batch, the moulding tool is put into storage. When it is needed the next time, it is essential to know quickly and exactly where to find it in order to prevent a long search and perhaps production bottlenecks as a result.

HASCO's innovative Mould Track System offers an intelligent solution with precise indoor localisation technology for the injection moulding sector. HASCO once again sets the standard in terms of efficiency and productivity. The key to the success of Mould Track lies in the highly modern technology. Through the integration of precise ultra-broadband radio modules and an intelligent software platform, Mould Track offers a localisation

HASCO Mould Track for precise indoor localisation of injection moulding tools

accuracy of down to a few centimetres. With robust algorithms, the system enables the exact tracking and localisation of injection moulding tools indoors.

The advantages for the injection moulding sector are considerable, providing a significant advantage over the competition: The system enables the exact tracking of injection moulding tools in real time and the digital interlinking of processes. Bottlenecks can thus be reduced and resources used more efficiently. The precise tracking of the moulds allows improved production planning. This enables companies to optimise the use of moulding tools and reduce throughput times.

Fast and easy location detection can eliminate superfluous downtimes. Valuable time no longer has to be invested in the search for moulds.

Through the exact tracking and localisation of the moulds, it is ensured that they are used at the right place at the right time. Mould Track enables fast setting-up of injection moulding machines because the exact position of the moulds is known. This means that companies can respond more flexibly to customer requirements and make optimum use of the production capacities.

With its new Mould Track, HASCO offers an intelligent pioneering solution and thus once again defines the standard with increasing digitalisation in the world of mouldmaking. ♦

Simulation strategies to optimise tool & die mould performance

Tool and die moulds are essential components in the manufacturing industry. They play a pivotal role in the production of a wide range of products — from intricate metal parts to complex plastic components. These moulds are at the heart of manufacturing processes, and their precise design and performance are critical to achieving high-quality end products. This article delves into the definition and importance of tool and die moulds, as well as explores the various types of moulds used in the manufacturing sector.

Sudhanshu Nayak

The importance of tool and die moulds in manufacturing cannot be overstated. They serve as the moulds and dies for various processes, including injection moulding, die casting, stamping, and extrusion. The moulds are crucial for maintaining product consistency, quality, and repeatability. They ensure that every part or component produced adheres to precise specifications, eliminating variations and defects.

Challenges across the tool and die mould design

Due to the complex nature of tools and die, several challenges and high levels of precision are required during its manufacturing. Some of the key challenges include:

- ▶ **Precision and tolerance requirements:** Tool and die moulds must meet tight precision and tolerance requirements. Even small deviations can result in defects in the final product. Achieving and maintaining these tight tolerances is a significant challenge.
- ▶ **Complex geometries:** Many modern products have complex shapes and features. Designing moulds to produce these intricate parts can be challenging, requiring innovative solutions to ensure uniform filling, cooling, and ejection of the moulded parts.
- ▶ **Durability and longevity:** Tool



Image Courtesy: TopSolid SaS

and die moulds are subjected to repeated stress and wear during their operational life. Ensuring their durability and longevity is a continuous challenge, particularly when manufacturing high volumes of products.

- ▶ **Cooling system design:** Efficient cooling is crucial in preventing defects and achieving uniform mould temperatures. Designing an optimal cooling system to control temperature gradients and prevent warping is a challenge.
- ▶ **Mould flow control:** In processes like injection moulding, controlling the flow of molten material within the mould is essential to prevent defects like air traps, weld lines, and warping. Ensuring a smooth and uniform flow is challenging. Meeting these challenges often requires a combination of advanced design tools, materials science, process optimisation, and a deep understanding of the specific manufacturing processes involved. Collaboration between design

engineers, materials experts, and manufacturing specialists is crucial to overcome these challenges and achieve high-quality tool and die mould performance.

What is simulation? How does it work?

Simulation is a technique that uses computers to create a virtual model of a real-world system or process. This model is then used to predict and analyse how the system or process would perform under different conditions, scenarios, or inputs. Simulation allows us to experiment with a virtual representation of reality, providing insights and data without the need for physical experimentation.

Simulation begins with model development, where a representation of the system is constructed using equations, algorithms, and rules that describe how its components interact. Input data, which includes parameters, initial conditions, and boundary conditions, is then provided to define the starting point and constraints for the simulation. The simulation model is executed on a computer or specialised software, involving complex mathematical calculations that can include solving differential equations and using numerical methods. Once the simulation is complete, the results are analysed to gain insights into the system's behaviour under different scenarios. It is crucial to validate and verify simulation models by

comparing their results to real-world data and ensuring the software functions correctly.

Why is simulation important for tool and die performance?

Simulation plays a crucial role in optimising tool and die mould performance for several reasons. Let's take a look at some of them:

- ▶ **Error reduction and defect prevention:** Simulation allows engineers to virtually prototype tool and die moulds, enabling them to identify and rectify design flaws and performance issues before physical production. By simulating the manufacturing process, engineers can pinpoint potential errors and defects, reducing the likelihood of these issues occurring in real-world production. This results in a significant reduction in costly and time-consuming trial-and-error processes.
- ▶ **Quality improvement:** High precision and consistent quality are essential in manufacturing. Simulation helps achieve this by predicting and preventing defects and errors in the manufacturing process. It provides insights into how the mould design, material selection, and production parameters can affect product quality, ensuring that each part or component meets the desired specifications.
- ▶ **Cost and time savings:** Traditional methods of trial-and-error in mould design and production can be

expensive and time-consuming. Simulation allows for design optimisation and process fine-tuning in the digital realm, reducing the need for physical prototypes and iterations. This not only saves time but also significantly lowers production costs.

▶ **Material selection and performance prediction:**

Simulation can assist in the selection of the most appropriate materials for tool and die moulds by analysing material properties and their impact on performance, durability, and cost. This ensures that the chosen material aligns with the specific requirements of the manufacturing process and the expected wear and tear the mould will experience.

▶ **Cooling system optimisation:**

Efficient cooling is crucial in mould performance. Simulation can help designers determine the optimal cooling channel layout, cooling fluid flow rates, and temperature control. This optimisation enhances the mould's longevity and minimises thermal stress, reducing the risk of warping and defects in the final product.

▶ **Predicting mould flow:**

In processes like injection moulding and die casting, it's essential to predict how molten material flows and solidifies in the mould. Simulation provides insights into this flow behaviour, helping to identify potential issues like air traps, weld lines, and warping. Design adjustments can be made to optimise the flow and reduce defects.

▶ **Performance prediction:**

Simulation can evaluate the stress, strain, and thermal behaviour of the mould during operation. This ensures that the mould can withstand the manufacturing process without deformation or failure, leading to longer mould life and higher product consistency.

In summary, simulation

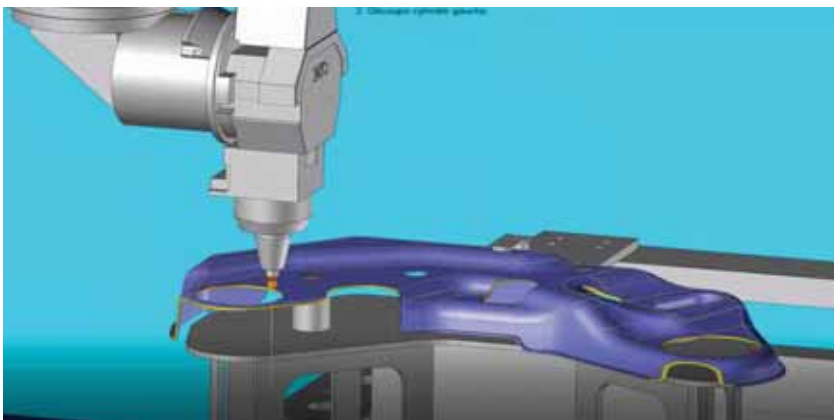


Image Courtesy: TopSolid SaS

is important for tool and die performance because it offers a cost-effective, efficient, and data-driven approach to design, analyse, and optimise these critical components in manufacturing. By simulating various scenarios and variables, engineers and designers can fine-tune the moulds, enhance product quality, and reduce production costs, ultimately leading to better overall performance and competitiveness in the market.

Design optimisation through simulation

Design optimisation through simulation is a critical approach in enhancing the performance of tool and die moulds. It harnesses the power of CAD and engineering simulation software to refine mould designs and predict their performance under various conditions. Two key components of this approach are virtual prototyping and stress and thermal analysis, which play pivotal roles in improving tool and die performance.

Virtual prototyping is a process wherein a digital representation of the tool and die is created and subjected to simulations. This allows engineers to experiment with design changes, material selections, and other variables without the need for physical prototypes. The benefits of virtual prototyping include rapid design iterations, substantial cost reductions by minimising physical prototypes, risk mitigation through early issue detection, and the optimisation of various mould features, such as cooling channels, gating systems, and ejection mechanisms. This results in better-performing moulds and enhanced product quality.

Stress and thermal analysis are vital aspects of simulation that assess how tool and die moulds respond to mechanical and thermal loads during the manufacturing process. Stress analysis evaluates the structural integrity of the mould under forces such as mechanical loading, part



Both Images Courtesy: Mastercam

ejection, and clamping forces. It identifies areas of high stress and deformation, enabling engineers to reinforce critical regions and ensure the mould's ability to withstand the production process without failure. Thermal analysis, on the other hand, simulates heat transfer within the mould, which is particularly important in processes like injection moulding and die casting. It assesses temperature distribution, heat dissipation, and the impact of thermal cycling on the mould's material. By optimising the cooling system and insulation, engineers can prevent thermal stress, warping, and material degradation.

Collectively, virtual prototyping, stress analysis, and thermal analysis provide a holistic understanding of a tool and die mould's performance under real-world conditions. These simulations empower engineers to make informed design decisions, resulting in moulds that are not only structurally robust but also capable of producing high-quality components with minimal defects. Design optimisation through simulation ensures that tool and die moulds are finely tuned for efficiency, longevity, and consistency in manufacturing processes.

Future trends

The future of tool and die mould performance optimisation is set to be shaped by two key trends: advancements in artificial intelligence (AI) and machine learning, and the integration of simulation with Industry 4.0 technologies. AI and machine learning are poised to

revolutionise the field, offering optimised mould designs, real-time decision-making, predictive maintenance, quality control, and process optimisation. AI-driven simulations will adapt and respond dynamically to changing manufacturing conditions, leading to higher efficiency and product quality. Machine learning will play a crucial role in predictive maintenance, ensuring the timely upkeep of moulds, thus reducing unplanned downtime.

Moreover, the integration of simulation with Industry 4.0 technologies is set to transform manufacturing by leveraging digital tools and data-driven processes. The Internet of Things (IoT) will enable real-time data collection from sensors embedded in moulds, facilitating performance adjustments as conditions change. Digital twins, which are virtual replicas of physical moulds, will continually update with real-world data, resulting in more accurate and dynamic simulations. Big data analytics will unlock insights for optimising tool and die mould performance and predicting maintenance needs. Cloud computing will make simulations more accessible and collaborative, while cyber-physical systems will enable seamless communication and control, creating adaptive manufacturing processes that respond to real-time feedback from simulations. In conclusion, these trends promise to enhance efficiency, quality, and sustainability in manufacturing, all while reducing costs and time-to-market for new products. ♦

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Advancements in injection moulding technology

Injection moulding technology is undergoing significant changes and trends, including the adoption of Industry 4.0 principles, the utilisation of 3D printing for creating moulds, the development of new materials such as bio-based plastics and composites, the application of nanotechnology to improve part properties, increased automation and robotics, and the use of digital tools to reduce production time. Keeping up with these innovations is crucial for success in manufacturing, offering improved efficiency, cost-effectiveness, and sustainability. Companies that embrace these advancements will be better equipped to address the demands of the modern manufacturing landscape and satisfy consumer and environmental requirements.

Sudhanshu Nayak

Injection moulding is a pivotal manufacturing process that holds a prominent place in the world of production. It involves the creation of parts and products by injecting molten material into a carefully crafted mould. The beauty of injection moulding lies in its remarkable versatility – it is not limited to plastics alone but can handle an array of materials, including thermoplastics, thermosetting polymers, elastomers,

and even some metals. This adaptability makes it indispensable across diverse industries, from automotive and aerospace to consumer goods and healthcare.

What sets injection moulding apart is its capability to deliver precision and complexity. It can craft intricate, finely detailed parts with remarkable accuracy. From simple components like bottle caps to intricate medical devices and automotive parts, the possibilities

are nearly limitless. This process is an industry favourite for mass-producing identical components due to its high precision and repeatability, making it an economically sound choice for large-scale production. It's also incredibly flexible in terms of design. You can create parts with varying thicknesses, shapes, textures, and even incorporate overmoulded components. Moreover, injection moulding is incredibly eco-friendly, generating minimal waste, as any

excess material is often recyclable.

Now, let's delve into why staying updated with the latest advancements in injection moulding technology is important. It all boils down to maintaining a competitive edge. As technology advances, embracing these innovations can give companies the upper hand, enabling them to produce higher-quality products with enhanced efficiency and cost-effectiveness, ultimately increasing market share. These advancements often translate into reduced production costs, enhancing profit margins.

Quality and consistency see marked improvements with new technologies. In industries with strict quality standards, like medical devices or aerospace, these developments are particularly vital. More importantly, environmental concerns have brought sustainability to the forefront. Staying current with eco-friendly materials and reduced energy consumption is crucial.

Regulatory compliance, too, is a driving factor. Many industries are subject to ever-changing regulations, and staying updated ensures products meet new standards. Innovation and product development benefit greatly from advancements in injection moulding, opening up possibilities for previously unimaginable products. Lastly, these innovations streamline the production process, reduce lead times, and improve overall efficiency, enabling faster product development and delivery to market. Staying informed about the latest in this field is pivotal for businesses aiming to remain competitive and agile in an evolving manufacturing landscape.

Advancements in injection moulding technology



Industry 4.0 integration:

Injection moulding machines are now part of the Industry 4.0 trend, which is all about making manufacturing smarter. These

machines are becoming more connected. It means they can talk to each other and share data. The benefits of this are significant. Being able to watch your machines in real-time, like tracking their temperature, pressure, and how the materials are flowing. This helps you spot problems early and fix them before they cause defects. Connected machines are also more efficient. They can adjust how much energy they use, reducing power bills. And if something goes wrong, you can often fix it remotely. Moreover, with all the data these machines collect, you can make better decisions. You can see trends, predict issues, and even customise your machines for different jobs. It's like having a super-smart assistant to help you run your manufacturing business.



Additive manufacturing and hybrid processes:

The integration of additive manufacturing technologies with injection moulding is a game-changer for the manufacturing industry. It involves using 3D printing to create moulds or even mould inserts. These 3D-printed moulds offer greater design flexibility and allow for rapid prototyping. This is incredibly valuable because it means that manufacturers can quickly test and refine designs before committing to expensive steel moulds. Additive manufacturing can also be used to create complex cooling channels within the moulds, improving the efficiency and quality of the injection moulding process. Traditional injection moulding materials have long been known for their reliability and durability, and this is where their synergy with additive manufacturing truly shines. Complex, customised parts can be manufactured using high-quality materials that meet specific performance requirements. This approach not only ensures that the parts are strong and durable but also allows for intricate, tailor-made designs that might be impractical with other manufacturing methods.



Materials Innovation:

The development of new materials, particularly bio-based plastics and composites, represents a significant step forward in the field of manufacturing. Bio-based plastics are derived from renewable resources like cornstarch or sugarcane, offering a sustainable alternative to traditional petroleum-based plastics. Composites, on the other hand, are materials made by combining different substances to create a material with improved properties. These innovative materials play a vital role in enhancing sustainability in manufacturing.

The importance of these new materials lies in their ability to improve the overall ecological footprint of various industries. These materials are biodegradable or compostable, addressing the issue of plastic waste in our environment. Composites, when engineered effectively, can lead to lightweight yet highly durable products. This means that less material is needed, reducing energy consumption and waste in the production process.

In essence, the development and utilisation of these new materials not only drive innovation but also contribute significantly to a greener and more sustainable manufacturing industry.



Nanotechnology:

The implementation of nanomaterials to enhance the properties of moulded products is a compelling and innovative development in the field of manufacturing. Nanomaterials are engineered at the nanoscale, which is at the molecular or atomic level. When incorporated into the moulding process, these materials can significantly improve the strength and performance of the moulded parts. This is due to their extraordinary properties at the nanoscale, such as increased strength, enhanced electrical conductivity, improved thermal resistance, and even unique

optical characteristics.

Nanomaterials are capable of reinforcing the mechanical properties of moulded products, making them stronger and more durable. The high surface area of nanomaterials allows for better adhesion and dispersion within the polymer matrix, leading to improved material homogeneity and overall performance. Nanotechnology is playing a pivotal role in advancing the capabilities of moulded products, making them more resilient, efficient, and versatile than ever before.



3D-printed moulds: The use of 3D printing for mould creation has had a profound impact on rapid

prototyping and design changes in manufacturing. Traditionally, mould fabrication involves a time-consuming and costly process of machining moulds from materials like steel or aluminium. 3D printing, however, offers a faster, more cost-effective alternative. It allows manufacturers to rapidly produce moulds, or even mould inserts, by depositing layers of material, typically plastic or resin, according to a digital 3D model. This streamlined approach to mould creation has several significant advantages. First and foremost, 3D-printed moulds can be produced in a fraction of the time it takes to manufacture traditional moulds. This means that designers and engineers can quickly iterate on product designs and test different versions. Rapid prototyping, the process of creating physical prototypes for testing and evaluation, becomes significantly faster and more cost-efficient. Design changes, modifications, and refinements can be implemented with ease, which is crucial for industries that require quick adaptation to market demands or where product design complexity is high.



Automation in injection moulding: Automation has become integral to the entire injection moulding process, from raw material handling



Image used for representation only. Courtesy Envato Elements.

and preparation to part ejection and quality control. These robotic systems perform tasks with speed and precision, leading to a range of benefits, with improved efficiency and reduced labour costs at the forefront. Automation enhances efficiency in injection moulding by significantly reducing cycle times. Robots can perform tasks such as part removal and placement with remarkable speed and consistency, eliminating the need for human operators to perform these repetitive, physically demanding actions. This, in turn, allows for continuous, round-the-clock production, minimising downtime, and increasing overall machine utilisation. Automation improves process control and repeatability, resulting in a reduction in defects and waste.



Reduced lead time: Digital tools and automation are playing a pivotal role in reducing

lead times in the injection moulding industry. These advancements streamline various aspects of the manufacturing process, resulting in significant time savings from design to final product delivery. One of the key ways this is achieved is through computer-aided design (CAD) and simulation software. These tools enable designers to create and refine moulds digitally, significantly shortening the product development cycle. Additionally, the use of automation in mould making and part production ensures a faster and more consistent manufacturing process.

The benefits of quicker product development and production are substantial. Shorter lead times mean

that manufacturers can bring their products to market faster, gaining a competitive edge. This speed is especially valuable in industries with rapidly changing consumer demands or where being the first to market is crucial. It allows for more agile responses to market changes and product improvements, increasing overall customer satisfaction. In a nutshell, digital tools and automation are not only reducing lead times in the injection moulding industry but also delivering tangible advantages in terms of competitiveness, cost-efficiency, and customer satisfaction.

Staying updated is key

Injection moulding technology is witnessing several key advancements and trends. These include the integration of Industry 4.0 principles, the use of 3D printing for mould creation, the development of new materials like bio-based plastics and composites, the application of nanotechnology to enhance part properties, the growing role of automation and robotics, and the use of digital tools to reduce lead times. Staying updated with these innovations is of paramount importance in the manufacturing industry.

In a rapidly evolving manufacturing landscape, staying updated with these innovations is the key to not only maintaining competitiveness but also achieving higher efficiency, cost-effectiveness, and sustainability. Companies that embrace these advancements will be better positioned to meet the challenges of the modern manufacturing world as well as meet the needs of consumers and the environment. ♦

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'Let's reconsider our approach to engineering and innovation'



“Embrace openness and a continuous learning mindset. While I've witnessed numerous innovative technologies and developments in the tooling industry, there's a gap in seamlessly integrating two or three technologies to address significant engineering challenges—a convergence that I haven't seen extensively in India. Driving innovation and engineering involves the timely adoption of tools like Moldflow or digital twin and the strategic marriage of various technologies to craft effective solutions,” says **Mr. Ramesh K. S., Sr. Vice President - Engineering & Manufacturing, Ather Energy**, during a conversation with **Nishant Kashyap**.

Q. What is Ather Energy all about? Please tell us about Ather Energy's activities, specifically discussing the company's tooling-related activities.

Ather, founded by two IIT Madras graduates, Tarun Mehta and Swapnil Jain, is marking its tenth anniversary in 2023. The venture originated at IIT Madras under the name Ather Energy, initially conceptualized as an energy company utilizing lithium-ion-based batteries.

The initial five years were dedicated to product development, leading to our market debut in 2018. Our growth has been continuous, starting from Bangalore and expanding into Chennai, reaching a nationwide presence with approximately 150 outlets. As a testament to our commitment to accessibility, we have become the leading provider of fast charging, boasting of over 1500 fast charging outlets across the country.

In terms of tooling, it's important to note that all our required toolings are sourced from India. However, while the tools themselves may not all be domestically manufactured, we strive to keep the production within the country. For instance, some tools used by our lamp suppliers are imported, mainly from China, Taiwan, or Korea. Despite our preference for local sourcing, certain tools, particularly in the lamp industry, still see indirect imports.

Specifically addressing lamps, an area where India continues to import tools, there's a recognition of this challenge. However, it's essential to highlight that the majority of our tools, around 80%, including those for casting and plastic, are locally produced. Although there are exceptions, such as the import of special tools like sintering tools, the positive trend in the industry is towards increasing indigenous tool manufacturing.

Q. Recently, news of BIS approving Ather-developed connector as the new charging standard for light EVs in India was doing the rounds. Also, Mr. Tarun Mehta, the company's Co-founder, stated in a recent interview that Ather has one of the largest teams of R&D engineers globally. Can you please elaborate on your R&D efforts in developing high-performance vehicles?

As mentioned earlier, our journey began in 2013, and it wasn't until 2018 that we introduced our product to the market. During the initial five years, our focus was on extensive research and development, encompassing the creation of every component in-house through ground-up engineering. Every part of the Ather vehicle is meticulously engineered in India by our dedicated teams, making us home to the largest engineering teams for two-wheelers in the country.

The size of our team is attributed to the comprehensive development of our scooter and the entire ecosystem surrounding it, including hardware, software, and mechanical engineering. This integrated approach ensures a holistic and homegrown solution.

Regarding the charger you mentioned, we've pioneered a unique AC-DC combined charger. Notably, India lacked a standard for charging connectors, prompting our collaboration with the government to

establish our connector as the Indian standard. Despite holding a patent for this technology, we have opted to make it accessible to all other Original Equipment Manufacturers (OEMs). In essence, we have opened up the patent, allowing everyone in the industry to utilize this connector technology for the benefit of the electric vehicle ecosystem.



The evolution of EVs is transforming traditional vehicle manufacturing methods. For instance, companies like Tesla employ techniques such as giga casting to produce the outer body of the car and I see many car makers will follow the same. This shift benefits toolmakers, as innovative manufacturing processes create new demands.

Q. Based on your years of experience in the automotive industry, what would you say are the unique challenges and opportunities in the tooling division when working within the EV industry compared to traditional automotive manufacturing?

First and foremost, it's crucial to recognize that producing electric vehicles (EVs) involves more than simply replacing the engine with a battery pack. The integration of increasing amounts of electronic software into vehicles is a significant aspect, contributing to enhanced user experiences. The primary challenge lies in optimizing every aspect of the vehicle and refining the manufacturing process for improved sustainability.

The second challenge revolves around achieving lightweight designs for the vehicles. Our goal is to minimize the vehicle's

weight, maximizing the potential range for users. Considering that approximately 35% of the Bill of Materials (BOM) is attributed to the battery, it is imperative to reduce the overall weight. Our initial battery platform addresses this by incorporating a complete aluminium body, an aluminium chassis, and outer body parts made of engineering plastic. The use of engineering plastic not only reduces weight but also offers opportunities for introducing unique features and diverse styling in the body panels. This approach increases the reliance on plastics, creating more opportunities for plastic tool suppliers.

The evolution of EVs is transforming traditional vehicle manufacturing methods. For instance, companies like Tesla employ techniques such as giga casting to produce the outer body of the car and I see many car makers will follow the same. This shift benefits toolmakers, as innovative manufacturing processes create new demands. Additionally, our transition from LPDC to HPDC presents numerous opportunities for casting tool suppliers, showcasing the dynamic nature of the EV industry.

Q. At Ather, what specific factors are considered when sourcing tools and dies for your production requirements? What are the key evaluation factors before finalising the tool room for any project?

Before delving into the topic, I want to dispel a common misconception based on my years of experience: Original Equipment Manufacturers (OEMs) do not solely prioritize the cheapest options. While cost considerations are certainly on the table during sourcing discussions, the emphasis is equally on appreciating quality and timely delivery. Another prevailing myth is that Indian tool rooms cannot match the quality of overseas

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toolmakers, which is also untrue. The competence of Indian tool rooms has significantly grown, enabling them to compete globally in most cases.

Now, turning to the question at hand, we evaluate the strength of the engineering team in tool rooms as a starting point. Factors such as team size, qualifications, experience, and the nature of past projects are fundamental considerations. Additionally, we assess the experience and simulation capabilities of the design team.

In the electric vehicle industry, which is a sunrise sector, everything involves ground-up design rather than incremental innovation. Given this, our reliance on first principle-based engineering is substantial, necessitating a strong emphasis on simulation technology. As the industry progresses towards digitalization, with trends like IoT, smart manufacturing, and digital twins shaping the landscape, we encourage our toolmaker partners to delve into and adopt digital twin technology. Creating a digital twin of the tool before its physical counterpart is crucial in our design process.

Infrastructure considerations, such as the machinery, in-house processes, and software capabilities, also play a significant role and are common denominators in our assessment.

Lastly, we've embraced a unique requirement known as concurrent or simultaneous engineering. The shrinking time to bring new products to the market necessitates this approach. Concurrent engineering involves engineering & development stages operating concurrently rather than sequentially, reducing product development time and time to market. This approach aligns with the industry trend, and major players like Mahindra are also adopting

concurrent engineering to enhance productivity and decrease costs.

Q. As demand increases and your production volume goes up, would you set up an in-house tool room or prefer to continue to source it from commercial toolmakers?

Currently, my perspective is based on the present circumstances, but it's important to acknowledge that times and dynamics may evolve.

As of now, my aspiration leans towards establishing a tool room. However, this tool room wouldn't be solely dedicated to meeting the requirements of Ather. I



In the electric vehicle industry, which is a sunrise sector, everything involves ground-up design rather than incremental innovation. Given this, our reliance on first principle-based engineering is substantial, necessitating a strong emphasis on simulation technology.

believe it's not financially viable to claim complete in-house tooling profitability. Moreover, having our own tool rooms might not optimize our resources economically. Instead, the vision for establishing a tool room is geared towards facilitating quick engineering changes and addressing minor corrections. Essentially, the aim is to set up a small-scale tool room for these specific purposes, without intending to compete with or diminish the role of commercial tool rooms in the larger landscape.

Q. Based on your experience of working with toolmakers, what would you say are the fundamental differences of working with

overseas toolmakers versus Indian toolmakers?

I'd like to share insights from my current perspective, and I'll be speaking from my own standpoint. Let's begin with a crucial factor: lead time. Rather than delving into the well-known situation in China with its excess capacity and minimal queuing, I want to shift the focus to Taiwan and Korea.

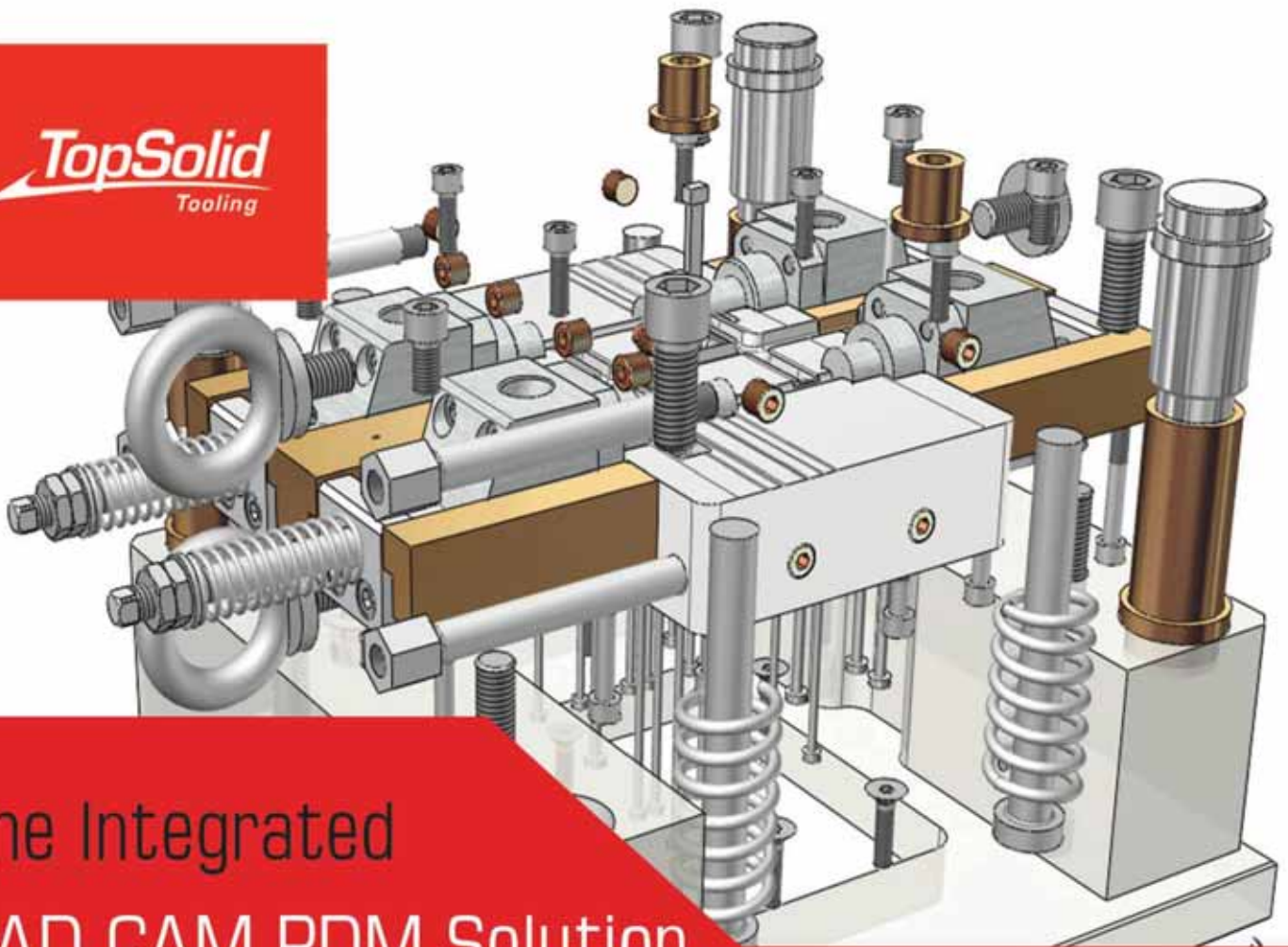
Unlike China, Taiwan and Korea don't enjoy the same economic conditions of surplus capacity, yet they consistently lead in terms of shorter lead times. I've collaborated with small Korean tool rooms, similar in scale to Indian ones, that have demonstrated an impressive ability to significantly reduce lead times.

One notable observation with companies from Taiwan and Korea is their approach to running tool rooms akin to manufacturing units. They prioritize minimizing downtime and ensuring efficient infrastructure utilization, keeping their machines operating at peak efficiency.

In India, the general rule tends to be a lead time of 12-14 weeks, whereas in Taiwan and Korea, the conversation revolves around 8-10 weeks. This significant discrepancy in lead times stands out as one of the most substantial differences between Indian and Taiwanese/Korean tool rooms.

Q. Could you share insights into the specific expectations that Ather Energy has from Indian toolmakers in terms of quality, innovation, and timely delivery to meet the demands of the EV market?

I would like to sincerely request, on behalf of Ather, for greater collaboration during the early stages of the design process. Often, despite the best efforts of the design team, a design may fall short of yielding the desired results when executed. Through our experience



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with the production of Ather 450X, we found significant advantages in collaborative efforts during the early stages. We actively engaged with multiple stakeholders in toolmaking, including toolmakers and raw material suppliers. This collaborative approach proved beneficial in achieving a more satisfying outcome.

As industry peers, I believe there should be a heightened emphasis on collaborative engineering. This approach not only reduces development efforts but also contributes to obtaining superior parts, ensuring better quality, and expediting time-to-market.

The second aspect I'd like to highlight is simultaneous engineering, a practice that accelerates processes and helps identify potential design iterations. This involves initiating work on the design when it's only 60-70% complete. Many companies follow a similar model with a milestone known as the "tool kick-off". At Ather, we have integrated four milestones – tool sourcing kick-off, tool procurement kick-off (initiating the procurement of long lead items), tool design kick-off, and tool cutting kick-off. This structured approach ensures that our tooling partners commence work when our design is at the 70% maturity stage.

It's essential to clarify that the intention is not to exert pressure on toolmakers but rather to involve them collaboratively in our process, aiming for mutually beneficial results.

Q. That's very interesting. To date, how has been your experience of working with Indian toolmakers? What are the kinds of issues you have faced? Could you explain with the help of an example, without naming any company?

Honestly, our experience in India has been positive, and we haven't

encountered any significant challenges. Working with Indian toolmakers has been a good journey for us. I believe that the Indian tooling industry has made substantial progress in recent years, showcasing significant maturity. While we've come a long way, there are still areas where we need to catch up, and that's just part of the ongoing journey.



Often, despite the best efforts of the design team, a design may fall short of yielding the desired results when executed. Through our experience with the production of Ather 450X, we found significant advantages in collaborative efforts during the final stages.

Q. How would you rate the skill set of Indian toolmakers? Are they at par with their global counterparts?

While India boasts of a pool of skilled professionals, one noticeable gap is the scarcity of seasoned toolmakers with 20-25 years of experience. In comparison to Europe or Japan, where many toolmakers have accumulated over two decades of expertise, we observe a gap in India. These seasoned professionals overseas have mastered the art of toolmaking through years of dedicated work—a dimension that currently seems to be less prevalent in India.

Additionally, the challenge of talent retention is one that confronts us collectively. Retaining experienced professionals poses a hurdle that many of us in the industry share. Addressing this challenge and fostering an

environment conducive to the long-term growth and development of skilled toolmakers is crucial for the industry's progress.

Q. What are your top three suggestions for Indian toolmakers?

Let's reconsider our approach to engineering and innovation! Embrace openness and a continuous learning mindset. While I've witnessed numerous innovative technologies and developments in the tooling industry, there's a gap in seamlessly integrating two or three technologies to address significant engineering challenges—a convergence that I haven't seen extensively in India. Driving innovation and engineering involves the timely adoption of tools like Moldflow or digital twin and the strategic marriage of various technologies to craft effective solutions.

Secondly, building a robust talent pipeline is a critical challenge. Tool rooms often face talent drain, as OEMs attract and recruit skilled professionals, leading to a significant industry-wide issue. It's imperative for us to collectively address this concern and devise viable solutions.

The third aspect is driving efficiencies and identifying waste. Implementing lean techniques in the operation of tool rooms is crucial. We must stay vigilant and embrace such methodologies to pinpoint areas for improvement, ultimately aiming for reduced waste and optimal utilization of machines and technologies.

Despite the challenges, I have full confidence that Indian toolmakers are doing commendable work and will continue to thrive in the days ahead. With vast opportunities in India, it's time for us to seize them by enhancing productivity and efficiency across the industry. ♦

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Measuring Components: On the limits of technology



If you've never seen a 30 µm thick drill, you shouldn't worry – nobody can see one without a magnifying glass. Half the thickness of a human hair – that is the scale the company W Präzisionstechnik works on. High-precision five-axis milling machines produce the tiniest components with almost incredible accuracy. Laser-based measuring systems from Blum-Novotest are used for tool setting and breakage detection on sensitive tools.

Helmut Wandinger founded his company back in 1997 to produce machine components on a four-axis machining centre. He quickly made a name for himself thanks to his extremely accurate and small-scale milling work, such as production of micro-nozzles as small as 50 micrometres. Today, six employees work at W Präzisionstechnik and the machinery in use has expanded to a total of six five-axis machines from Chiron, Mikron and Primacon. The range of products manufactured - as is typical for a subcontractor - is as varied as the types of customers involved in sectors such as electrical engineering and medical technology, while parts for adhesive metering systems and laser optical systems are also produced. Apertures, nozzles and

micro-mechanical components sit alongside custom-made products for university research facilities or Fraunhofer Institutes. A short time ago, Wandinger produced metal parts with several hundred recesses, each with a diameter of 30 micrometres; the ball cutter used had a diameter of just 10 micrometres. Even nozzle matrices with almost a thousand holes in the micrometer range are no problem for W Präzisionstechnik.

To maintain the required precision in the micrometer range, significant investment is required. The climate in the production shops is precisely controlled to 0.1 degree Kelvin and the machines are fitted with temperature sensors all the way to the base. If it is very cold outside, the machine base cools down when the machine is turned

off. The machining centre then has to run empty for several hours until the entire system is once again at a uniform temperature level. Wandinger remembers, "In the early days, we had a window in the production shop, and sunlight used to come through the shutters onto one of the machines. This beam of sunlight caused such significant temperature expansion that precision production was out of the question."

Wandinger's precision demands are certainly extreme. "If we were to produce to DIN tolerances, we would have gone out of business a long time ago. We are often operating in tolerance ranges between two and three micrometres - not just for drilling, but for contour milling too." Contactless tool measurement systems from Blum-Novotest are used on all the machines. Wandinger remembers, "At the beginning, we calibrated the tools manually by touch, but even the slightest contact can destroy the tiny tool cutting edges or totally break off the tool, and we quickly moved over to laser systems." Wandinger has been using Blum equipment for 15 years now, initially arriving as part of a Chiron system and impressing from day one.

As the LaserControl measurement systems have to be located in the working space in the machining centres, the optics need to be protected. Blum uses several methods to do this. On the one hand, the laser optics are mechanically protected by a shutter during machining. A pneumatically actuated shutter piston moves in front of the optical inputs and outputs. When the shutter opens for measurement, a sudden blast of air is released to clear the device of dirt and chips. During measurement, a stream of barrier air reliably protects the optics from contamination, for example, caused by drops of coolant being

I am fascinated by how accurately tools can be measured... This has a direct impact on costs. For instance, we once had a workpiece that had to have 960 tiny holes drilled in it. At this diameter, the feed rate is 1.5 millimetres per minute. So if I slow down the movement a tenth of a millimetre too early above the surface of the workpiece when approaching a drilling point, I will be drilling nothing but air for four seconds before the drill actually gets to the workpiece. With 960 holes, this adds up to more than an hour of 'dead drilling'. However, if I have measured the length of my drill to an accuracy of a few micrometres, I can get closer to the surface at high speed, saving lots of time - and ultimately production costs.
- Helmut Wandinger,
Founder, W Präzisionstechnik

thrown off. This enables excellent in-process reliability to be achieved. Unlike other laser measurement systems, the laser beam on the Blum devices is focused, in other words, the beam is extremely thin at a particular point between the laser transmitter and receiver. The models in the Nano NT series reach a beam thickness of just a few micrometres. On unfocused systems with a greater beam thickness, it is possible that the measuring system will "miss" the actual drill when determining the tool length and only detect the significantly thicker shaft. If these incorrect tool values are then used for milling,

when using such small drills a tool breakage and a rejected workpiece are almost inevitable, as in a worst-case scenario the axis may still be moving rapidly when the drill comes into contact with the workpiece. Even if the tool does not break, the wrong length is being used, which results in dimension deviations on the workpiece.

An extremely powerful electronic system, which Blum-Novotest calls "NT technology" allows such fast measurements that each blade on a tool running at its rated speed can be individually monitored for breakage. Even the tiniest breaks and wear to the blade





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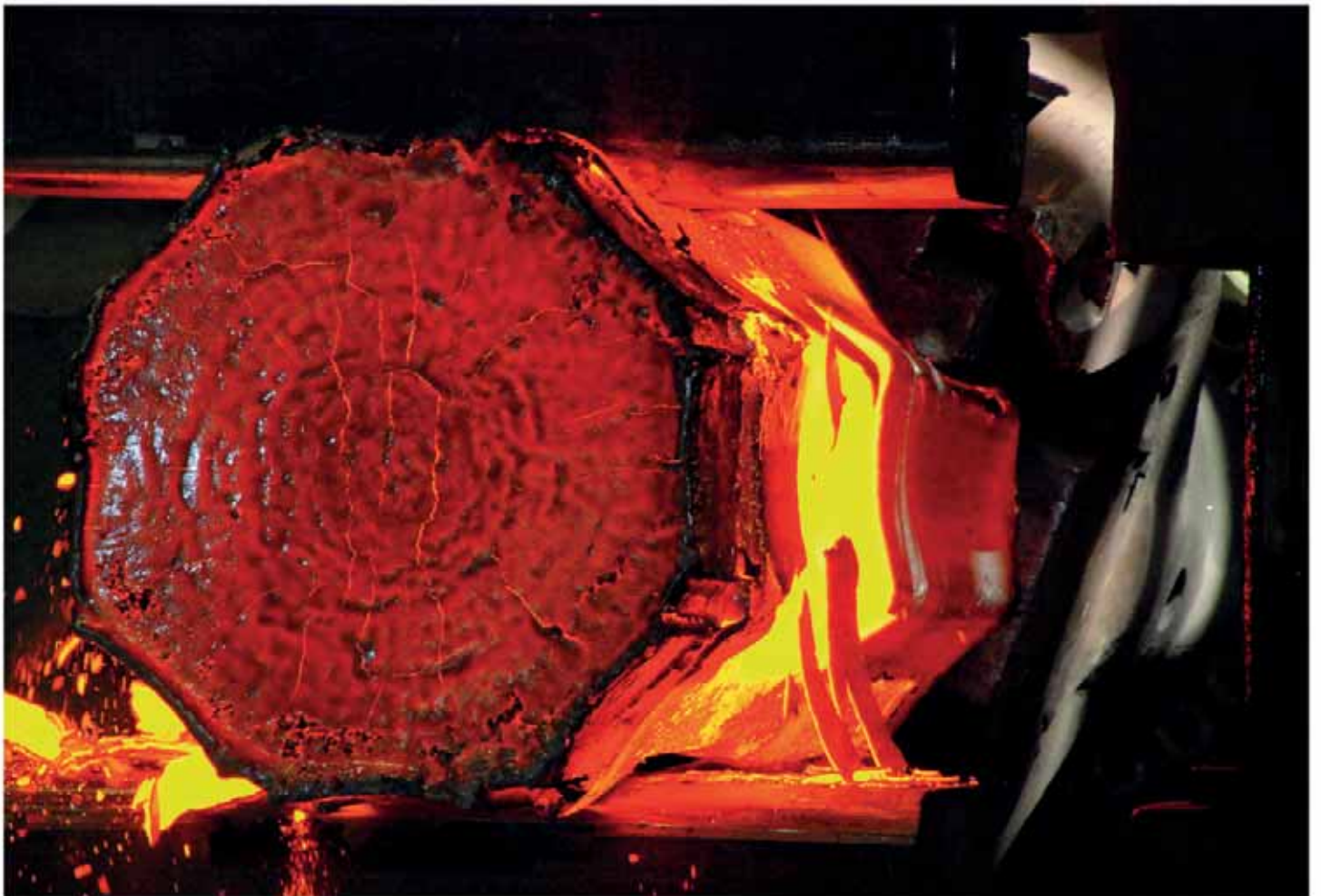
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can thus be detected. Alongside the shutter system, this intelligent electronics is the reason why the systems in the machine work reliably despite the use of coolant. Thanks to plausibility tests and the “pulling” measurement from the laser beam, falling or discharged coolant has no influence on the measurement. Wandinger has Blum Micro Compact NT or Nano NT type measuring systems on all his machining centres. They differ in terms of the transmitter to receiver distance, allowing some of them to measure larger tools. Tool breakage monitoring is also an important application for the Blum measuring systems. Between two machining cycles, for example between drilling of two holes, the tool spindle briefly moves to the laser measurement system, which measures whether the drill is still in place. At 30,000 rpm, even a very minor resonance, e.g. due to a 2 micrometer imbalance, can cause a 100 micrometer drill to break, demonstrating how important breakage detection is.

Wandinger calls it “total breakage” – for example if the drill intended to pre-drill a hole, is no longer in place. In a worst-case scenario, all of the downstream tools could also break as a result. The costs of a “total breakage” – but also of an individual broken tool – are far from negligible, as a single one of these highly sensitive tools can cost anywhere between 25 and 180 Euro, in some cases as much as 250 Euro. In addition, the forces resulting from collision with the workpiece can also jeopardise the accuracy of the spindle, possibly causing further high costs. And we should not forget the costs of

the blank, which can be very high depending on the material being used. For Wandinger, it is important that the laser measurement systems are fitted directly in the working space, ideally immediately adjacent to the tool holder. “This enables all influences, such as temperature-related expansion of the machine, to be measured and taken into account. The thermal expansion of the spindle and the

The measurements that can only be carried out in the working space also include concentricity tests at operating speed; sometimes it is not until the drill is being calibrated on the machine that incorrect labelling on the packaging is noticed.

tool fitting, as well as the speed-related displacement of the spindle, can also be compensated, which is essential when accuracy levels of less than ten micrometres are required.” The measurements that can only be carried out in the working space also include concentricity tests at operating speed; sometimes it is not until the drill is being calibrated on the machine that incorrect labelling on the packaging is noticed. “You are trying to fathom why your 100 micrometre holes have a diameter of 120 micrometres, until you



measure the tool diameter and identify the fact that the incorrect drills have actually been supplied,” Wandinger said.

“I am fascinated by how accurately tools can be measured,” he continues. “This has a direct impact on costs. For instance, we once had a workpiece that had to have 960 tiny holes drilled in it. At this diameter, the feed rate is 1.5 millimetres per minute. So if I slow down the movement a tenth of a millimetre too early above the surface of the workpiece when approaching a drilling point, I will be drilling nothing but air for four seconds before the drill actually gets to the workpiece. With 960 holes, this adds up to more than an hour of ‘dead drilling’. However, if I have measured the length of my drill to an accuracy of a few micrometres, I can get closer to the surface at high speed, saving lots of time – and ultimately production costs.”

“We are extremely satisfied with the laser measurement systems from Blum,” Wandinger concludes. “Because the tools are measured directly in the machine, we can achieve a level of precision that is at the very limits of what is technically feasible. That is why we had to acquire a scanning electron microscope back in 2004 so that we could inspect our workpieces. We have reached the limits of conventional measurement methods. The contactless measurement technology and extreme accuracy of the Blum tool measurement systems are the only way we can achieve these tolerances – to say nothing of the robustness that is possible by fitting such a precise piece of measuring equipment where chips are flying and cooling lubricant is spraying around. In most cases, we can now make the very first part a good part, and this is thanks largely to the LaserControl equipment.” ♦

*Article and Images Courtesy:
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Post-processors and CAD/CAM: Ensuring transparency in the manufacturing industry



Post-processors are critical switching points in the manufacturing industry, enabling the transition from digital modeling to physical reality. They play a central role in the production process to ensure smooth and reliable production. Post-processors' communication must be open and transparent to ensure a smooth CAD/CAM experience. This article explains what post-processors are all about, their programming and the PP unique selling point of WeSt GmbH. It also highlights how you can particularly benefit from these aspects.

A post-processor is a software component that's closely linked to the CAM software. It plays a central role in the production process. The main job of a post-processor is to convert the representation of the machining in the CAM software into an NC code that the machine can understand and execute. The NC code ultimately controls the machine's movements and operations.

The challenge is to achieve precise and efficient translation from digital representation to physical reality. It is crucial that the machine produces what was previously planned and visualised in the simulation. A post-processor is therefore crucial to ensure smooth and reliable production.

The development process

The development process of post-processors is a fascinating undertaking that requires precision, adaptability and technical expertise. Ideally, this process would begin with a comprehensive structure diagram that acts as a detailed blueprint for the post-processor. This structure, comparable to a comprehensive overview image, would include all conceivable constellations in the CAM software. This would already determine in advance which expenses are required and where.

This structogram is the foundation on which the developers build. It is continually refined and differentiated. This creates a robust basis from which the actual development of the post-processor begins. The precise elaboration of

this structogram makes it possible to achieve a finished output in comparatively few steps.

However, the reality is often more complex. New machines, changing requirements or unclear specifications can complicate the development process. Flexibility is therefore a key aspect in adapting the post-processor to specific needs. An iterative approach is crucial here. There are often several small steps where the team adjusts the post-processors accordingly and ensures that the machine performs exactly what it should show in the simulation.

In practice, an incremental approach is often chosen. Initially, rough or imprecise specifications are used to develop initial approaches. These are converted into a coherent

picture using the team's experience. Feedback plays a crucial role in this iterative process. This could include feedback from customers or adjustments made in collaboration with machine manufacturers or TopSolid. To approach the goal step-by-step, you need to create an NC program that controls the machine precisely while ensuring safety and efficiency.

Communication is key

Effective communication is key to a successful development process. To ensure that everyone involved is well-informed and pursues common goals, WeSt GmbH uses a special tracking document that is visible to all those involved. This document contains relevant information about the post-processors and includes the current status, open points, need for clarification and completed tasks. Transparent communication and documentation of the development processes help to maintain a clear structure and organisation. All relevant information is easily accessible and understandable, regardless of who is involved. This approach facilitates coordination

and collaboration between different parties and helps developers stay on top of the development process.

Focus on safety and precision

Over the years, WeSt GmbH has developed a clear philosophy that rests on three central pillars: security, precision and transparency. These basic principles are not mere buzzwords; they are at the heart of how they work and influence every aspect of their activities, especially the post-processor development for TopSolid and CAD/CAM.

Safety is the top priority for WeSt GmbH. It is crucial that the machines in the manufacturing industry do exactly what they are supposed to do. The machines must work safely and reliably to minimise human errors and ensure effective production processes. Therefore, WeSt GmbH places the highest value on ensuring that the post-processors they develop offer a one-to-one correspondence between simulation and machine behaviour. This consistency is key to ensuring that machines operate according to previous simulations, ultimately creating confidence and security in the production process.

At the same time, precision plays an equally critical role. The post-processors must provide exactly the right commands and instructions so that the machines carry out their work with the highest precision. WeSt GmbH strives to design the CNC programs to make the most of the capabilities of the machines while ensuring clear readability for those who understand and monitor these programs.

Another fundamental aspect of WeSt GmbH's philosophy is transparency in communication. This openness extends to all areas of work. In post-processor development, it is crucial that everyone involved can understand the current status of the project at all times. As mentioned earlier, WeSt GmbH relies on a customer-specific tracking document that guarantees the best possible transparency between customers and developers.

The philosophy of WeSt GmbH combines security, precision and transparency into a holistic approach that aims to achieve optimal results for its customers. These principles are reflected in every project in which WeSt GmbH is involved and form the

Thema	Status	Hinweise	Eingangsdatum	Erledigt Datum	Zugehörige Dateien
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foundation for its ongoing success story in the manufacturing industry.

Sharing knowledge for more efficient post-processors

Another central element in the work philosophy of WeSt GmbH is the transfer of knowledge through specific training courses on post-processors. This focus on training and knowledge sharing is crucial to ensuring that not only WeSt GmbH developers, but also their customers, are able to optimally understand, adapt and use post-processors.

WeSt GmbH's training courses are aimed at two main groups:

- ▶ The first group comprises customers, who have the desire and ability to create or customise post-processors on their own. These could include companies that own a large number of machines and want to be able to manage the post-processors internally. The participants are intensively introduced to the programming and customisation of post-processors to address their specific requirements independently.
- ▶ The training is also offered to customers who do not want to make extensive post-processor adjustments, but who need a sound understanding of how the post-processor works and its possibilities. This understanding allows them to make minor adjustments if necessary or at least communicate more effectively with developers.

The training courses are by no means a static concept. Rather, WeSt GmbH continually adapts the training content and methodology to meet the changing requirements and technologies. The training participants have the opportunity not only to benefit from the expertise of WeSt GmbH, but also to actively give feedback and thus contribute to the continuous improvement of the training offering.

Overall, training courses are

an integral part of WeSt GmbH's service offering. They underline the company's commitment to knowledge sharing, collaboration and continuous training. WeSt GmbH believes that sharing knowledge ultimately leads to more efficient use of post-processors and thus creates added value for its customers.

Conclusion

Post-processors, CAD/CAM and thus, TopSolid play a crucial role in optimising production processes, increasing efficiency and ultimately delivering high-quality products. WeSt GmbH shows how a clear

philosophy, effective communication and training courses can make a difference in the world of post-processors.

In an ever-evolving technological landscape, it is crucial to stay informed about current developments and best practices. With a sound understanding of post-processors, TopSolid and CAD/CAM, companies are well-positioned to take advantage of the opportunities of the future and strengthen their competitiveness. ♦

Article and Images Courtesy: WeSt GmbH and TopSolid

The poster features the following text and elements:

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- Event Title:** International Conference & Exhibition: You are Cordially Invited to Visit Mega Event Exhibition on Aluminium Diecasting Industry & Forging Industry.
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 - 2nd Dec 2023 09.30 to 18.00 Hrs.
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'SMEs seek support from government to embrace digitisation and sustainability practices with greater vigour'

Incorporating digital technologies in business functions leads to higher productivity and lower operational costs amongst SMEs; sustainability is high on the agenda as it helps companies to mitigate their ecological footprint, optimise resource utilisation and minimise waste generation, according to the FICCI Report.



Image used for representation only. Courtesy Envato Elements.

The FICCI Report on SMEs in India was conceptualised to assess the awareness of and preparedness for digitalisation and sustainability by small and medium enterprises from the manufacturing sector in India. It is based on a nationwide survey of more than 600 SMEs across 14 cities followed by focussed group discussions. The report highlights how SMEs are adapting to the digital transformation taking place and adopting sustainability practices; it identifies the challenges in this regard and, more importantly, makes specific recommendations on how to overcome them.



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Digitalisation of SMEs in India

Digitalisation has gained traction. SMEs in India have been increasingly adopting technology and digital solutions to enhance their competitiveness. This includes the use of e-commerce platforms, digital marketing, cloud computing, and automation tools.

The survey reveals that SMEs have been utilising digital technology across different business functions, with 60% of enterprises using digital tools for human resources, 51% for sales and marketing, and 48% for finance. The accounting software (such as Tally/ Vyapar/ Busy, etc.) and business applications like ERP and

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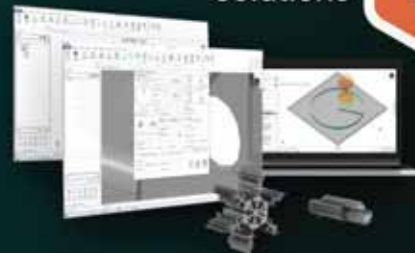
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CRM were reported to be the most used digital tools by SMEs. What is noteworthy is that about 37% of enterprises surveyed were also using cloud-based business applications such as IaaS, PaaS, SaaS, etc.

Most of the firms have experienced improvements in productivity and reductions in operational costs as a result of incorporating digital technology into their business functions. Approximately 35% of respondents reported a reduction in their annual operational costs by 11-20% as a result of digitalisation. Another 30% of respondents indicated that their annual operational costs had decreased by more than 20%.

SMEs have also been leveraging e-commerce platforms and online marketplaces to reach a larger customer base and expand their market presence. These platforms provide opportunities for SMEs to showcase and sell their products nationally and globally. In terms of online markets and sales platforms, a significant 71% of participating enterprises had their own online channels or sales platforms (such as a website to display or sell products).

Amongst the enterprises that reported selling through online channel(s), 24% reported that more than half (50 to 75%) of their overall sales came through online platforms like e-commerce platforms or own website. Another 39% of respondents reported that one fourth to half of their sales were through such online platforms.

The adoption of online markets and sales platform has increased their sales, profits as well as reach to customers.

The study also brings to the fore some of the key challenges faced by SMEs in integrating technology in business functions, especially in onboarding on e-commerce platforms. About 40% of respondents highlighted lack of skilled resources and technological expertise required to effectively integrate and operate



Image used for representation only. Courtesy Envato Elements.

these technologies, as well as limited knowledge of business-specific technology solutions.

While there is a government scheme 'Digital MSME', as a part of the Champions Scheme to promote digital adoption amongst MSMEs enterprises, there is perhaps a need to create greater awareness about the scheme and its utility to SMEs across India.

SMEs in India can also take advantage of Digital Public Infrastructure (DPI) for improving their access to finance and access to markets. For instance, the GeM (2016) portal for public procurement and the TReDS (2014) platform for receivables financing have been instrumental for the development of SMEs in India. The survey findings reveal that while there is reasonable awareness about these platforms amongst SMEs, there is a scope for further improving awareness and adoption of these platforms.

The two portals have high utility for SMEs and a further push may be given through capacity-building workshops and awareness campaigns to increase SME registration on these platforms. Additionally, policy suggestions were offered to improve the performance of these platforms. In case of TReDS, the key suggestions offered include automatic publishing of GST registered MSMEs' invoices on TReDS and deemed acceptance by corporates; allowing participation of

State Government Agencies in TReDS; and making Customer Care Helpline of TReDS more robust. In case of GeM, the suggestions offered include reduction in charges and ensuring timely payment to SMEs.

Sustainability practices by SMEs in India

In recent years, there has been a growing emphasis on the adoption of sustainable practices by Small and Medium Enterprises (SMEs) in India. By adopting sustainable practices, SMEs can mitigate their ecological footprint, optimise resource utilisation, and minimise waste generation.

Businesses have recognised the importance of integrating Environmental, Social, and Governance (ESG) practices into their operations, not only to meet regulatory requirements but also to improve their competitiveness and reputation.

FICCI study shows an overwhelming 72% of respondents were generally aware of sustainability and ESG practices. The importance of buyer support in implementing sustainability and ESG practices was instrumental, as 64% of enterprises received guidance and support from their buyers.

Over the past two years, a significant number of surveyed enterprises have taken steps to adopt sustainable practices. The highest proportion of enterprises (41%) implemented measures to eliminate paper usage, demonstrating a growing awareness of the need to reduce waste and conserve resources, conserve water (41%), invest in green projects (39%), etc. The respondents also highlighted their priority for implementing sustainable practices over the next two years, which included the usage of renewable energy (36%), and investment in green projects (35%).

The enterprises have also reported benefits and cost savings by transitioning to green and sustainable

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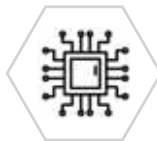
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practices, including the adoption of water conservation practices.

The respondents also highlighted the key impediments faced by SMEs in adopting sustainable practices. Majority respondents (42%) have indicated that time constraint is a key challenge in adopting sustainability practices, followed by limited funding (41%) and lack of incentives for implementation (41%).

In order to overcome these challenges, enterprises may invest in sustainability training and education, define clear goals and metrics for sustainability efforts, and establish partnerships and collaborations with other stakeholders in the industry. In addition, approximately half of the respondents have suggested increasing awareness through targeted campaigns, training programs, etc. and providing subsidies or other benefits to incentivise compliance (35%).



Image used for representation only. Courtesy Envato Elements.

Other issues and suggestions

While the study primarily focused on the digitalisation and sustainability preparedness of SMEs in India, the survey and discussions with SMEs also bring to the fore some of the key challenges and issues faced by these enterprises in their day-to-day business. Besides the need for enhancing access to finance, the

SMEs also highlighted issues with electricity supply and land leasing.

The key recommendations for improving the SME ecosystem include improving access to finance, especially by laying emphasis on cash-flow-based lending to SMEs. Another suggestion was to revise the classification norm of MSMEs in relation to NPAs from the current limit of 90 days to 180 days.

Other suggestions critical for improving the growth and development of SMEs in India include regular monitoring and evaluation of government schemes for SMEs to ensure effective implementation; further simplification of processes and encouraging self-certification; creating single window for all compliances; easy access to land and infrastructure in industrial zones; and create institutional mechanisms for technology transfer. ♦

Article Courtesy: © FICCI 2022



Late Shri. N.R.G. Krishnan,
Founder,
Multiple Special Steel Pvt Ltd

Obituary

In the village of Nurani in Palakkad, Kerala, a humble boy began a journey that would shape his destiny and impact the business world. Born into simplicity, he ventured from his village to the bustling city of Bombay with a determination to carve his own path.

In 1961, Shri. N.R.G. Krishnan founded "Multiple Agencies (Bombay)," a steel and aluminium trading firm. Over six decades, it evolved into a symbol of trust and reliability. His commitment to excellence and customer satisfaction made the company more than a business—it became a name synonymous with integrity.

In the late 1970s, recognizing the need for a South India presence, he moved the office to Bangalore, showcasing foresight and adaptability. The journey wasn't just about business success; it was about nurturing dreams. Employees were family, and the company became a beacon of inspiration for aspiring entrepreneurs.

Shri. N.R.G. Krishnan's transformative journey, from Nurani to Bombay and Bangalore, was a testament to building a legacy of trust, reliability, and growth. As we mourn his passing on November 10, 2023, we are determined to carry forward his vision, values, and the impact he made on the business world. MSSPL will remain a bastion of trust, growth, and unwavering commitment to excellence.

In his journey, he played a pivotal role in the Indian tooling and tool steel industry by introducing the latest and best global innovations to the Indian market.

With heartfelt condolences, TAGMA India extends its deepest sympathy to MSSPL on the passing of Shri. N.R.G. Krishnan.



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Commitment to upskilling



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Here's how Tata Motors is creating a future-ready workforce and building talent for the auto sector.

Tata Motors, India's leading automobile manufacturer and the pioneer of the EV revolution in India, is implementing a multi-pronged strategy to develop a rightly skilled and future-ready workforce focused on EVs and other new-age technologies, as well as developing talent for India's rapidly growing and dynamically evolving auto sector.

With a focus on capability-building being critical to navigate through the rapid technology advancements and changing market dynamics, Tata Motors has adopted a holistic approach to upskilling. Specially curated training modules address the requisite developmental needs of all – from shop floor technicians to line engineers, and plant management. These modules deliver relevant technical skills, functional skills, as well as managerial and leadership capabilities.



Upskilling Tata Motors' employees to create a future-ready workforce

Tata Motors has set an ambitious aspiration of equipping over 50% of its workforce with new-age auto tech capabilities within 5 years. In FY23, over 3,40,000 hours were invested in specialised training and development by Tata Motors' employees. This training and development is being delivered in various forms and formats.

► **Certification in CESS through collaboration with tech partners:** Tata Motors has collaborated with ARAI, Bosch, Mathworks, SAE, Tata Technologies Limited, and other organisations to provide its employees with professional certification programmes in Connected, Electric, Shared and Safe (CESS). This includes domain expert-level modules on Advanced ADAS, Battery Technology, V2X connectivity, Blockchain & Cybersecurity, Big Data Analytics, and more. By partnering with these organisations, Tata Motors ensures that its employees receive quality education and hands-on

experience in emerging technologies.

► **Transforming mechanics to auto electronics:** Tata Motors has co-created bespoke courses in partnership with local universities. These company-sponsored programmes provide employees with higher education opportunities including B.Tech, M.Tech, and also Executive MBA. Collaborations with renowned institutes including BITS Pilani, MIT-ADT University Pune, Institute of Technology Nirma University, Symbiosis International (Deemed University), Ganpat University, DY Patil International University, Oxford Polytechnic, ARKA Jain University and Amity University, for specialised programmes enables employees to further develop their technical, professional, and leadership skills required to excel and optimise the opportunities ahead.

► **Higher education for shop floor technicians:** A higher education programme designed specifically for shop floor technicians working across plants enables them to pursue a 'Diploma in Engineering' with a focus on auto electrical and electronics, mechatronics, and specialised



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welding skills. This programme enables technicians to acquire the necessary qualifications for growth and to meet the evolving demands of the automotive industry.

► **Digital transformation and e-learning:** Embracing digital transformation, Tata Motors has embarked on a journey of curated functional e-learnings and virtual classrooms for all employees. By leveraging digital technologies, the company provides accessible and efficient learning opportunities that cater to the diverse needs of its workforce. This approach allows employees to upskill at their own pace and convenience, ensuring continuous growth and development.



Upskilling ex-Ford employees in the newly acquired plant at Sanand, Gujarat

Post-acquisition of the Ford India facility at Sanand in January 2023, Tata Motors partnered with Gujarat's renowned Ganpat University to upskill 100% of the newly acquired workforce. Curated learning programmes developed by the university in collaboration and with inputs from Tata Motors are being offered on the latest, future-oriented manufacturing technologies, including Industry 4.0, Smart Manufacturing, Advanced Control Engineering, and Advanced Manufacturing Systems and Processes. Trainings on new-age auto systems like ADAS, Connected Cars, CESS, Control System, etc.



We are committed to further taking forward Tata Motors' established legacy of nation building and being the pioneer in the Indian auto industry. A dynamically evolving industry like ours mandates consistent upskilling and training to remain ahead of the curve and future ready. Tata Motors has evolved into a learning organisation with a structured and thoughtful approach to upskilling. Collaborating with tech partners and academic institutions, tailor-made training programmes, a nationwide 'Learn & Earn' apprenticeship programme and a sharp focus on diversity and inclusion, is enabling us to develop and nurture a capable, future-ready workforce that is fit to excel. We are doing this not just for ourselves and our channel partners but also for the Indian auto industry at large as well its' enabling ecosystem.

- **Sitaram Kandi,**
Vice President – HR, Passenger Vehicles and Electric Vehicles, Tata Motors

are being delivered via a judicious mix of classroom sessions and practical trainings at various levels – Postgraduate (MTech), Graduate (BTech), and Diploma. Individual candidates are enrolled for the appropriate level programme as per their eligibility. These advanced courses, which began in February 2023, are being enthusiastically pursued by over 820 employees.



Apprenticeship Programme: Developing qualified and skilled talent pool for Tata Motors' ecosystem and industry at large

Tata Motors' flagship full-time Apprenticeship Programme, demonstrates commitment to developing young, skilled, agile, and digital-enabled professionals. The programme focuses on in-demand skills like mechatronics, IoT, robotics, and AI, offering hands-on training that prepares students for rewarding careers in the automotive industry. Students with ITI/12th pass backgrounds are trained in specific skills via a novel 'Learn & Earn' model. On successful completion, apprentices are capable to secure

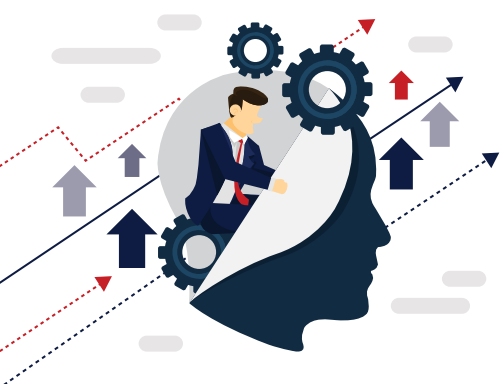
jobs across the auto industry and its enabling ecosystem, ensuring a smooth transition from learning to employment. More than 13,000 students are currently enrolled in the programme. Over 88% of successful pass-outs are working with channel partners. The percentage of registered women participants in FY24 has more than quadrupled from FY22.



Promoting diversity and inclusion in manufacturing

Tata Motors fosters workplaces that promote diversity and equal opportunities. The company has taken significant steps towards increasing gender diversity on the shop floor, with the TCF assembly line in their Pune plant being entirely operated and managed by women employees. Currently, Tata Motors has over 4500 women employees working on the shop floor across all plants, exercising a range of functional capabilities. This commitment to diversity ensures a more inclusive and innovative work environment. ♦

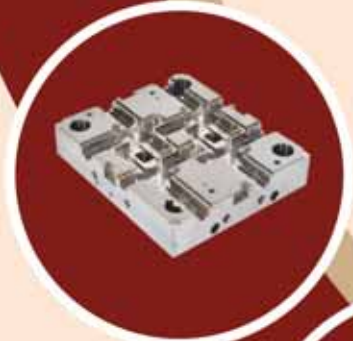
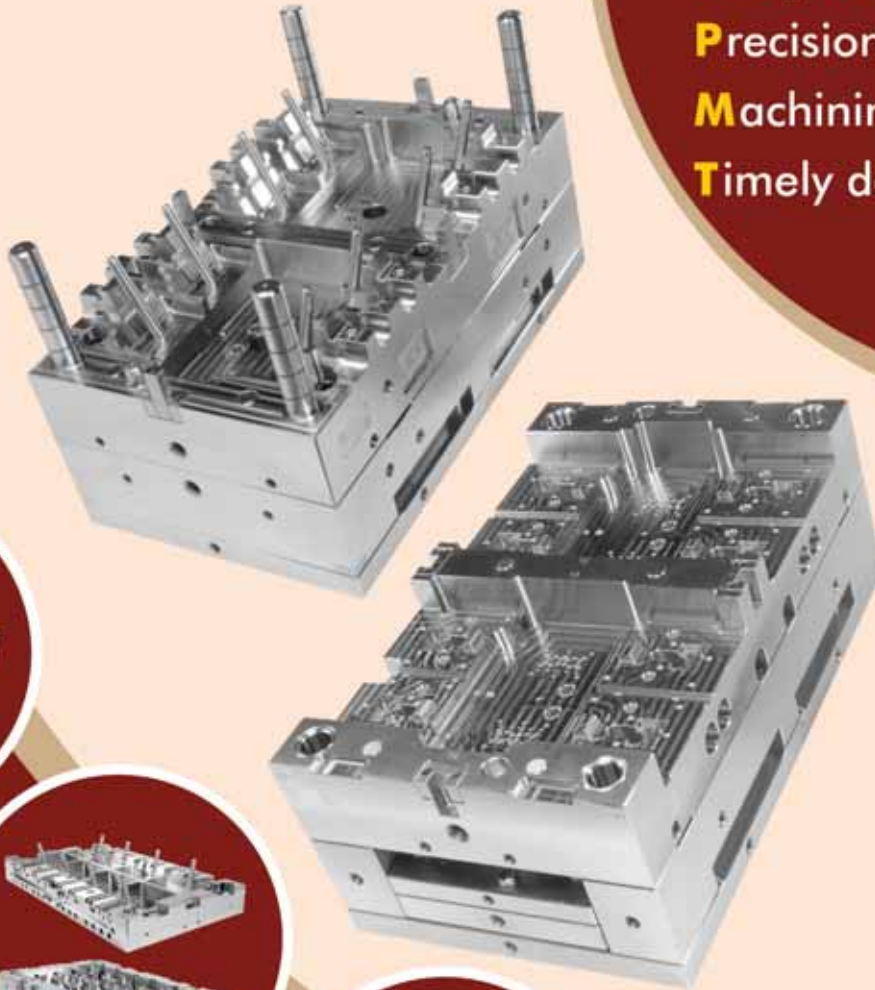
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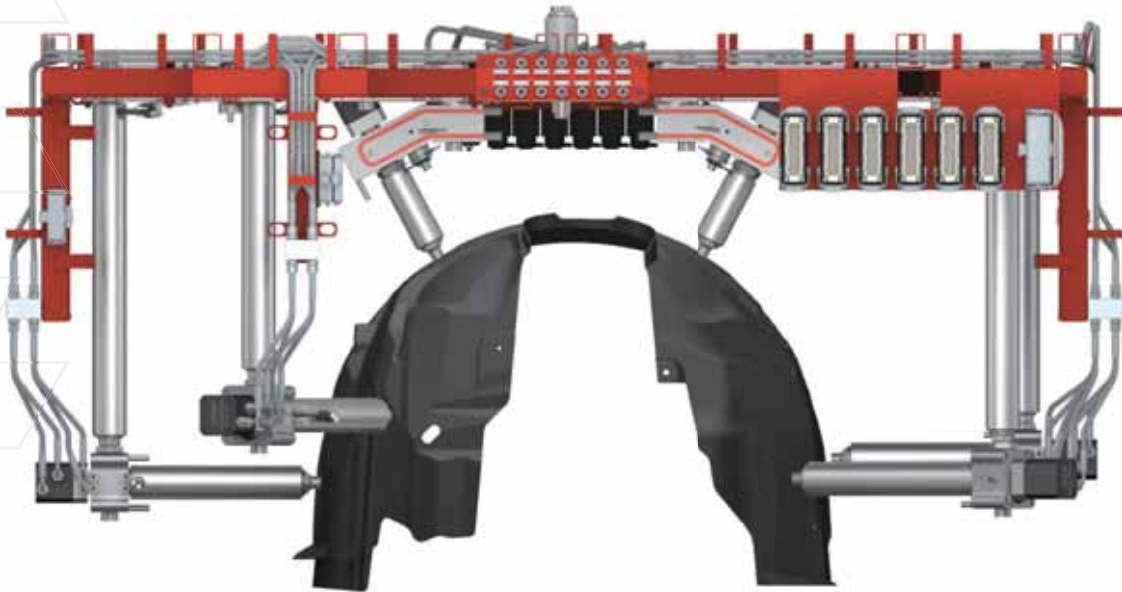
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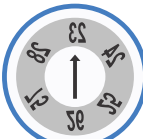


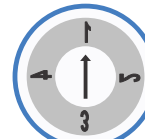
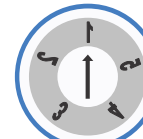
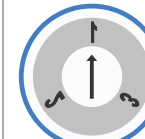
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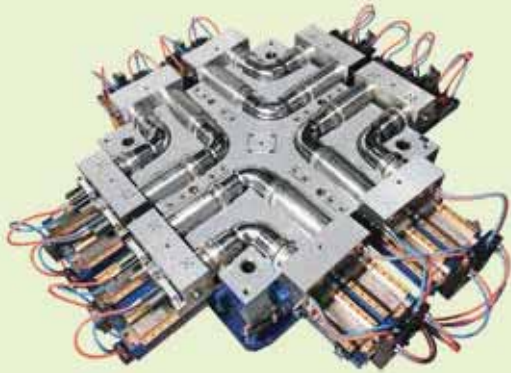
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