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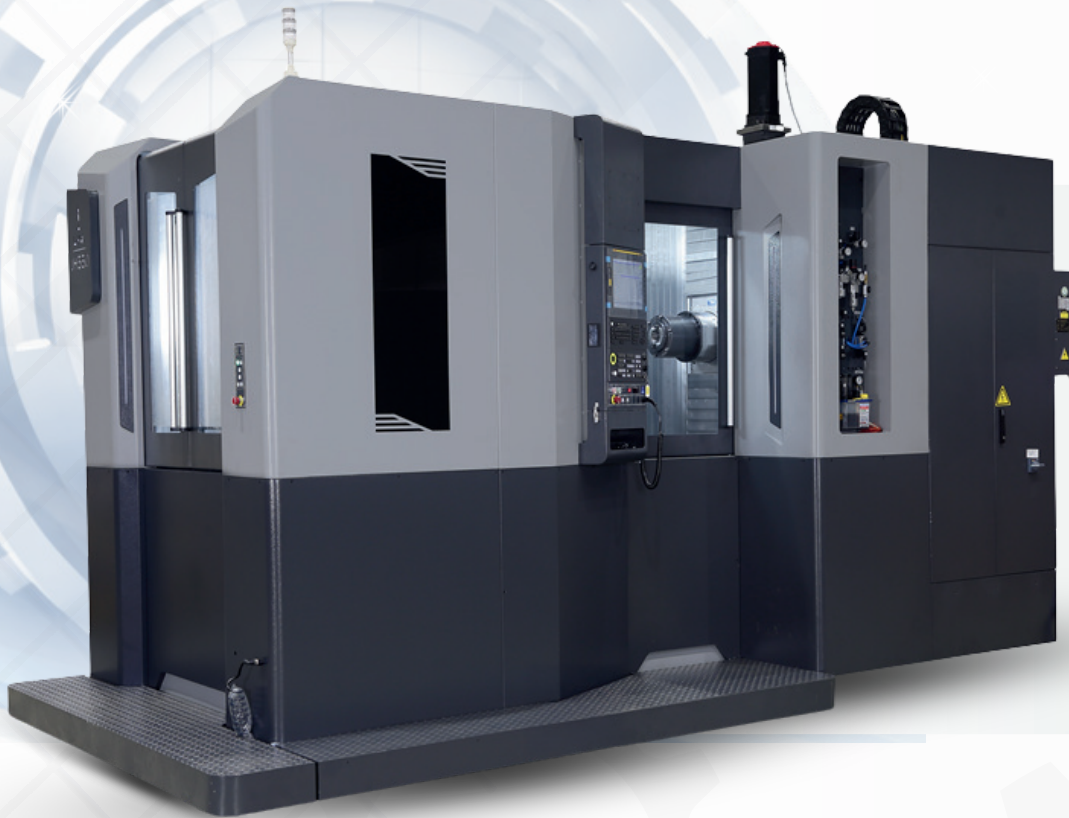
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The Liquid Advantage



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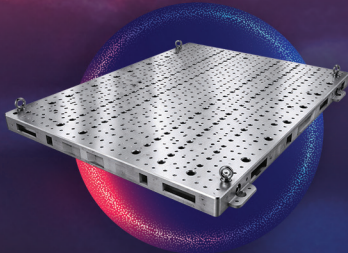
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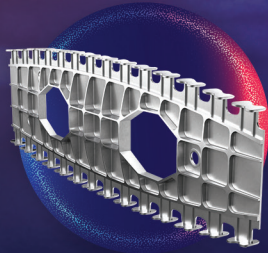


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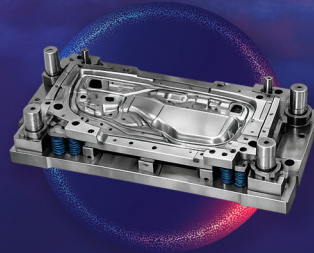
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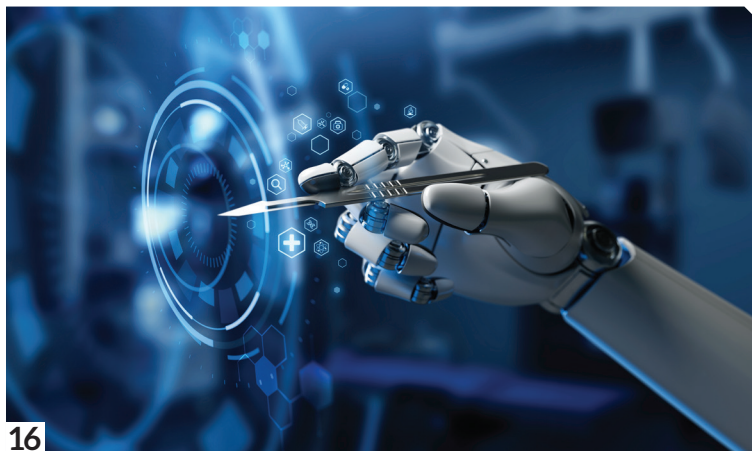


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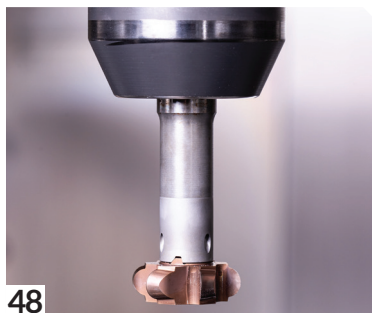
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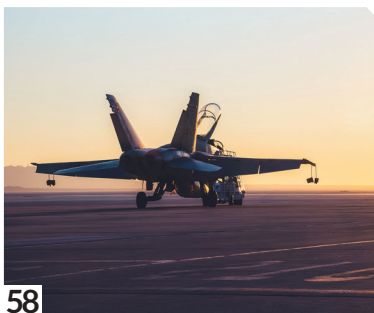
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IMPRINT

PUBLISHER
DIRECTOR GENERAL, IMTMA

EDITORIAL

Editor-in-Chief
Soumi Mitra

Chief Copy Editor
Poonam Pednekar

Associate Editor
Sovan Tudu

Senior Correspondent
Murali Sundaram

VIDEOGRAPHY

Videographer
J Jayabharathi
Abinesh Umapathi

Video Editor
Jyotipriyo Pal
Gobinda Pippale

DESIGN
Magic Wand Media

SALES & MARKETING

Murali Sundaram, Magic Wand Media Inc
murali.sundaram@magicwandmedia.in

Shankhasubhro Chakraborty, Magic Wand Media
shankha@magicwandmedia.in

Published and Printed by Indian Machine Tool Manufacturers' Association (IMTMA). Printed at Pentaplast Printer's Pvt Ltd Sy.No.1/2 Situated at Anjanadari Estate, Lingadeeranahalli, Adjacent to D Group Society Yeshwathpur Hobli, Bangalore North - 560091, Karnataka and Published from Indian Machine Tool Manufacturers' Association; Head Office: 10th Mile, Tumkur Road, Madavara Post, Bengaluru - 562123, Karnataka. Editor: Soumi Mitra

Publishing frequency: 6 times per year

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Dear Readers,

Manufacturing activities are evolving rapidly, driven by automation, digital technologies, precision engineering, and resilient supply chains. Across industries, manufacturers are increasingly investing in advanced manufacturing capabilities to improve quality, productivity, and global competitiveness.

Indian industries are on a strong growth trajectory, supported by sustained investments, policy reforms, infrastructure development, and surging domestic demand. As industries accelerate their adoption of smart manufacturing technologies, India's business ecosystem is expected to gain prominence.

India's machine tool industry in FY 2025-26 reflected this momentum with robust growth. Consumption grew by 15 percent to INR 36,419 crore (US\$ 4.1 billion), while production surged by 19 percent to INR 17,387 crore (US\$ 2 billion). Although imports grew by 16 percent to INR 21,628 crore (US\$ 2.4 billion), machine tool exports from India during the period increased by 76 percent, totalling INR 2,596 crore (US\$ 0.3 billion).

These figures reaffirm the machine tool industry's significant role in enhancing India's manufacturing competitiveness.

This edition of Modern Manufacturing India (MMI) focuses on Medical Machining, where precision, quality, reliability, and regulatory compliance are paramount. As the medical manufacturing sector advances, healthcare technologies, advanced

machining solutions, automation, and digital manufacturing will play an increasingly important role in producing next-generation implants, surgical instruments, and high-precision medical components.

Automation is a key enabler of this transformation. Hence, to accelerate technology adoption, Indian Machine Tool Manufacturers' Association (IMTMA) is hosting the ninth edition of the Symposium on Automation & Robotics. The event will be held from August 13-14, 2026, at Bangalore International Exhibition Centre (BIEC), Bengaluru.

Businesses, technology providers, and global experts will converge at the

Symposium to explore practical automation solutions, robotics, artificial intelligence-driven manufacturing, and smart factory concepts shaping the future of manufacturing.

MMI will continue to provide industry perspectives, emerging trends, and technological developments to help manufacturers remain globally competitive. We thank our members, partners, contributors, and readers for their continued support.

Happy Reading.

With the aim to accelerate technology adoption, Indian Machine Tool Manufacturers' Association (IMTMA) is hosting the ninth edition of the Symposium on Automation & Robotics. The event will be held from August 13-14, 2026, at Bangalore International Exhibition Centre (BIEC), Bengaluru.

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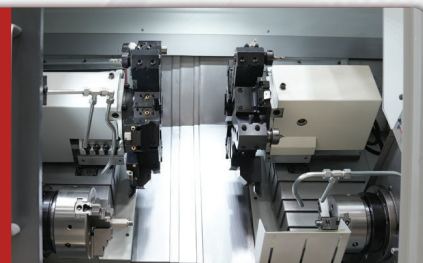
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BANGALORE INTERNATIONAL EXHIBITION CENTRE

Dear Readers,

Businesses in India continue to demonstrate resilience and innovation, with technology, digitalization, and policy support driving new opportunities. The July-August edition of Modern Manufacturing India (MMI) captures this momentum through a diverse range of themes and milestones.

This edition of MMI features insights into coolant and lubricant technologies, as well as perspectives on medical machining, covering cutting tools, and additive and subtractive manufacturing approaches. A special article from the Indian Machine Tool Manufacturers' Association (IMTMA) explores the rapidly evolving field of medical machining, highlighting the precision engineering and advanced cutting technologies enabling the production of next-generation medical devices and implants.

The edition also brings out new landmarks achieved by IMTMA members, related to manufacturing record number of machines within a short span. It further examines how artificial intelligence is emerging as the next big driver of operational excellence.

A compelling case study on the impact of lean manufacturing, digitalization, and employee empowerment, along with revisiting landmark framework of the Eight Dimensions of Quality and an article examining developments in defence supply chains are also included.

Businesses in India continue to demonstrate resilience and innovation, with technology, digitalization, and policy support driving new opportunities. The July-August edition of Modern Manufacturing India (MMI) captures this momentum through a diverse range of themes and milestones.

An exclusive interview with leaders on India's evolving semiconductor industry and the policies shaping its future sheds light on the advancements in this segment.

Indian Machine Tool Manufacturers' Association (IMTMA) extends its thanks to the contributors, partners, and readers for their continued support for MMI. We hope this edition offers sharp insights and meaningful perspectives to the manufacturing community. Your feedback is invaluable in helping IMTMA enhance the magazine's relevance and quality.

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Soumi Mitra

SOUMI MITRA
Editor-in-Chief
Modern Manufacturing India
soumi.mitra@magicwandmedia.in

FROM THE TURF OF LORD'S TO THE GLOBAL BOARDROOM

On a historic Monday in July 2026, the hallowed turf of Lord's Cricket Ground became the stage for a landmark victory. The Indian Women's Cricket team rewrote its legacy by dismantling England by 270 runs.

The commanding performance is more than a sporting milestone. It serves as a metaphor for India's broader trajectory on the global stage. India has transitioned from an eager participant to a dominant, standard-setting force. This steady evolution is highly visible in global markets. Driven by Production Linked Incentive (PLI) schemes, Indian manufacturing has moved up the value chain, transitioning from basic assembly to high-tech exports like advanced electronics and precision defence equipment. This industrial push is closely supported by long-term investments in space technology and semiconductor manufacturing, establishing the country as a reliable, alternative anchor for global supply chains.

"Strategy is about setting yourself apart from the competition. It's not a matter of being better at what you do, it's a matter of being different at what you do."

- Michael Porter

This structural shift is more evident in the global boardroom. In a reversal of historical trends, Indian conglomerates are actively acquiring established foreign firms to secure mature distribution networks, key intellectual property, and greater global market share.

Much like the 'Women in Blue' proving their place at Lord's, India's business leaders, scientists, and engineers are quietly demonstrating that they are right at home on the world stage.



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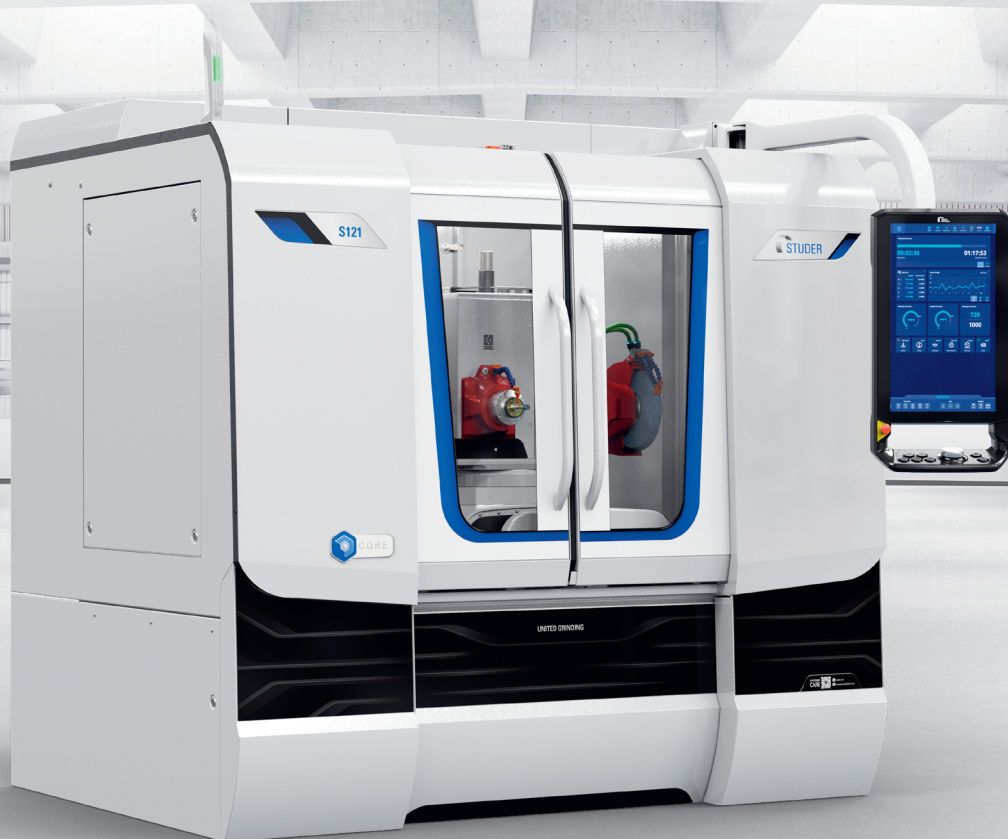
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INDIAN MANUFACTURING ON AN UPWARD TRAJECTORY

The outlook for India's manufacturing sector remains encouraging as industrial activity, investment, and domestic demand continue to gather pace. This positive momentum has translated into a strong performance for the machine tool industry, which is steadily enhancing both its domestic capabilities and global competitiveness.

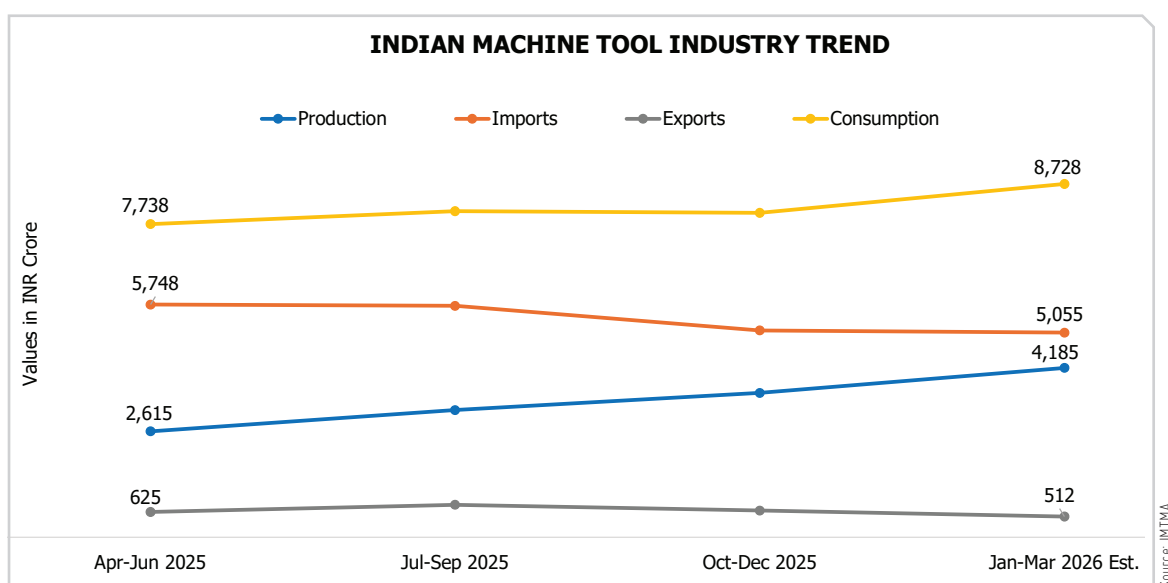


Table 1. Indian Machine Tool Industry Trend

The fiscal year 2025–26 concluded with the Indian economy sustaining strong growth. Provisional national accounts estimates placed real GDP growth at 7.7 percent (2022–23 base year), an improvement over 7.1 percent in FY2024–25. In the fourth quarter, real GDP and Gross Value Added (GVA) expanded by 7.8 percent and 7.9 percent, respectively, indicating a marginal moderation from the 8.0 percent growth recorded for both in the preceding quarter. High-frequency economic indicators pointed to strengthening domestic economic activity at the beginning of FY2026–27. In May 2026, the Manufacturing and Services Purchasing Manag-

ers' Index (PMI) increased to 55.0 and 59.8, respectively, reaching three-month and six-month highs, reflecting sustained expansion in business activity. Industrial production also gained momentum, with the Index of Industrial Production (IIP) under the 2022–23 base series growing by 4.9 percent in April 2026, a four-month high, compared with 3.2 percent in March 2026. The Monetary Policy Committee retained the repo rate at 5.25 percent with a neutral policy stance in its June 2026 review. Headline CPI inflation increased to 3.9 percent in May 2026 from 3.5 percent in April, while WPI inflation (2022–23 base year) rose to 9.7 percent from 8.3 percent, reflecting broad-based price pressures.

On the fiscal front, the Government of India achieved its fiscal and revenue deficit targets of 4.4 percent and 1.5 percent of GDP, respectively, in FY2025–26, while gross tax revenues and total expenditure grew by 6.0 percent and 5.4 percent, respectively. Gross bank credit remained stable, growing by 16.0 percent in April 2026. On the external front, net FDI inflows increased sharply to US\$ 6.6 billion, while net FPI outflows remained elevated. On the external trade front, merchandise exports and imports grew by 18.0 percent and 20.6 percent, respectively, in May 2026, led by higher engineering goods exports and crude imports. The merchandise trade deficit remained elevated at US\$

28.2 billion, while global crude oil prices averaged US\$ 100.4 per barrel during the month. OECD projects global growth at 2.8 percent in 2026 and 3.1 percent in 2027, while India's real GDP is expected to grow by 6.6–6.8 percent in FY2026–27, supported by strong domestic fundamentals, resilient demand, and improving global supply conditions.

Machine Tool Industry Records Strong Growth

As per revised estimates from IMTMA (Indian Machine Tool Manufacturers' Association), the production of the Indian Machine Tool industry in FY26 is estimated to have increased by around 19 percent year-on-year, reaching about INR 17,387

crore (US\$ 2.0 B). The industry's imports in FY26 saw a rise of 16 percent year-on-year, amounting to INR 21,628 crore (US\$ 2.4 B). Machine tool exports from India during FY26 surged by 76 percent, totalling INR 2,596 crore (US\$ 0.3 B) and consumption is estimated to have increased by about 15 percent to reach INR 36,419 crore (US\$ 4.1 B) in FY26.

Trade Highlights

In FY2025-26, China (30%), Japan (21%), and Germany (12%) emerged as the top countries for imports to India, contributing to 63 percent of the total machine tool imports. Presses (16%), Vertical Machining Centers (VMCs) (12%), and Lathes (10%) were the top machinery

types imported, valued at INR 8,122 crore (US\$ 923 M), constituting approximately 38 percent of total machine tool imports during the period.

In exports, Russia (34%), Vietnam (9%), and the UAE (7%) emerged as the major destinations, collectively representing 50 percent of total machine tool exports in FY2025-26, amounting to a total export value of INR 1,293 crore (US\$ 147 M). Among the machinery types, VMCs (22%), Presses (15%), and Lathes (11%) stood out as the top three machinery types exported, with a combined value of INR 1,262 crore (US\$ 143 M), accounting for roughly 49 percent of total machine tool exports during FY2025-26. 

According to the World Machine Tool Industry Outlook – CY2025 by CECIMO, India ranks 9th globally in machine tool production and 4th globally in machine tool consumption. This highlights India's growing significance in the global manufacturing ecosystem.



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Source: Magic Wand Media

PRECISION ON PRESCRIPTION

India's medical devices sector is expanding rapidly, creating new opportunities for precision manufacturing. As demand for complex, high-quality medical components grows, advanced machine tools and metrology systems are becoming critical to India's ambitions in this segment.

India's medical devices sector is entering a period of rapid expansion. The sector has emerged as a critical component of India's healthcare and manufacturing landscape, with medical device exports crossing US\$ 4 billion in FY25. The Government of India is working towards building a US\$ 30 billion medical devices market by 2030, supported by policy initiatives to strengthen manufacturing, exports, innovation, and global competitiveness. The National Medical Devices Policy, 2023, brought forth by the Government of India, focuses on regulatory streamlining, infrastructure development, and R&D,

and coupled with PLI schemes and dedicated medical devices parks, is actively steering this growth. These measures are easing regulatory pathways, encouraging local value addition, and reducing India's long-standing dependence on imports, which account for roughly 40 percent of exports and 60 percent of domestic consumption of medical devices.

According to Carl Zeiss, a provider of high-precision metrology and quality assurance solutions, conversations with machine tool and metrology solution providers serving this segment suggest that for many specialized manufacturers of implants and surgical components, 35-40 per-

cent of output is shipped abroad, largely to European markets, with only a small share being consumed domestically.

What the Machines Must Deliver?

Medical components such as implants, surgical instruments, dental fixtures, and drug-delivery devices require zero-tolerance manufacturing precision, as even the smallest defect can be fatal. In high-precision medical manufacturing, tolerances are measured in microns, contact surfaces must be strictly biocompatible, and all production batches must be fully traceable under FDA and CE regulations.



Alongside advanced machine tools, high-precision metrology systems have become equally indispensable, enabling manufacturers to verify micron-level tolerances, validate processes, and demonstrate compliance with stringent FDA and CE requirements, notes Carl Zeiss.

These stringent quality requirements have driven market demand for a specialized range of manufacturing technologies. While Carl Zeiss shares that five-axis machining centers capable of producing the complex geometries of implants in a single setup have emerged as the workhorses of this segment, Ind-Sphinx Precision Ltd, a specialist in precision tooling and high-precision manufacturing solutions, explains that sliding-head machines, high-precision multi-axis centers, EDM and wire-cut EDM systems, and CNC drilling platforms are the preferred configurations among end users, particularly for components made from titanium, cobalt-chrome,

and other difficult-to-machine new-age materials.

On the additive side, the company adds that 3D printing and metal injection molding are steadily gaining ground, particularly for patient-specific implants and complex micro-components where subtractive methods alone fall short. Micro-machining and micro-electronics, driven in part by the rise of robot-assisted surgery, are opening a new demand stream that will deepen as robotic and minimally invasive procedures expand across Indian and global hospitals and as living standards and healthcare spending continue to rise.

According to Carl Zeiss, IMTEX and similar initiatives could evolve beyond exhibition platforms into dedicated ecosystems for medical manufacturing, bringing together machine tool builders, metrology specialists, medical device manufacturers, regulators, and end users. Such forums could accelerate technology adoption, improve awareness of global regulatory requirements, and strengthen India's capability to compete in export-oriented medical manufacturing.

Where Does the Machine Tool Industry Fit In?

India is the world's ninth-largest producer and fourth-largest consumer of machine tools, according to CECIMO estimates. Indian machine tool production in FY26 rose by about 19 percent year-on-year to INR 17,387 crore (US\$ 2 billion). The industry's imports in FY26 grew 16 percent year-on-year to INR 21,628 crore (US\$ 2.4 billion). Machine tool exports from India surged by 76 percent in FY26, totalling INR 2,596 crore (US\$ 0.3 billion). Consumption increased by about 15 percent to INR 36,419 crore (US\$ 4.1 billion) in FY26.

Indigenous manufacturers meet only about 40 percent of the national demand for machine tools, leaving a significant gap that is filled by imports. In medical manufacturing, this gap presents an opportunity as global buyers seek to de-risk supply chains by reducing dependence on a single country.

Indian machine tool builders have a genuine opportunity to embed themselves more deeply in medical component supply chains, provided they can deliver the precision, surface finish, and regulatory-compliant repeatability that users seek. The government's PLI scheme and dedicated medical devices parks, layered on top of the machine tool industry's own capability upgrades, give Indian manufacturers a stronger platform to compete on quality rather than on cost alone.

Machine tool companies are already pursuing these opportunities while continuing their engagement on flagship platforms like IMTEX and deepening collaboration with metrology and quality-certification specialists. This positions the Indian machine tool industry not only as a supplier of equipment but also as an enabler of India's ambition to become a trusted, quality-certified source for medical components worldwide.

As India works towards building a US\$ 30 billion medical devices market by 2030, the Indian machine tool industry's role will become even more central, not as a peripheral input but as the foundation for precision, compliance, and export competitiveness in medical manufacturing.

A dedicated ecosystem for medical manufacturing, supported by seminars, customer engagement, and technology platforms, could play a pivotal role in achieving this objective, according to Carl Zeiss. 

As India works towards building a US\$ 30 billion medical devices market by 2030, the Indian machine tool industry's role will become even more central, not as a peripheral input but as the foundation for precision, compliance, and export competitiveness in medical manufacturing.

AI FUELS SMART MANUFACTURING

As manufacturers move beyond automation, artificial intelligence is emerging as the next driver of operational excellence. However, realizing its full potential requires more than deploying advanced algorithms—it demands trusted data, contextual intelligence, and human oversight.



Source: Isgec Heavy Engineering Ltd

Over the last few years, I have walked the floors of more than 25 factories and worked with over 80. As an engineer, the fascination never fades. I have watched imbibition water land on a bed of crushed sugarcane, a lab validate a pharmaceutical batch molecule by molecule, an air conditioner take shape across two miles of assembly line, and a semiconductor fab run in air cleaner than an operating theatre.

The Next Frontier

The last decade was the era of automation. The factory built a

body. Sensors gave it the ability to feel; automation systems enabled it to act. In most advanced plants, that body is now firmly in place. The next frontier is intelligence—the ability to anticipate what lies ahead, notice signs that something is going wrong, and recommend the next course of action. That, in essence, is smart manufacturing and it rests on three capabilities: forecasting, anomaly detection, and optimization.

Intelligence needs something to think with, and that is where many AI projects falter. Walk into almost any manufactur-

ing plant and a familiar pattern emerges: sensor data exists, but confidence in it is low. Critical readings are still logged by hand, while information remains scattered across SCADA, historians, LIMS, ERP systems, and spreadsheets, leaving no single source of truth. Without a trusted data foundation, even the most advanced AI models cannot deliver reliable outcomes.

Before intelligence comes memory—a governed data layer built through data logistics. It provides a catalog of available data, traces its lineage from the shop floor to the dashboard, and

SAGAR MAHURKAR
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Metalworking companies face challenges today as never before. Under increasing pressure to reduce costs and environmental impact, they are also dealing with new highly engineered materials, creating new requirements in manufacturing processes and metalworking fluids. At this critical point in time, we are the long-term partner for manufacturers seeking to anticipate and overcome these challenges. We are committed to offering innovative solutions to help our metalworking customers run more efficiently today and reap the opportunities of the future.

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Metal Removal Fluids



For Indian manufacturers, the good news is that AI does not require replacing existing control systems or ERP platforms. Instead, these capabilities sit as an intelligent layer above the current infrastructure.

establishes semantic models so that 'yield' means the same thing across the enterprise. It is unglamorous work, but it creates the Information Architecture (IA) that makes AI possible. Generative AI, after all, is only one branch of the broader AI ecosystem.

Forecasting with AI

Forecasting is foresight, and it is where AI most clearly beats traditional spreadsheets. On the shop floor, demand, warranty returns, and part failures are often treated as random events to be managed with safety stock. In reality, they are rarely random. A warranty return is often the delayed consequence of a sale made years earlier, while many components follow predictable failure curves three to five years after deployment. When these timelines are mapped against the installed base, what appears to be noise begins to reveal clear patterns. Working with manufacturers such as Daikin and Bourns taught me that forecasting accuracy depends less on sophisticated algorithms than on the breadth of data—often drawing on more than 500 external variables, from weather to construction—and the discipline of data management. Classical methods typically deliver error rates of 15–40 percent, while multivariate machine learning models

routinely reaches 5–15 percent. That gap is the difference between the forecast finance trusts and one it overrides.

Detecting the Unexpected

Anomaly detection is a sharper sense, and perhaps the most undervalued capability of AI. A plant produces far more signals than any control room can monitor, and the anomalies worth catching rarely reveal themselves through a single tag. Instead, they lie in the relationship between a decision and its consequence—a wash time and final-product purity, or a cleaning schedule and steam economy. AI can monitor all of these relationships continuously, keeping the closest watch on assets one cannot afford to lose: mills, turbines, boilers, and centrifugals.

The real craft lies in tuning the alerts with the operators themselves. A tool the shop floor learns to ignore is worse than having no tool at all. In factory operations, that continuous watch transforms reliability from a monthly post-mortem into something managed in real time. We have seen downtime fall from 4.89 percent to 0.03 percent.

Optimization with Human Oversight

Optimization is judgment, and it has to be earned. Once the plant trusts what the system sees, the same models can recommend

decisions: a setpoint, a cleaning interval, or a scrap-or-keep call. Optimization that comes before people trust the underlying detection simply gets switched off. The version that lasts keeps a human in the loop: the model recommends, the operator decides and acts, and the manager reviews at regular intervals. Here, intelligence is an advisor with an audit trail.

Building Trust in AI

For Indian manufacturers, the good news is that AI does not require replacing existing control systems or ERP platforms. Instead, these capabilities sit as an intelligent layer above the current infrastructure, drawing data from systems and feeding recommendations back into the manufacturing operations. Manufacturers should calibrate against their own measurements rather than industry reference values and rely only on numbers validated by their own data. The next wave of smart manufacturing will not belong to those who simply adopt the most advanced AI models. It will belong to those who build the trustworthy data foundation, apply intelligence to the decisions that matter most, and have the patience to earn one proven trust result at a time. The body is built. The interesting work now lies in orchestrating it with intelligence. 



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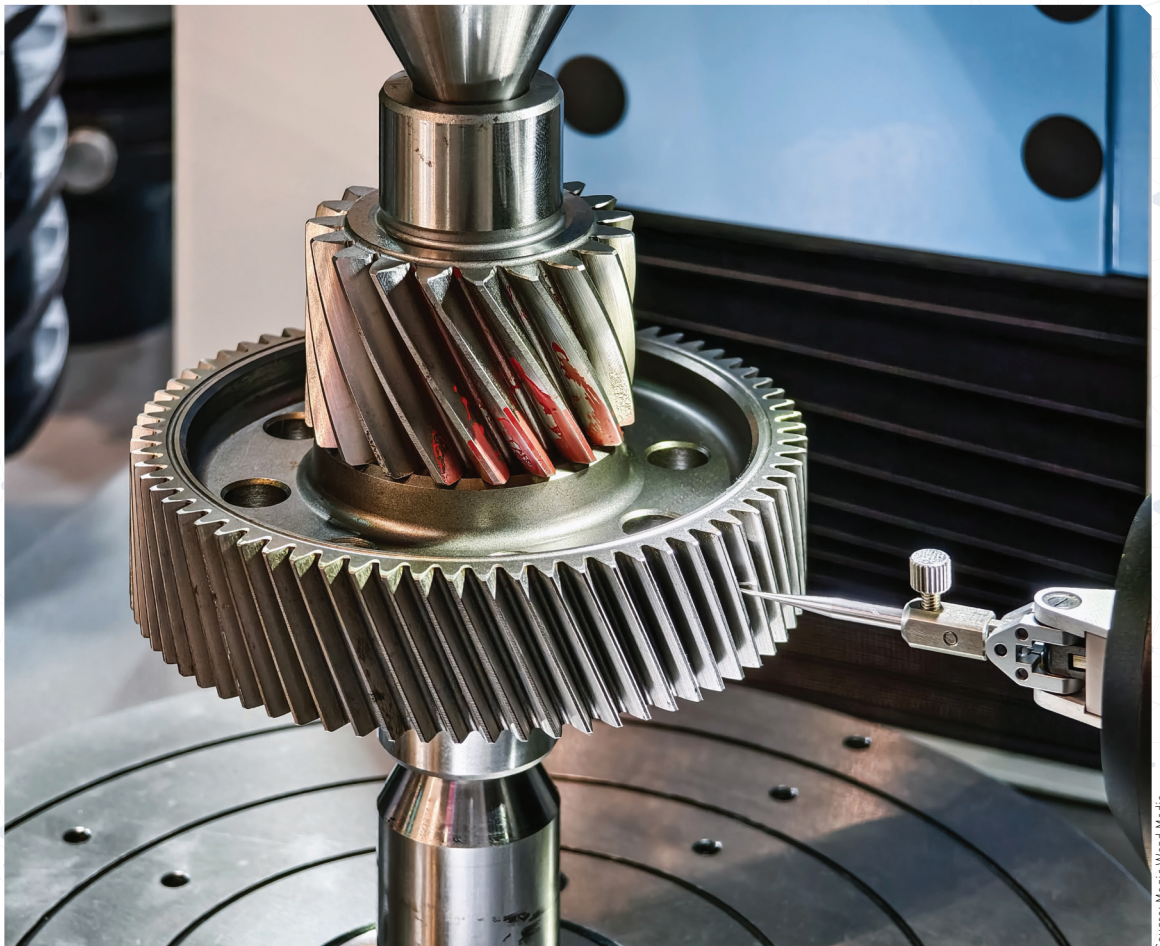
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COMPETING ON THE EIGHT DIMENSIONS OF QUALITY

Reji Varghese revisits Harvard professor David Garvin's landmark framework on the Eight Dimensions of Quality, showing why true manufacturing excellence is about much more than inspections and tolerances, and how companies can create lasting competitive advantage by understanding quality through the customer's eyes.



Source: Magic Wand Media

REJI VARGHESE
President
RV Forms & Gears
fngreji@gmail.com



Ask ten manufacturing professionals what quality means, and the answers are likely to vary.

A production engineer may define quality as meeting specifications, while a purchase manager may associate it with supplier consistency. Customers often view quality as a product's ability to perform reliably over time, whereas service

engineers may focus on how quickly a machine can be repaired when problems arise.

The reality is that quality is much broader than most of us assume.

In the 1980s, Harvard Business School professor David Garvin challenged the traditional view of quality in his landmark article, 'Competing on the Eight Dimensions of Quality'. His central argu-

ment was simple: quality is not a single characteristic but a combination of different dimensions, each capable of influencing customer satisfaction and competitive advantage.

Four decades later, Garvin's framework remains highly relevant, particularly for Indian manufacturers serving demanding global markets in automotive, aerospace, electronics and industrial machinery.

Why Quality is Often Misunderstood

Many organizations reduce quality to inspection reports, rejection rates, and compliance audits. These measures matter since no manufacturer wants defective products reaching customers. However, they represent only part of the picture. Some companies achieve excellent inspection results yet struggle to succeed in the market. Others have products that technically meet specifications but fail to delight customers.

Garvin argued that quality should be viewed from the customer's perspective rather than purely from the factory floor. Customers judge products across multiple dimensions, not just their conformance to drawings.

Understanding these dimensions helps manufacturers make better strategic decisions and avoid optimizing one aspect of quality while neglecting others.

1

Performance: Does It Do the Job Well?

Performance refers to the primary operating characteristics of a product.

For a CNC machine, performance may be measured by accuracy, cutting speed, and productivity. An aircraft engine's performance may be judged by thrust, fuel efficiency, and reliability. In the case of a smartphone, it may involve processing speed, battery life, and camera performance. Customers usually notice performance first because it directly affects productivity and value. Toyota's global success was built partly on delivering vehicles that performed consistently well in everyday use and were economical to maintain. In Aerospace, companies such as Boeing and Airbus compete intensely on performance metrics that matter to airlines, like safety, fuel efficiency, and operating costs. Although performance is often the most visible dimension of quality, it is only one piece of the puzzle.

2

Features: The Extras That Create Differentiation

Features are the additional characteristics that complement core performance. For example, a machine tool manufacturer may offer remote diagnostics, predictive maintenance soft-

ware, or automated tool management systems. While these features do not determine whether the machine functions, they can significantly enhance customer value.

In today's manufacturing environment, software has become an increasingly important source of features. The challenge lies in determining which features customers genuinely value. Adding complexity for its own sake rarely creates a competitive advantage.

As many manufacturers have discovered, customers are often willing to pay for useful features but not for unnecessary ones.

3

Reliability: Will It Work Consistently?

Reliability measures the probability that a product will perform without failure over a specified period.

In industries such as Aerospace, Medical Devices, and Automotive Manufacturing, reliability is critical. A machine that produces accurate parts most of the time is far less valuable than one that performs accurately every time.

Japanese manufacturers gained global recognition because they focused relentlessly on reliability. Customers learned that products from companies such as Toyota, Honda, and Canon could be trusted year after year.

Reliability reduces downtime, maintenance costs, and customer frustration. It also builds something far more valuable than product performance alone: trust.

4

Conformance: Does It Meet Specifications?

Conformance is the dimension most engineers immediately associate with quality. It refers to the extent to which a product meets its design specifications and manufacturing standards. For example, if a drawing calls for a tolerance of ± 10 micron, quality requires consistently achieving that tolerance. This is where systems such as ISO 9001, statistical process control, and rigorous inspection procedures play an important role.

Conformance remains essential because poor conformance creates defects, rework, and customer complaints. However, as Garvin cautioned, conformance alone does not guarantee customer satisfaction. A product can perfectly meet specifications and still fail to meet customer expectations.

5

Durability: How Long Will It Last?

Durability reflects the useful life of a product before replacement becomes necessary.

Many organizations reduce quality to inspection reports, rejection rates, and compliance audits. These measures matter since no manufacturer wants defective products reaching customers. However, they represent only part of the picture.

Garvin's framework reminds us that quality is multidimensional. Improving quality requires more than reducing defects. It requires understanding what customers value and delivering excellence across multiple dimensions.

Customers often evaluate value by comparing initial cost against expected lifespan.

Heavy industrial equipment, aircraft components and automotive powertrain systems are expected to deliver years of dependable service.

Durability can be a significant competitive advantage. Customers frequently remember products that continue working long after competitors' products have failed. At the same time, manufacturers must balance durability with cost. Overengineering can make products unnecessarily expensive.

The goal is to achieve the durability customers need without adding costs they do not value.



Serviceability: What Happens When Something Goes Wrong?

No product is perfect. Eventually, maintenance or repairs may be required.

Serviceability refers to the ease, speed, and effectiveness of servicing a product. This dimension is becoming increasingly important in modern manufacturing.

A customer may forgive an occasional failure if support is fast, competent, and responsive. On the other hand, even a reliable product can create frustration if repairs are difficult and spare parts are unavailable.

Many successful machine tool builders have built strong reputations through their service organizations. Ultimately, customers remember how effectively a company responds when problems arise.



Aesthetics: The Emotional Side of Quality

Engineers sometimes underestimate aesthetics since they are inherently subjective.

Yet a product's appearance, feel, sound, and overall sensory experience can strongly influence customer perceptions of quality.

Consider the difference between two machines with identical technical performance. One looks thoughtfully designed, organized, and professional. The other appears cluttered and unfinished. Although both may perform equally well, most customers will instinctively perceive the first machine as of higher quality.

Apple demonstrated the power of aesthetics on a global scale, but the principle applies equally to industrial products.

Ultimately, aesthetics communicate care, attention to detail, and professionalism.



Perceived Quality: Reputation Matters

Perceived quality reflects the customer's overall impression of a product or company. This perception may be influenced by brand reputation, previous experience, recommendations, and market standing.

In many cases, customers cannot immediately evaluate every technical detail of a product. Instead, they rely on signals that indicate likely quality. This is why reputation is such a valuable business asset. Companies spend years building trust and can lose it remarkably quickly.

For manufacturers entering global markets, perceived quality often determines whether they are invited to participate in major projects.

What This Means for Indian Manufacturing

India's Manufacturing sector is undergoing a significant transformation. As Indian companies expand their presence in global automotive, aerospace, electronics, and industrial supply chains, customers are evaluating suppliers on far more than price alone. They expect reliability, durability, service support, innovation, and strong quality systems.

Garvin's framework reminds us that quality is multidimensional. Improving quality requires more than reducing defects. It requires understanding what customers value and delivering excellence across multiple dimensions.

The most successful manufacturers do not simply produce parts within tolerance. They create products that perform well, last longer, inspire confidence, and strengthen customer trust.

The Real Competitive Advantage

W Edwards Deming famously observed that quality should be aimed at the needs of the customer, present and future. Garvin expanded that idea by showing that customer needs are more complex than many organizations realize.

When manufacturers think beyond inspection reports and rejection percentages, quality becomes a strategic tool rather than a compliance requirement. That shift in thinking may be one of the most important lessons modern manufacturing leaders can learn. Because in the end, customers rarely judge quality through a single dimension. They experience it through all eight.



Reji Varghese is the President of RV Forms & Gears, a 54-year-old engineering company based in Chennai, India. A dedicated meditation practitioner since 2015, he writes on business, manufacturing, leadership and contemplative practice for a range of Indian and international publications.



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Regional HQ - Singapore

Motul Asia Pacific Pte Ltd
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Lead-Free Machining and the Cutting Tool Industry

The regulatory landscape governing lead in manufacturing is undergoing a significant transformation in Europe. Driven by a suite of directives and regulations, the permissible use of lead across a broad range of products and materials is being curtailed with increasing rigor. For engineers and manufacturers, particularly those supplying European markets or working with free-cutting alloys, this transition demands both awareness and adaptation.

Europe's restrictions on lead are governed not by a single regulation but by an interlocking set of frameworks, each targeting a distinct product category or use case.

RoHS (Restriction of Hazardous Substances) limits lead in electrical and electronic equipment to a maximum of 0.1 percent by weight in homogenous materials. Exemptions that previously allowed lead in high-melting-point solders and as an alloying element in steel, aluminum, and copper are being phased out on fixed timelines, offering manufacturers a narrowing window for compliance.

REACH takes a broader view, restricting total lead content in consumer products and accessible articles — particularly those reachable by young children — to 0.05 percent (500 ppm) by weight. The European Chemicals Agency (ECHA) continues to advance authorization requirements for metallic lead in European manufacturing, signaling that restrictions will only intensify.

The Drinking Water Directive has halved the permissible lead concentration at the tap from 10 µg/L to 5 µg/L, effectively mandating a 0.1 percent maximum lead threshold for alloys such as brass and bronze used in plumbing applications. EU Positive Lists are now being enforced to ensure compliance across all water-contact materials.

Ammunition Restrictions round out the picture: the EU has banned lead gunshot in wetlands and is progressing toward broader habitat-wide restrictions under REACH, with the eventual phase-out of lead in shots, bullets, and fishing weights firmly on the agenda.

NIKHIL NAYAK
Managing Director
NN Combined
Engineering
Agencies Pvt Ltd



Implications for Indian Manufacturers

For Indian manufacturers exporting to European markets, these regulations carry direct compliance obligations. Products containing lead concentrations above the prescribed thresholds — whether in electronic components, plumbing fittings, or consumer-accessible parts — risk rejections, withdrawal from the market, or significant financial penalties. Exporters must audit their material supply chains, update product declarations, and engage proactively with EU customers to confirm conformity.

These regulations make it clear that early adaptation is preferable to reactive compliance.

The regulatory landscape governing lead in manufacturing is undergoing a significant transformation in Europe, demanding both awareness and adaptation from engineers and manufacturers. RoHS, REACH, and the Drinking Water Directive are collectively narrowing the permissible use of lead across a broad range of products and materials. For Indian manufacturers exporting to Europe, products exceeding prescribed lead thresholds risk rejection, market withdrawal, or significant financial penalties.

The Machining Challenge

From a cutting tool perspective, the shift away from lead-containing alloys introduces a set of machining challenges that deserve careful attention. Alloys developed under the new lead restrictions will have significantly different machining properties compared to their leaded counterparts.

To understand why, it helps to examine precisely what lead does within an alloy's microstructure. During machining, lead — a soft, heavy metal — forms small nests or inclusions within the

alloy. These inclusions act as

predetermined breaking points, causing chips to fracture at regular intervals and producing the short, controllable chips that are essential for machining. At the same time, lead functions as an in-situ lubricating film at the tool-workpiece interface, reducing friction, lowering cutting forces, and measurably extending tool life. It is this dual role — structural chip breaking and interfacial lubrication — that makes lead so effective as a machinability additive, despite its well-documented toxicity.

Without lead, whether in brass or free-cutting steel, chips tend to become long and stringy, increasing the risk of tool entanglement, surface damage, and unplanned machine downtime. The absence of the lubricating effect also means greater heat generation at the cutting edge, accelerated tool wear, and the need for more frequent tool changes — all of which carry cost and productivity implications.

Tooling and Process Adaptations

Transitioning to lead-free alloys is not simply a material substitution — it requires a systematic review of the entire machining process. Cutting speeds, feed rates, and depth of cut may all need recalibration. Tool coatings optimized for leaded materials may perform sub-optimally on alternatives such as bismuth-bearing brass or silicon-brass alloys. Carbide grades, insert geometries, and chip breaker designs should be evaluated specifically for the lead-free substitute in question, as performance characteristics vary considerably between alternative alloys.

Coolant selection and delivery also warrant attention. High-pressure coolant systems can help mitigate the increased heat generation associated with lead-free machining, though the appropriate approach will depend on the specific alloy and component geometry. Tooling suppliers and end users alike will benefit from systematic trials rather than assuming that existing parameters translate across to lead-free materials.

The regulatory momentum in Europe is unambiguous: lead will be progressively removed from the manufacturing supply chain. For the Cutting Tool industry, this represents both a challenge and an opportunity — to develop tooling solutions, test methodologies, and process knowledge that enable manufacturers to machine lead-free alloys with the efficiency and reliability previously achieved with leaded materials. Early engagement with this transition will be the distinguishing factor for those who compete successfully in this new environment. 



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The Liquid Advantage



Source: Magic Wand Media

SOUAMI MITRA
Editor-in-Chief
Modern Manufacturing
India
soumi.mitra@
magicwandmedia.in



The modern manufacturing shop floor is undergoing a seismic shift. Driven by high-speed CNC centers, complex lightweight alloys, strict sustainability mandates, and the digital push of Industry 4.0, metalworking fluids, and industrial lubricants are no longer viewed merely as passive consumables.

Industry leaders now regard fluid as an essential, active component, a 'Liquid Tool' that directly affects total cost of ownership (TCO), tool life, process stability, and operator safety.

As automotive, aerospace, and defence sectors scale up production using lightweight and hard-to-machine materials such as titanium, Inconel, aluminum, and advanced composites, the thermal and mechanical demands on cutting tools have intensified. Titanium, for instance, presents a severe challenge due to its low thermal conductivity, which traps heat directly at the cutting edge and rapidly destroys tools.

Mastering High-Speed Machining and Tough Alloys

To address these extreme conditions, Blaser Swisslube Solutions collaborated on high-pressure 5-axis horizontal machining trials with Makino and Walter Tools. Punit Gupta, Managing Director, Blaser Swisslube Solutions Pvt Ltd, explains, "Titanium is exactly where our specially designed fluid formulation makes or breaks the economics of a job. On the face insert, tool life went from 27 minutes with standard coolant to 31 minutes with Vasco Skytec H 600—a 15 percent improvement. On peripheral inserts, it was even bigger: 44 minutes up to 66 minutes—a 50 percent jump."

Similarly, handling non-ferrous and exotic lightweight alloys introduces issues like built-up edge (BUE), micro-cracking, and thermal shock. MotulTech India leverages global innovation labs to counter these issues. Yatendra Rajput, Business Head, MotulTech India Pvt Ltd, elaborates, "These products prevent built-up edge formation

on soft and ductile lightweight materials, eliminate temperature spikes caused by uneven coolant application, and shield tools from micro-cracking." The company's specialized chemistries also ensure crack-free working for titanium, which can be a big problem if metal-working fluids contain EP additives that react with titanium over time.

Quaker Houghton targets similar challenges in electric vehicle (EV) component manufacturing, such as high-pressure aluminum die castings. Raul Jurado Yanini, Vice-President - India, Middle East, Africa (IMEA), Quaker Houghton, outlines the company's strategy, "Quaker Houghton is working on improvising the boundary lubrication and enhancing the EP additives to prevent metal-to-metal contact, thus ensuring that the BUE issue is taken care of balancing the products by improvising heat dissipation over sheer lubricity."

Witmans Advanced Fluids, in collaboration with OEST Germany, focuses on high thermal stress in high-speed CNC machining. Santosh Chakraborty, Managing Director, Witmans Advanced Fluids Pvt Ltd, emphasizes, "Our formulations rapidly dissipate heat, provide superior lubricity, and remain thermally stable under extreme cutting temperatures, ensuring consistent performance without additive breakdown."

Foam Suppression and High-Pressure Reliability

Modern machine tools operating with through-spindle coolant pressures exceeding 50 to 70 bar create highly turbulent sump environments that can lead to micro-foaming, cavitation, and sudden tool degradation. Addressing these intense mechanical stresses, Kluthe



"LTM - Liquidtool Manager - is already rolled out in India. It is helping customers in creating visibility and transparency on the dataset. Our digital dashboard gives customers an overview of their machines and its measured values at any time."

PUNIT GUPTA
Managing Director
Blaser Swisslube Solutions
Pvt Ltd

India deploys engineered chemical architectures.

Pankaj Maheshwari, General Manager, Kluthe India Pvt Ltd, shares, "Our HAKUFORM and HAKUFLUID technologies are formulated to release entrained air quickly and prevent persistent foam formation. This is achieved through the optimal selection of amines, carboxylic acids, emulsifiers, and defoamers, and is tested on our own CNC machines equipped with a high-pressure system."

Stability under extreme pressure requires a holistic approach to machine hardware compatibility. Sandeep Limbekar, Managing Director, STRUB India Pvt Ltd, points out, "At STRUB, we

As automotive, aerospace, and defence sectors scale up production using lightweight and hard-to-machine materials, the thermal and mechanical demands on cutting tools have intensified.

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"Indian shop floors are shifting toward bio-sourced fluids, not out of ideology, but out of operational logic. Motul Green Tech™ range, formulated from vegetable and synthetic esters, proves this commercially. In MQL-based billet cutting, atomized micro-droplets replace flood coolant entirely, delivering longer blade life, dry chips, zero disposal cost, and near-zero mist, thanks to its exceptional >300°C flash point."

YATENDRA RAJPUT
Business Head
MotulTech India Pvt Ltd

consider metalworking fluid as part of the complete machining system. High anti-foaming stability is important, but so is compatibility with modern tool coatings, guideways, hydraulic systems, and sealing materials." For specialized applications such as precision solid carbide tool grinding and gear hobbing, Zavenir Daubert tackles micro-foaming and fluid breakdown alongside chemical risks like cobalt leaching. Mudit Mathur, Senior Product Manager, Zavenir Daubert India

Pvt Ltd, explains, "ZET-GRIND TT 200 has been specifically engineered to address cobalt leaching. Built on advanced Gas-to-Liquid (GTL) base oil technology, ZET-GRIND TT 200 delivers low-misting and low-evaporation characteristics. Rapid air-release properties further support foam-free operation."

"X-CUT 940 has been specifically engineered for high-speed gear hobbing applications. Built on advanced vegetable ester technology with a high flash point, X-CUT 940 provides outstanding lubricity and efficient heat dissipation," he adds.

Eliminating Cross-Contamination

A persistent pain on shop floors is cross-contamination between tramp oils, slideway lubricants, metalworking fluids, and industrial parts washers. When these chemistries clash, wash defects, residue accumulation, and premature fluid breakdown occur. To resolve interface friction between sequential production stages, Kluthe advocates for a closed-loop philosophy.

Maheshwari elaborates, "Coolant, slideway lubricant, and cleaner must be chemically and physically compatible in the right way. The key advantage of our 5-C Concept—Cutting, Cleaning, Coating, Conserving, and Waste Management—is that we do not optimize a single product in isolation; we understand the entire manufacturing process. We align the chemistry so that each process step supports the next."

Industry 4.0 and Cognitive Fluid Management

Fluid monitoring is transitioning from manual, subjective dipstick checks to automated, real-time digital ecosystems.



"We have successfully reduced 22 percent of Carcinogenic, Mutagenic, or Reprotoxic (CMR) Category 1A/B labeled finished goods by effectively replacing them across 33 active formulations in our portfolio."

RAUL JURADO YANINI
Vice-President - India,
Middle East, Africa (IMEA)
Quaker Houghton

Quaker Houghton has introduced its global digital monitoring technologies locally. Yanini states, "QH FLUID INTELLIGENCE™ provides differentiated value to our customers so they can operate safely, sustainably, and at the optimized total cost of ownership. As a pilot project, we have installed Greenlights® systems at select customer sites. The feedback is clear—customers are looking for zero-human-intervention, Industry 4.0 automation at their sites."

Blaser Swissslube is similarly advancing its digital offerings in India. Gupta highlights, "LTM - Liquidtool Manager - is already rolled out in India. It is helping customers in creating visibility and transparency on the data-



“Successful coolant management is driven by process discipline rather than product alone. Regular monitoring of concentration, water quality, tramp oil, microbiological activity, and filtration is essential.”

SANDEEP LIMBEKAR
Managing Director
STRUB India Pvt Ltd

set. Our digital dashboard gives customers an overview of their machines and its measured values at any time.”

At Zavenir Daubert, fluid chemistry is integrated directly with sensors under that ‘Chemistry 4.0’ vision. Mathur shares, “Our smart fluid management capabilities utilize state-of-the-art sensor technology to monitor fluid performance remotely in real time, providing enhanced control and ensuring consistent performance by minimizing the risk of human error.”

Large-scale operations require rigorous discipline to maintain process consistency. Limbekar, whose team oversees central systems as large as 100,000 liters, remarks, “Successful coolant management is driv-

en by process discipline rather than product alone. Regular monitoring of concentration, water quality, tramp oil, microbiological activity, and filtration is essential.”

Sustainability and Total Cost of Ownership

Environmental standards, regulatory pressures, and operator health considerations are driving manufacturers toward bio-sourced alternatives, hazardous additive phase-outs, and zero-hazard labeling. Blaser Swisslube’s long-standing bio-concept leverages natural micro-flora instead of harsh chemicals. Taking pride, Gupta shares, “Our Blasocut Bio-Concept, introduced in early 70s promotes a naturally robust microbiological equilibrium that ensures long emulsion life. In fact, one central coolant system in India has run on Blaser technology for over 20 years without a complete fluid change.”

MotulTech’s acquisition of Chem Arrow Corporation and its bio-sourced Green Tech™ range further illustrate this eco-friendly shift. Rajput highlights, “Motul Green Tech™ is built on three pillars: products from renewable raw materials, performance that reduces chemical consumption, and technology that lowers energy costs. MotulTech ChemArrow’s proven low- and zero-VOC fin-stamping and tube-bending lubricants are now deployable locally.”

Quaker Houghton actively reduces hazardous substances within its product portfolio through its QH FLUIDCARE™ program. Yanini points out, “We have successfully reduced 22 percent of Carcinogenic, Mutagenic, or Reprotoxic (CMR) Category 1A/B labeled finished goods by effectively replacing



“Our formulations rapidly dissipate heat, provide superior lubricity, and remain thermally stable under extreme cutting temperatures, ensuring consistent performance without additive breakdown.”

SANTOSH CHAKRABORTY
Managing Director
Witmans Advanced Fluids
Pvt Ltd

them across 33 active formulations in our portfolio.”

Witmans Advanced Fluids aligns its formulations with European health standards. Chakraborty states, “Eliminating legacy chemicals such as secondary amines, boron, formaldehyde-releasing biocides requires advanced formulation expertise and strong ethics. We develop products as per European standards, using carefully selected, safer raw materials, even where such regulations are not mandatory.”

Ultimately, transitioning manufacturers from a ‘lowest cost-per-liter’ mindset to a Total Cost of Ownership (TCO) perspective relies on demonstrated operational efficiency, fluid longevity, and waste reduction.

A persistent pain on shop floors is cross-contamination between tramp oils, slideway lubricants, metalworking fluids, and industrial parts washers. When these chemistries clash, wash defects, residue accumulation, and premature fluid breakdown occur.

Ultimately, transitioning manufacturers from a 'lowest cost per-liter' mindset to a Total Cost of Ownership (TCO) perspective relies on demonstrated operational efficiency, fluid longevity, and waste reduction.



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PANKAJ MAHESHWARI
General Manager
Kluthe India Pvt Ltd



“Our smart fluid management capabilities utilize state-of-the-art sensor technology to monitor fluid performance remotely in real time, providing enhanced control and ensuring consistent performance by minimizing the risk of human error.”

MUDIT MATHUR
Senior Product Manager
Zavenir Daubert India Pvt Ltd

As Chakraborty sums up, “Too many suppliers push volume regardless of whether it helps or harms the customer. At WAF, we train representatives to speak the truth. We earn entry by solving problems and focusing on productivity, not litres sold.” 



Company	Key Technology/Product Series	Primary Focus & Operational Impact
Blaser Swisslube Solutions Pvt Ltd	Vasco Skytec H 600, Blasocut Bio-Concept, Liquidtool	15–50% tool life extension in titanium machining; up to 20 years sump life without full fluid change.
Kluthe India Pvt Ltd	5-C Concept, HAKUFORM, HAKUFLUID, HAKUPUR	Closed-loop process harmony; prevents foam and cavitation under high-pressure (>70 bar) machining.
MotulTech India Pvt Ltd	Motul Green Tech™, Bio Clean®, ChemArrow	Bio-based, hazard-label-free fluids; zero-VOC fin-stamping; up to 90% cleaner consumption reduction.
Quaker Houghton	QH FLUID INTELLIGENCE™, QH FLUIDCARE™	22% CMR hazard reduction across formulations; automated dosing and cloud-connected monitoring.
STRUB India Pvt Ltd	Stabillocut Series	Swiss tribology formulation tailored for biostability and large central sump (100,000L) discipline.
Witmans Advanced Fluids Pvt Ltd	OEST Germany Collaboration Formulations	Biostatic, ester-based fluids free from secondary amines, boron, and formaldehyde releasers.
Zavenir Daubert India Pvt Ltd	X-COOL Series, ZET-GRIND TT 200, X-CUT 940	Nano-emulsion, GTL-based anti-cobalt leaching oils, and biodegradable high-speed gear hobbing fluids.

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ENGINEERING THE FUTURE WITH DESIGN-LED MANUFACTURING

In this exclusive conversation with MMI's Editor-in-Chief Soumi Mitra, Rabindra Srikantan, Founder & Managing Director, ASM Technologies Ltd, discusses the company's transformation from an Engineering Research & Development (ER&D) services provider to a Design-Led Manufacturing (DLM) partner, its expansion plans, the growing role of Industrial AI, and how India can strengthen its position as a global hub for high-value engineering and advanced manufacturing.



Source: ASM Technologies Ltd

Rabindra Srikantan, Founder & Managing Director, ASM Technologies Ltd

ASM Technologies has successfully transitioned from being a pure Engineering Research and Development (ER&D) service provider to a global leader in Design-Led Manufacturing (DLM). How has this evolution altered your core value proposition for high-tech sectors like semiconductors and aerospace? Headquartered in Bengaluru, ASM Technologies Ltd is a glob-

al ER&D and digital engineering firm. We deliver product design, consulting, and design-led manufacturing services. The company primarily serves the semiconductor, automotive, and solar energy industries. We were established in 1992 and now have a global presence in USA, Singapore, UK, Canada, Mexico and Japan. As an ER&D provider, ASM was focused on two broad verticals—

high-tech capital equipment (semiconductors, electronics and solar) and engineering. We made a conscious decision to pivot to Design-Led Manufacturing (DLM) while continuing to focus on these core verticals. Today, we support our customers across the complete value chain and product lifecycle—from design and engineering to manufacturing—powered by Industrial AI.

SOUMI MITRA
Editor-in-Chief
Modern Manufacturing
India
soumi.mitra@
magicwandmedia.in



With major infrastructure investments underway, including substantial expansion initiatives in Karnataka and Tamil Nadu for Electronic System Design and Manufacturing (ESDM), what specific capacities and technological capabilities are these new facilities designed to unlock?

Our expansion is focused on building world-class manufacturing capabilities for high-precision capital equipment. We have already commissioned three new manufacturing facilities, including one in Vietnam, in addition to our existing operations. We are also setting up a 10-acre integrated Design-Led Manufacturing campus in Karnataka. These facilities will enhance our capacity to support semiconductor, electronics and industrial equipment manufacturing, while strengthening our ability to serve global customers through advanced manufacturing, AI-enabled operations, and scalable production capabilities.

India's semiconductor landscape is experiencing an unprecedented surge. From your perspective as an industry pioneer, what are the most critical engineering and design gaps that Indian firms must bridge to compete on a global scale?

India has already established itself as a global leader in semiconductor chip design, and these capabilities will continue to scale for global markets. With the semiconductor industry entering a new growth cycle and India emerging as a strategic manufacturing destination, this presents a significant opportunity for the entire ecosystem. To compete globally, Indian companies must strengthen capabilities in advanced engineering skills, talent development, capital equipment, materials, precision manufacturing and supporting infrastructure.

"The recently announced ISM 2.0, with an outlay of INR 1.27 lakh crore, will accelerate the ecosystem by focusing on six key pillars—design, machines and materials, fabrication, ATMP/OSAT, R&D, and talent development—providing a major boost to India's ambition of becoming a globally competitive semiconductor manufacturing hub."

**Rabindra Srikantan
Founder &
Managing Director
ASM Technologies Ltd**

The Government of India's India Semiconductor Mission (ISM) 1.0 has laid a strong foundation, with 12 approved projects involving investments of over INR 1.64 lakh crore, including three units already in commercial production. The recently announced ISM 2.0, with an outlay of INR 1.27 lakh crore, will further accelerate the ecosystem by focusing on six key pillars—design, machines and materials, fabrication, ATMP/OSAT, R&D, and talent development—providing a major boost to India's ambition of becoming a globally competitive semiconductor manufacturing hub.

The joint venture between ASM Technologies and Hind High Vacuum (HHV) represents a major step forward for domestic semiconductor equipment manufacturing. Could you share some insights on how this synergy is progressing?

Our joint venture with Hind High Vacuum (HHV) is focused on building indigenous capabilities

in advanced manufacturing equipment for India's solar and semiconductor ecosystem.

During FY26, we made significant progress in developing next-generation photovoltaic materials, silicon processing technologies, and specialized manufacturing equipment for solar cell production. We have successfully completed process simulations and engineering validation, while prototype hardware is currently under fabrication. Customer qualification is also underway for specialized intermediate storage and handling systems, with repeat orders already secured.

Looking ahead, we are developing indigenous silicon crystal growth equipment and believe the opportunities under ISM 2.0 will significantly accelerate India's journey towards self-reliance in strategic manufacturing equipment under the 'Make in India' initiative.

Through your subsidiary, RV Forms & Gears, LLP, ASM has driven significant innovation in industrial fixtures with Smart-Fix 4.0. How are intelligent fixture technologies reshaping the shop floor, and what is the next frontier?

Manufacturing is evolving towards intelligent, connected and autonomous operations. Across our manufacturing equipment and sub-systems, we are integrating automation, Industrial AI, sensors, IIoT, and advanced analytics to improve precision, productivity, and quality.

At ASM, this transformation is powered by our AI strategy, with AI Assist serving as the foundational intelligence layer that enables engineers and operators to access enterprise knowledge and machine data through natural language. Building on this foundation, Predictive AI, Vision AI, Engineering AI, and Conversational AI, together with our strategic partnership with Myelin Found-

The opportunities under ISM 2.0 will significantly accelerate India's journey towards self-reliance in strategic manufacturing equipment under the 'Make in India' initiative.

India is well positioned to become a significant player in the global supply chain, particularly in advanced manufacturing, by leveraging its strong engineering and design capabilities alongside the growing demand driven by its expanding economy.

“With the semiconductor industry entering a new growth cycle and India emerging as a strategic manufacturing destination, this presents a significant opportunity for the entire ecosystem.”

Rabindra Srikantan
Founder & Managing Director
ASM Technologies Ltd



Source: ASM Technologies Ltd

ry, are enabling AI-native manufacturing equipment. The next frontier is the development of self-optimizing manufacturing systems capable of predictive maintenance, intelligent process control, autonomous decision-making, and continuous learning across the entire production lifecycle.

ASM has built deep expertise in integrating IoT, Virtual Reality (VR/AR), and advanced simulation into product design. How are your clients leveraging these digital tools?

Digital engineering continues to evolve rapidly, and today the focus has expanded beyond traditional technologies such as IoT, VR/AR and simulation to AI-enabled engineering and intelligent manufacturing.

At ASM, we are helping customers leverage AI Assist, Vision AI, Predictive AI, Engineering AI and Conversational AI to transform engineering, manufacturing, and lifecycle support. These technologies enable faster product development, improved design quality, predictive maintenance, enhanced asset performance, and intelligent decision-making.

Combined with our Design-Led Manufacturing approach, they help customers accelerate innovation, improve operational effi-

ciency and build AI-native manufacturing ecosystems that are ready for the future.

With a footprint extending across the US, Europe, Japan and emerging manufacturing hubs like Vietnam, how do you balance global design standards with localized production requirements?

We operate across multiple geographies and adhere to globally recognized certifications and quality standards. While we have our own design standards, we also adapt to customer-specific design requirements to meet local market needs.

We have established manufacturing operations in Vietnam to serve customers across Asia, and we will continue to expand our manufacturing footprint in strategic global locations.

High-precision industries like semiconductor equipment require highly specialized engineering talent. What initiatives is ASM undertaking to cultivate a future-ready workforce?

Talent development is a strategic priority at ASM. We work closely with leading academic institutions to strengthen hiring, skill development, and collaborative research, creating a strong pipeline of future-ready engineers.

At the same time, we continu-

ously invest in upskilling our existing workforce to keep pace with rapidly evolving technologies in semiconductors, Industrial AI, advanced manufacturing, and engineering.

By combining academic partnerships, continuous learning, and hands-on exposure to emerging technologies, we are building a highly skilled workforce capable of delivering next-generation engineering and manufacturing solutions for global markets.

Please share your long-term vision for ASM Technologies' role in shaping India's identity as not just a manufacturing hub, but a global powerhouse for complex, high-value engineering design.

India is well positioned to become a significant player in the global supply chain, particularly in advanced manufacturing, by leveraging its strong engineering and design capabilities alongside the growing demand driven by its expanding economy.

Global companies will increasingly manufacture in India—not only to serve the domestic market but also to supply global markets. ASM Technologies aims to play a pivotal role in this transformation by strengthening India's position as a global hub for high-value engineering, design, and advanced manufacturing. 

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Vignesh M +91 81971 75872 vigneshm.v@eplan.in



Source: Magic Wand Media

BRIDGING THE DIVIDE BETWEEN 3D PRINTING AND MILLING

As medical manufacturing evolves from standard mass production to patient-specific implants and complex trabecular lattice structures, the traditional boundary between Additive Manufacturing (AM) and high-precision CNC machining (HMC/VMC) is rapidly dissolving. Yet, seamlessly blending 3D printing with metal-cutting processes presents a formidable mix of technical, digital, and regulatory hurdles.

Creating a modern implant requires marrying two fundamentally opposite manufacturing philosophies - Additive Manufacturing (AM), which uses lasers or electron beams to build organic shapes layer by layer from metal powder, and Subtractive Manufacturing (CNC Machining), which uses ultra-precise

spinning cutters to shave away metal down to the fraction of a micron.

Bridging these two worlds is anything but simple. How do you clamp a fragile, porous titanium structure into a multi-tonne CNC vise without crushing it? How do you pass data seamlessly between a 3D printer and a milling machine?

And should the medical factory of the future rely on all-in-one hybrid machines, or automated, specialized production cells?

To decode this technical cross-road, industry experts from across additive manufacturing, machine tool building, and industrial automation share their insights on the future of medical engineering.

SOUMI MITRA
Editor-in-Chief
Modern Manufacturing
India
soumi.mitra@
magicwandmedia.in





“Designing with both additive and subtractive processes in mind improves dimensional accuracy, reduces handling risks, and makes automation easier without affecting the functional performance of the final medical part.”

Dr Vishwas Puttige
CEO & Managing Director
amace solutions Pvt Ltd

The Digital Thread: Software Handshake or Shared Illusion?

The ideal vision for smart manufacturing is a seamless ‘digital thread’—an unbroken software pipeline where a 3D printer embeds orientation, structural history, and datum coordinates directly into a digital file for a CNC milling center to read automatically. However, bringing this digital twin to life on the shop floor reveals significant software silos. Rahul Singh, Senior Manager, Business Development, Jyoti CNC Automation Ltd, points directly to the software fragmentation that slows down regulated shops. “A major challenge in bridging additive and subtractive manufacturing for medical engineering is the fragmented digital workflow. AM, CAM, and CNC machining still operate on separate software platforms, requiring file conversions that

increase validation risks. While standards such as STEP AP242, MTConnect, and OPC UA are improving interoperability, a universal digital twin remains under development.”

Where Singh sees software gaps waiting to be bridged over the next five to six years, Jagannath Varadaraja Iyengar, EVP & COO, m2nxt Solutions Pvt Ltd, sees a problem of architectural ownership.

“The industry talks about a unified digital twin handshake, but the real gap isn’t software — it’s ownership,” Iyengar argues. “Too many players are trying to bolt AM and subtractive systems together without seamless connectivity. At m2nxt, our approach has been to build hybrid platforms where that handshake is never needed in the first place, because deposition and machining reside in one control architecture from day one.”

For material and hardware developers like Payal Doshi, APAC Marketing Manager, Formlabs, expecting a single proprietary platform to solve everything is unrealistic. Instead, the focus must be on open interoperability. “Today, many manufacturers still rely on multiple software platforms and manual data transfers, which can introduce inefficiencies and increase validation effort, particularly in regulated sectors like medical manufacturing,” she observes. “The focus should be on improving interoperability through open standards and seamless data exchange rather than expecting a single software ecosystem to dominate.”

Machine tool builders are working toward practical realities while these standards evolve. Jayarama Naidu, Managing Director, GROB Machine Tools India Pvt Ltd, offers a realistic assessment of where the industry stands today. “How close are we?



“Printed-on datum features and on-machine probing enable flexible, patient-specific implant production. By pairing our machining centers with the GMP300 additive system, GROB seamlessly bridges both sides of this handover.”

Jayarama Naidu
Managing Director
GROB Machine Tools India
Pvt Ltd

Honestly: a truly unified, plug-and-play standard is still some years away — today the handshake works reliably only inside integrated CAM chains,” he highlights. “But the building blocks are emerging: the 3MF format is evolving to carry build and traceability data, STEP AP242 embeds product information directly in the model, QIF closes the loop on the measurement side, and UMATI, based on OPC UA, gives machines from different manufacturers a common language.” While software developers refine these formats, hardware automation is stepping in to maintain physical alignment across production steps. Raghav Badhaya TV, President, Makino India Pvt Ltd, highlights how physical fixtures help support the digital thread. “By combining AML-Series additive manufacturing machines with conventional subtractive machines, Makino can

The ideal vision for smart manufacturing is a seamless ‘digital thread’—an unbroken software pipeline where a 3D printer embeds orientation, structural history, and datum coordinates directly into a digital file for a CNC milling center to read automatically.

A major challenge in bridging additive and subtractive manufacturing for medical engineering is the fragmented digital workflow. AM, CAM, and CNC machining still operate on separate software platforms, requiring file conversions that increase validation risks.

support an integrated workflow where additive and machining operations are coordinated through centralized job management and automated sequencing. Robotized pallet transfer with 0-point clamping helps preserve the physical datum from deposition through final machining.” Dr Vishwas Puttige, CEO & Managing Director, amace solutions Pvt Ltd, shares that embedding data at the start of the build remains the goal for regulatory traceability. “Going forward, additive manufacturing systems are expected to embed datum references, orientation details, and traceability information directly into the build file,” he explains. “This would allow downstream CNC machines to automatically identify the workpiece orientation and manufacturing history, reducing manual setup while improving traceability and process validation for regulated medical components.”

The Physical Paradox: How to Clamp a Cloud

Once a complex titanium bone implant is printed, the physical challenge begins. Unlike a solid block of steel, an additive implant often features delicate, porous lattice structures designed to mimic human trabecular bones. Clamping such a part in a traditional metal vise risks crushing the geometry before machining even starts.

“Organic, porous geometries are exactly where conventional workholding starts to break down, and that’s a signal, not a nuisance,” states Iyengar. “It tells us the two processes were never meant to be solved separately.” To protect these delicate shapes, machine builders are moving away from traditional mechanical touch probes toward non-contact, optical scanning. According to Singh, the company has moved away from relying on



“Part scanning is becoming an important approach for reducing setup time on irregular AM components, especially organic titanium implant geometries where traditional probing and workholding can be challenging.”

Raghav Badhya T V
President
Makino India Pvt Ltd

touch-probe points on organic geometries and now scan the whole part with on-machine laser or blue-light scanning and let a best-fit algorithm align the mesh to nominal CAD in real time. It cuts setup from hours to minutes and paired with conformal fixtures and soft-jaw holding, Jyoti CNC is protecting those fragile trabecular structures instead of crushing them during clamping. Naidu elaborates that mathematical alignment turns a time-consuming physical setup into a fast, automated computation. “The part is probed against defined reference features, the coordinate system is compensated automatically or the NC program adapted on the machine, and the references are machined away afterwards,” he explains. “With on-machine measurement and best-fit alignment, the part is now aligned mathematically

rather than mechanically. This is the direct answer to the set-up-time problem.”

Reinforcing the advantage of keeping metrology inside the machine tool itself, Raghav explains, “By integrating scanning directly into the machine, the part can be measured without moving it to a separate inspection device, helping preserve setup accuracy and reduce manual datum setting.”

However, solving the clamping problem is not just a machine-side task—it begins back on the digital drawing board.

Dr Vishwas emphasizes that manufacturability must be built into the part from day one. “Instead of leaving fixturing entirely to the machining team, manufacturers are incorporating sacrificial locating features, machining allowances, and optimized support structures into the AM build,” he explains. “Smart build plates and standard reference features provide consistent datums for automated probing and machining, while also protecting delicate lattice geometries during handling.”

Doshi agrees, urging a cross-disciplinary approach. “While sacrificial features and optimized build orientations can simplify downstream machining, inspection, or fixturing, they should be viewed as part of a broader Design for Additive Manufacturing (DfAM) approach rather than standalone solutions. The most effective workflows are collaborative, where designers, additive manufacturing engineers, and machinists work together from the outset.”

The Metallurgical Crucible: Exotic Tooling vs. Heavy Iron

When an as-printed titanium or cobalt-chrome implant leaves the printer, its surface is rough, thermally stressed, and hard. Machining this raw outer layer

involves coping with interrupted cuts, variable surface allowances, and high tool wear.

Who bears responsibility for managing this tough material state—the additive process or the machining center?

Dr Vishwas advocates for a clear division of labor across the workflow. “This responsibility should be shared across the manufacturing chain, although the additive manufacturer plays an important role in providing a stable starting condition.” He points out that wherever possible, process optimization, stress relief, heat treatment, and quality assurance should be completed before the component reaches the machining stage. The CNC operation can then concentrate on achieving the final tolerances, surface finish, and functional features instead of compensating for material-related variations.

Echoing this view, Doshi shares that consistency is what regulators care about most. “In medical manufacturing, consistency, validation, and repeatability are far more important than assigning ownership to one stage of production.” A collaborative, process-driven approach ensures every step contributes to delivering reliable, high-quality components.

Agreeing that machining tools should not be asked to solve metallurgical problems that belong upstream, Raghav says, “Ideally, AM should deliver a stable near-net blank with controlled residual stress, sufficient machining allowance, and appropriate heat treatment where required.” Further he adds that current HMC and VMC platforms can machine titanium and cobalt-chrome with the right spindle, rigidity, tooling, coolant strategy, and cutting conditions. However, abrasive and variable as-printed surfaces make adaptive control increasingly important. Special-



“We have proven techniques with Digital Twin on subtractive with AM wherein the software will take the scanned image of the intended object to be built. Then run a tool path in real time for AM and create an automatic work offset for subtractive on the fly to produce a finished component seamlessly.”

Jagannath Varadaraja Iyengar
EVP & COO
m2nxt Solutions Pvt Ltd

ized spindle designs can improve productivity for target materials but may reduce versatility. Tool geometry development is best handled with tooling partners. Yet, when that raw metal hits the spindle, machine tool builders disagree on the best technical solution.

On one side, Singh argues that cutting raw 3D-printed metal requires specialized machine engineering. “As-printed titanium and cobalt-chrome persist with inconsistent stock allowance, hidden porosity, and a hardened outer skin from the build process, off-the-shelf tooling and rigid spindles just do not hold up. We have variable-helix cutters for interrupted engagement, adaptive toolpath control, and vibration-dampened spindles that sense chatter and adjust feed in

real time. Machine builders who ignore this will keep losing implants to tool breakage.”

On the other side, Naidu contends that relying on complex, highly specialized tooling is an expensive trap. For him, fundamental machine rigidity is what truly matters. “In my view, a stable machine concept is at least as important as specialized tooling.” “As-printed titanium and cobalt-chrome are hard and abrasive, and near-net shapes mean interrupted cuts – an argument for rigidity and thermal stability, not exotic tools. Small lots with individual geometries would otherwise demand many expensive special tools while proven solutions already exist for imperfect cast and forged materials. Stability also pays off in finishing: on a knee implant, defects may only appear after final polishing,” he adds.

He emphasizes, “I would invest in a stable machine with standard tooling – minimizing overall cost and avoiding risk in an already demanding, regulated process.”

All-in-One Hybrids vs. Sequential Production Cells

Perhaps the biggest strategic question facing medical device manufacturers today comes down to floor layout. Should a factory invest in all-in-one hybrid machines that deposit metal and mill it inside the same cabinet, or build dedicated sequential cells where automated robots hand off parts between separate 3D printers and CNC machines?

In this context, Iyengar makes a direct case for hybrid systems when dealing with patient-specific healthcare. “For customized, regulated medical devices, hybrid wins,” he asserts. “As traceability and validation are dramatically simpler when a part never leaves the datum under single controlled environment. Dedicated sequen-

The biggest strategic question facing medical device manufacturers today comes down to floor layout. Should a factory invest in all-in-one hybrid machines that deposit metal and mill it inside the same cabinet, or build dedicated sequential cells where automated robots hand off parts between separate 3D printers and CNC machines?

An additive implant often features delicate, porous lattice structures designed to mimic human trabecular bones. Clamping such a part in a traditional metal vise risks crushing the geometry before machining even starts.



“Over the next 5–6 years, broader adoption of open standards, AI-enabled process integration, and tighter CAM-MES-machine connectivity should enable seamless transfer of build data, datum references, and quality records for regulated medical manufacturing.”

Rahul Singh
Senior Manager - Business Development
Jyoti CNC Automation Ltd

tial cells have their place at high volume, but medical device manufacturing is rarely a high-volume game. On the contrary, products are becoming increasingly unique.” Naidu agrees that hybrid machines hold unique, life-saving potential for emergency trauma surgery like rebuilding a fractured skull after an accident. “Hybrids have their place where speed is everything: when throughput time is the critical factor in urgent trauma cases such as craniofacial reconstruction – a single machine with no handover between processes can be the deciding advantage,” he says. “Perhaps one day, a hybrid machine close to the operating room will genuinely save lives.” However, when scaling up to mass industrial production, he notes, “For high volumes, I clearly see sequential cells winning on ROI and throughput: additive

builds are slow while machining is fast, and spindles must run continuously to make money.” He highlights that validation also favors this path at scale – each step is qualified independently under ISO 13485, while a hybrid couples two fundamentally different processes into one validation envelope.

According to Raghav in LMD/DED workflows, coolant residue, chips, or surface contamination from machining must be carefully controlled before further deposition, as they can affect melt pool stability, bonding, shielding gas effectiveness, and deposition quality. He stresses, “Sequential cells allow each process to be optimized independently and run in parallel for higher utilization, validation control, throughput, and long-term ROI.”

This emphasis on flexibility is echoed by Doshi. “Dedicated, digitally connected manufacturing cells are likely to offer greater flexibility and scalability for most medical production environments,” she states. “This modular approach simplifies equipment upgrades, supports evolving production requirements, and makes process validation more manageable in regulated industries.”

Dr Vishwas reinforces this consensus for industrial production. “When these processes are linked through automation, robotics, and a common digital workflow, manufacturers can achieve higher throughput, better equipment utilization, and the flexibility to produce both patient-specific implants and larger production batches efficiently.”

Singh sees a pragmatic split in how the market will adopt these technologies. “Hybrids make real sense for those one-off, highly customized implants, where you simply can't afford to lose datums moving a part between machines. But once you are really scaling production, dedicat-



“In medical manufacturing, consistency, validation, and repeatability are far more important than assigning ownership to one stage of production. A collaborative, process-driven approach ensures every step contributes to delivering reliable, high-quality components.”

Payal Doshi
APAC Marketing Manager
Formlabs

ed sequential cells still win on ROI. The future looks more like modular cells with a clean, automated handoff, not one machine trying to do it all.”

Engineering the Future of Healthcare

The convergence of Additive Manufacturing and precision CNC machining marks a new era in medical technology. By bringing together open software protocols, adaptive optical scanning, rigid machine tools, and flexible automation cells, manufacturers are moving past old trade-offs between customization and speed. As these hybrid and sequential workflows mature, they promise to lower manufacturing costs, accelerate delivery times, and make custom-fit, high-performance medical implants accessible to patients around the world. 

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From a greenfield facility in Ranjangaon to a 1,000-machine milestone in less than three years, Yamazaki Mazak India has demonstrated how global quality standards, local manufacturing, and disciplined execution of Japanese manufacturing principles into an Indian production environment can create a new benchmark for India's machine tool industry.



Source: Mazak India

For most industrial manufacturers, the first three years of a greenfield facility are spent stabilizing operations, building supplier networks, refining production processes, and navigating inevitable ramp-up challenges. Reaching full-scale production often takes considerably longer.

Yamazaki Mazak India's Ranjangaon plant near Pune has defied timelines, reaching 1,000 machines produced in under three years and setting a new benchmark for greenfield industrial ramp-ups in India. Underpinned by Japanese quality governance, a rapidly maturing local supplier ecosystem, and disciplined sector diversification, the plant now produces over 50 vertical machining centers every month.

At the heart of the story lies a simple but powerful philosophy: growth should never come at the expense of quality.

According to Anil Bhardwaj, Managing Director, Yamazaki Mazak India Pvt Ltd, the milestone was not the result of aggressive expansion or favorable market conditions alone.

"The 1,000-machine milestone is a number we are genuinely proud of — but it was earned through a series of very deliberate decisions made in the earliest weeks of the plant's life, not through luck," he says.

Building for Flexibility from Day One

One of the most significant decisions made during the plant's establishment was the adoption of a cell-based assembly architecture. Rather than creating a traditional linear transfer line optimized around a fixed product mix, Mazak designed modular assembly cells capable of adapting as customer requirements evolved.



Source: Mazak India

"Zero-defect manufacturing is not a skill — it is a worldview. It requires believing, at a cellular level, that passing a defect downstream is simply not an option."

Anil Bhardwaj
Managing Director
Yamazaki Mazak India Pvt Ltd

The strategy proved particularly valuable as demand diversified faster than anticipated.

That flexibility has become one of the defining characteristics of the facility. It allows the plant to accommodate varying machine configurations, support multiple industry sectors, and respond to changing market requirements without major disruptions to production.

Today, the facility produces more than 50 vertical machining centers every month—a scale-up that many heavy industrial plants take considerably longer to achieve.

The Supply Chain Equation

Scaling production rapidly while maintaining quality demanded

an equally robust supply-chain strategy. Mazak adopted a hybrid sourcing model that combined mostly global precision components with some localized supplier ecosystem.

Critical precision subsystems such as spindles, linear guide-ways, ball screws, and CNC control units continue to come from Mazak's established global network, ensuring consistency with international standards. Simultaneously, the company initiated a structured qualification program for Indian vendors producing structural castings, sheet-metal enclosures, and coolant systems.

"This two-track approach meant we never had to choose between speed and quality during the ramp-up," says Bhardwaj.

The Human Factor

Technology and infrastructure alone do not create manufacturing excellence. Recognizing this, Mazak invested heavily in knowledge transfer during the facility's formative period.

For the first 18 months, Japanese master technicians worked directly alongside Indian technicians at the plant.

"These were not classroom instructors; they worked shoulder-to-shoulder with our Indian technicians at the assembly stations, transferring tacit knowledge that no manual can capture," Bhardwaj notes.

The impact was significant. Skills and production practices that could have taken years to develop naturally were transferred in a much shorter time-frame. By the end of the first full year of production, Indian teams were independently executing assembly protocols to Japanese standards.

Creating a Zero-Defect Culture

If scaling production was chal-

Mazak India's Ranjangaon facility crossed 1,000 machines in under three years through a combination of modular assembly architecture, Japanese production discipline, supplier development, and a relentless focus on quality.

Direct mentorship from Japanese master technicians and a zero-defect culture have enabled India-built Mazak machines to match global quality standards consistently.

lenging, cultivating the famed Japanese quality mindset proved even more demanding. Bhardwaj is candid about this aspect of the journey. “Honest answer: it was the hardest part of this entire venture – and it remains our most important daily discipline,” he shares.

According to him, the challenge was never a shortage of talent or commitment among Indian technicians. Instead, the real challenge lay in building a culture where quality becomes instinctive rather than procedural.

“Zero-defect manufacturing is not a skill – it is a worldview. It requires believing, at a cellular level, that passing a defect downstream is simply not an option, regardless of schedule pressure or production targets,” he adds.

That philosophy is reinforced through an extensive quality framework overseen by Japanese production directors. Rather than functioning as auditors who review completed work, the directors remain actively involved on the shop floor. They explain not only

“The intent is not to offer a transplanted European or Japanese automation package – it is to co-develop solutions that fit how Indian manufacturers actually operate.”

Anil Bhardwaj
Managing Director
Yamazaki Mazak India Pvt Ltd

what must be checked, but why. “That ‘why’ is transformative,” emphasizes Bhardwaj.

Understanding the downstream impact of every inspection point transforms quality checks from routine tasks into responsibilities with tangible customer consequences.

Every technician undergoes supervised assembly of a complete machine before being cleared for independent production. A digital quality-capture system records inspection outcomes at every stage, enabling rapid identification of trends and potential issues.

Quality reviews occur daily, weekly, and monthly. “Quality is the first agenda item at

every one of these forums – not safety, not output, not cost. The sequence is deliberate and symbolic,” he notes.

The VC-Ez 410, 510, and 610 models have made advanced machining technology accessible to a broader segment of Indian manufacturers.

Manufacturers are now able to access high-precision machining capabilities that were once financially out of reach. The impact is visible across Tier-2 and Tier-3 suppliers. Tighter tolerances, superior surface finishes, reduced cycle times, and lower scrap rates are becoming increasingly achievable.

“What we are observing is a step-change in what these sup-

Mazak India at a Glance

1,000 machines	Cumulative units produced during 2023–2026
50+ machines / month	Current peak production rate
3 VC-Ez models	VC-Ez 410 IP • VC-Ez 510 IP • VC-Ez 610 IP – locally assembled
4 key sectors	Automotive • Aerospace • Die & Mold • Medical Devices
JIS supply chain	Just-in-sequence vendor network
Japan-equivalent QA	Governed by on-site Japanese Production Directors
Started	2023 – Ranjangaon, Pune, Maharashtra

pliers can offer their OEM customers," he adds.

Serving Diverse Industries

While automotive remains Mazak India's largest market, the company is increasingly finding opportunities in aerospace, defence, medical devices, and die & mold manufacturing. Each of these sectors presents unique production requirements.

While, automotive manufacturing prioritizes throughput and repeatability, aerospace demands extreme precision, material traceability, and the ability to machine advanced alloys such as titanium and Inconel. Medical-device manufacturing introduces stringent cleanliness and dimensional-consistency requirements.

Balancing these varied demands would be difficult within a rigid production structure. However, the modular assembly-cell architecture implemented from the beginning enables the plant to adapt effectively.

"The modular cell-based assembly architecture we adopted from day one is what makes this sectoral agility possible," Bhardwaj explains.

Dedicated production slots and customized inspection protocols allow the facility to serve multiple industries without compromising quality or delivery performance.

This approach has created benefits that extend beyond Mazak's immediate supplier network.

As vendors improve their capabilities to meet Mazak standards, they become more competitive across multiple industries and customer segments.

The Next Chapter

The vision for Ranjangaon extends beyond the domestic market, with exports already reaching Southeast Asia and Europe. Mazak aims to establish the facility as a globally recog-

nized center of manufacturing excellence within its worldwide network. Producing 1,000 machines in under three years is a significant achievement, but its deeper importance lies in what it represents: proof that world-class machine tool manufacturing can thrive in India.

Through disciplined processes, supplier development, and an unwavering commitment to quality, Mazak India has shown that Make in India can be much more than a manufacturing slogan. It can be a blueprint for creating globally competitive industrial capability.

For Bhardwaj and his team, the journey is far from over. "The 1,000-machine milestone is a proud marker on that journey. It is emphatically not the destination," he concludes. 

The local manufacturing of the VC-Ez series is helping Tier-2 and Tier-3 manufacturers access world-class machining technology, improving tolerances, reducing scrap, and strengthening India's industrial competitiveness.



Source: Mazak India

ENABLING HIGH-ACCURACY MACHINING OF SURGICAL INSTRUMENTS

For HG-Micro-Instrumente GmbH & Co. KG, a German specialist in medical devices, meeting stringent quality requirements while machining titanium tweezers and forceps demanded a highly stable and precise machining solution. By combining HORN's circular interpolation milling technology with SCHUNK hydraulic toolholding systems, the company has optimized its in-house production process, achieving micron-level accuracy, superior surface quality, and reliable machining performance.

Maranello is famous for its red sports cars, and Geneva is the Mecca for watch enthusiasts – but the products from Tuttlingen are usually only known to specialists. Over 400 companies produce world-renowned instruments and devices in the global center of the Medical industry. Tweezers, implants, and endoscopes: the expertise in the Medical industry has grown over time and is passed down from one generation to the next. The company HG-Micro-Instrumente GmbH & Co. KG from Wurmlingen, near Tuttlingen, is one of these specialists. The team, led by Managing Director & Production Manager Christoph Götz, produces forceps, ear tweezers, and other medical instruments. In addition to skilled manual work, the company relies on modern CNC machining centers and tool systems. For milling tweezers, HG-Micro-Instrumente uses tool systems from Paul Horn GmbH and hydraulic chucks from Schunk.

“We once had a complaint because the forceps were four grams too light,” jokes Götz as he talks about his experience and continues, “Almost every-



Source: HORN/NCEA

Götz machines fillets using an end mill with a solid carbide insert.

NIKHIL NAYAK
Managing Director
NN Combined
Engineering Agencies
Pvt Ltd





No chatter marks: Despite the long overhang, the system achieves a high level of vibration damping.

thing is certified when it comes to surgical instruments. Even the slightest deviation from the target parameters is not acceptable, even if tweezers are made of titanium to reduce weight." Tolerances of a few microns are the order of the day in the production of medical instruments. HG-Micro-Instrumente manufactures products on a contract basis for the big players in the Medical industry according to drawings and customer requirements. Ninety percent of the instruments are titanium. "We process steels such as 1.4021 into ear tweezers," explains Götz.

Quality Was Not Good Enough

The carbide blanks for the tweezers arrive as turned parts. Götz and his team use a Hermle C22U machining center to produce both halves of the tweezers from carbide blanks. The two halves are laser welded together in a subsequent process. "We used to buy the halves already machined. However, the quality was no longer good enough for us. We were also inconvenienced by the long

delivery times," says Götz. The company, therefore, switched the production processes to complete machining. To do this, Götz looked for an appropriate tool solution. It was not just the insert that was important, but the entire system from the insert to the spindle interface. Due to the sometimes long tool overhang and the high surface finish required, the tool system must be vibration-damped to avoid chatter marks.

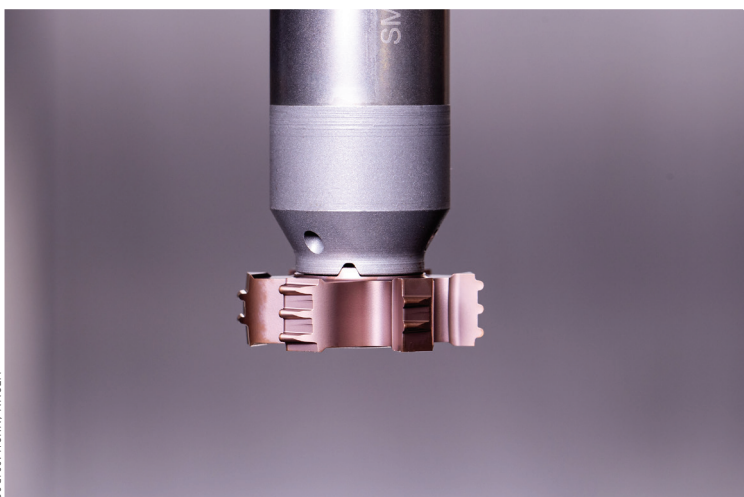
Together with Stefan Minder, Applications Engineer, HORN, Götz found the appropriate tool solution with HORN's circular interpolation milling system. The milling system performs three important processes: milling the hollow groove, milling the gear teeth of the tweezer tip, and milling the handle pattern for flat-handled tweezers. A six-edged type 632 full-radius insert is used for milling the chamfer, which serves to reduce weight. The tool has a diameter of 30 mm (1.181") and mills the 3 mm (0.118") deep chamfer in two cuts. "The tool demonstrated high milling performance right from the start. We just had to tweak the machining parameters a little here and there to achieve the best possible surface quality," says Minder.

Cut Distribution

A type 628 insert with six cutting edges is used for milling the handle pattern and the serrations of the tweezer tip. The individual insert edges are ground offset to each other. The six-edged insert, therefore, acts like a three-edged insert during the milling process. The advantage of this cut distribution is that fine serrations, for example, can be milled without high cutting pressure. The fine serrations must be present on the tweezer tip. In one milling pass, the 7 mm-wide insert mills 17 teeth to a depth of 0.35 mm. In addition, the milled serrations must be highly precise. In use, the serrations on the two halves of the tweezers must mesh precisely. This principle of cut distribution is also used when milling the handle pattern.

The optimized cutting edge geometry in conjunction with the IG35 coating ensures high productivity and process reliability when machining titanium. With a coating thickness of just 0.003 mm (0.0001") and a maximum operating temperature of around 1,100°C (2,012°F), the tool achieves on average twice the service life of conventional coat-

Due to the sometimes long tool overhang and the high surface finish required, the tool system must be vibration-damped to avoid chatter marks.



Profile for milling the handle pattern.

With a coating thickness of just 0.003 mm and a maximum operating temperature of around 1,100°C, the tool achieves on average twice the service life of conventional coatings.

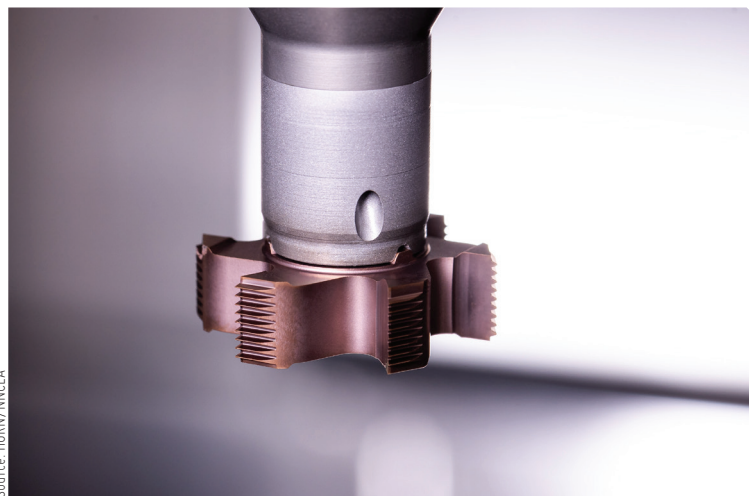
ings. HORN coats the tools in-house in its own HiPIMS coating systems. In addition to high cutting performance, this enables fast delivery of the tools.

HORN Circular Interpolation Milling System

HORN's circular interpolation milling system offers the user a number of advantages: it is fast, reliable, and achieves good surface results. The tool, which is guided on a helical path, plunges into the material either at a steep or a very shallow angle. It allows high-quality threads to be produced reproducibly. Compared to machining larger diameters with indexable inserts or smaller diameters with solid carbide milling cutters, circular milling cutters are generally more economical. They have a wide range of applications, including machining steel, special steels, titanium, aluminum, and special alloys. The precision tools are particularly suitable for slot milling, helical milling, thread milling, T-slot milling, profile milling, and gear milling. However, they are also highly effective in special applications such as milling sealing grooves or connecting rod machining.

Stable Overall System

Götz relies on the SCHUNK TENDO hydraulic clamping system for securing the milling tool. TENDO has been a byword for precise clamping of shank tools for decades. Thanks to continuous further development, this pioneering clamping technology meets the constantly increasing requirements of demanding, universal precision machining. TENDO is suitable for all common shank types. The wide range of products offers the appropriate solution for almost every application.



The tool mills 17 teeth in one pass for cutting the serrations of the tweezer tip.

The runout and repeatability of the clamping system is around 0.003 mm (0.0001"). The excellent vibration damping is particularly advantageous with long tool overhangs.

The combination of the insert, solid carbide tool shank and hydraulic chuck performs well in HG-Micro-Instrumente applications. "We have mastered the milling process and are very satisfied with the result. Furthermore, HORN's service and technical advice are of a very high standard," says Götz.



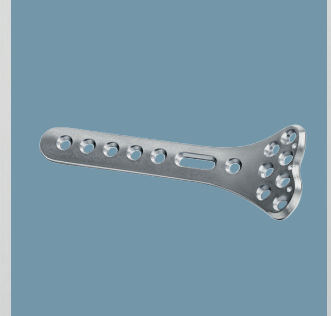
The production of surgical tweezers is precision work.

More On HG-Micro-Instrumente GmbH

For over three decades, HG-Micro-Instrumente GmbH & Co. KG has been dedicated to the manufacture of high-quality surgical instruments, which are 100 percent manufactured in Wümlingen. A family-owned company, HG-Micro-Instrumente focuses on high quality, flexibility, and reliability in every phase of production. Its expertise lies not only in the manufacture of surgical instruments, but also in CNC contract machining, where the team develops customized solutions for its customers. The company always strives to achieve a high level of customer satisfaction and makes no compromises when fulfilling exacting production requirements.

HORN in India

Precision Tooling Solutions for the Medical Industry from Paul Horn GmbH are available in India via NN Combined Engineering Agencies Pvt Ltd (NNCEA) in cooperation with select OEM partners. NNCEA provides complete logistics and supply chain management solutions for several major medical manufacturing industries in the Indian market. 



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FROM SHOP FLOOR TO SMART FACTORY

When the manufacturing sector faced increasing pressure from rising raw material costs, intense competition, and operational inefficiencies, Korrocoat Polymers Pvt Ltd chose transformation over stagnation. Rather than treating operational bottlenecks as routine challenges, the company launched a structured initiative rooted in lean manufacturing, digitalization, and employee empowerment.



Source: Korrocoat Polymers Pvt Ltd

YOGESH RASANE
Managing Director
Korrocoat Polymers
Pvt Ltd
yogeshrasane26@
gmail.com



With over 25 years of expertise in solvent-based and water-based industrial coatings, Korrocoat Polymers serves industries ranging from metal and wood to plastic and concrete. The company also exports to international hospitality chains while maintaining

strict quality and environmental commitments.

However, as operations scaled up, several systemic inefficiencies began to surface. There was a heavy dependence on top management for both technical and commercial decisions. Batch holds occurred because shade-matching expertise was limited to a few

individuals. Manual data entry slowed down production reporting, while inventory mismatches were frequently observed between physical stock and system records. In addition, delays in the production cycle began affecting delivery timelines.

As a result, traditional management structures were no longer

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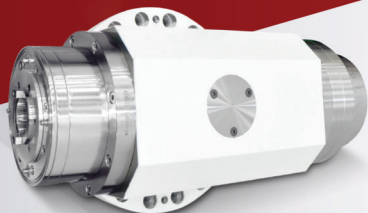
Belt-Drive Spindle - Milling



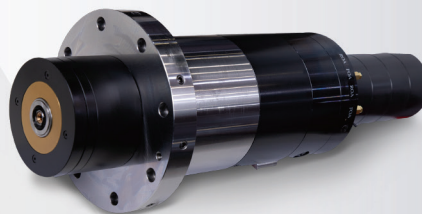
Direct-Drive Spindle



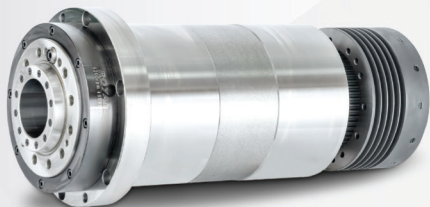
Motorized Spindle - Turning



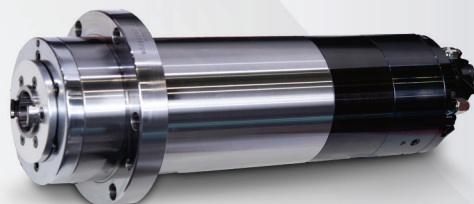
Motorized Spindle - Multi-Spindle



Motorized Spindle - Milling (40,000 rpm)



Belt-Drive Spindle - Turning



Motorized Spindle - Milling

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The transformation showed that decentralization helps accelerate decision-making, while standardization makes processes scalable.



Source: Korrocoat Polymers Pvt Ltd

sufficient to support the company's growing operations. The need for decentralization and digital integration became increasingly evident.

Identifying Structural Gaps

A cross-functional team, comprising Production Heads, R&D, Quality, and Supervisors, initiated a structured diagnostic study using Lean tools and process mapping. The study revealed several structural gaps within the organization. Knowledge was concentrated in a limited number of individuals, which created dependence and slowed decision-making. There was also a lack of standardized digital tracking across processes. In addition, centralized approvals were causing delays in routine operations. The team also observed a high workload related to manual documentation. Various forms of operational waste were identified, including waste in motion, waiting, rework, and overprocessing, commonly referred to as TIM-WOODS (Transport, Inventory, Motion, Waiting, Overproduction, Over-processing, Defects, and Skills) in Lean practices. Based on these findings, the company recognized that sustainable improvement would require not only technological

integration but also a broader cultural transformation within the organization.

The Strategic Response: Lean, Digital & Human-Centric

The transformation was built around five strategic pillars.

Shop Floor Empowerment

Operators were trained to perform independent shade matching, which removed the earlier dependence on a single expert for this task. Within a few months, five to six operators became self-sufficient in shade matching. As a result, batch holds were eliminated and delivery performance improved significantly. With this change, decision-making moved closer to the shop floor and the actual production process. This helped improve both the speed of operations and accountability among team members.

Marketing & Commercial Empowerment

The marketing team was trained in several key business and negotiation frameworks. These included Customer Value Proposition, the 4Ps (Product, Price, Place, and Promotion) and 5Cs (Company, Collaborators, Cus-

tomers, Competition, and Context) frameworks, BATNA (Best Alternative to a Negotiated Agreement) strategies, as well as contribution margin and break-even analysis.

As a result, the team was able to handle negotiations with customers even in the absence of senior leadership, which helped reduce the risk of losing orders.

Digitalization & ERP Integration

Korrocoat Polymers implemented a robust ERP system that integrated production, inventory, and reporting functions. Digital dashboards enabled real-time analytics and helped managers make faster and more informed decisions. The digitalization initiative led to several measurable improvements. Batch cycle time was reduced by 20 percent, from 13 hours to 10 hours for a 1000-litre batch. Overall Equipment Effectiveness (OEE) improved from 78 percent to 90 percent. Product defects were reduced by 32 percent, while raw material wastage declined by 15 percent. The company also achieved a 22 percent reduction in energy consumption and an 80 percent reduction in manual documentation work. In addition, inventory



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The journey highlights an important lesson: sustainable growth is possible when technology, process discipline, and people empowerment move together in alignment.

accuracy between physical stock and system records improved to 90 percent.

With these changes, digitalization helped the company move from reactive control to a more predictive and data-driven management approach.

Daily Small Improvement (DSI) & Kaizen Culture

The company institutionalized 'Daily Small Improvement' initiatives across several operational areas. These included quality improvement, cost reduction, productivity enhancement, delivery performance, safety practices, and environmental impact.

In addition, Korrocoat Polymers introduced daily 10-minute 'Tea Time Trainings' to create a continuous learning environment on the shop floor. During these sessions, operators discussed topics such as process optimization, safety awareness, and quality improvement.

This cultural shift helped strengthen employee engagement and encouraged a greater sense of ownership among team members.

Lean Manufacturing Implementation

The company implemented several structured Lean tools to improve operational efficiency. These included 5S (Sort, Set in Order, Shine, Standardize, and Sustain) for workplace organization, Value Stream Mapping (VSM) to analyze process flow, and Standard Work Procedures to ensure consistency in operations. In addition, it focused on waste elimination by addressing Muda, Mura, and Muri, which are key concepts in Lean practices. Visual management systems were also introduced to improve transparency and monitoring on the shop floor. Together, these practices helped reduce process variability

and strengthened overall operational discipline.

Measurable Business Impact

The transformation delivered results across multiple areas of the business.

Operational Impact: Production throughput increased, while rework and spillage were significantly reduced. The First-Time-Right rate improved from 80 percent to 96 percent. In addition, self-delivery performance improved by 10 percent.

Financial Impact: The improvements also led to a stronger operating cash cycle. Material wastage costs were reduced, and profitability increased as waste was systematically eliminated through Lean practices.

Competitive Positioning: Despite being a small-scale enterprise, Korrocoat Polymers competes product-wise with major industry players such as Asian Paints, Berger Paints, Kansai Nerolac Paints, and JSW Paints.

Lean-driven cost optimization, combined with a strong 'WOW factor' approach to customer experience, has enabled the company to steadily expand its customer base year after year.

Environmental & Social Responsibility

The initiative extended beyond financial performance. The company reduced energy consumption by 22 percent, while waste reduction helped lower its overall environmental footprint.

At the same time, vendor relationships were strengthened through consistent and timely payments. Employee satisfaction also improved, as reflected in the Q12 engagement metrics. The company also maintained a CMR-3 rating with its bankers, indicating strong financial discipline and credibility.

Throughout the transformation journey, the philosophy of Zero Defect Zero Effect Scheme (ZED) guided every step.

The Kaizen Spirit: A Culture of Ownership

Beyond systems and software, the project reinforced several important organizational learnings. The company recognized that empowered employees play a key role in driving productivity. It also emphasized that while digital tools are important, they are meant to enhance human intelligence rather than replace it.

The transformation also showed that decentralization helps accelerate decision-making, while standardization makes processes scalable. At the same time, a culture of continuous improvement helps organizations remain resilient in changing market conditions. Overall, what began as an efficiency improvement initiative gradually evolved into a full-scale cultural transformation.

Building a Future-Ready Organization

In an era where manufacturing competitiveness depends on agility and data-driven decision-making, Korrocoat Polymers has demonstrated that even mid-scale industries can achieve world-class operational excellence.

By combining Lean principles, digitalization, and employee empowerment, the company was able to turn operational challenges into strategic advantages. This integrated approach strengthened both efficiency and long-term competitiveness. The journey highlights an important lesson: sustainable growth is possible when technology, process discipline, and people empowerment move together in alignment. 



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MEETING THE EXPECTATIONS OF MODERN DEFENCE SUPPLY CHAINS

The growth of aerospace and defence manufacturing is creating new opportunities across the machining sector. Defence spending across Europe reached an estimated €381 billion in 2025, an increase of eleven percent compared to 2024. As orders increase, many SMEs are facing a familiar question: how can we increase capacity quickly enough to meet demand?



Source: Tezmaksan

Evidence of this demand can be seen beyond traditional defence contractors. Earlier this year, Volkswagen revealed that it had developed two prototype military vehicles in just four months. Renault has reportedly explored drone-related defence applications and more recently announced a military vehicle partnership.

Neither company is traditionally associated with defence manufacturing. Yet both are assessing opportunities within the sector, highlighting how demand is spreading across a much broader industrial base.

While entering defence supply chains often involves lengthy qualification processes and strict compliance requirements, increased demand is creating opportunities throughout the wider manufacturing ecosystem. Many subcontractors may encounter defence-related work indirectly through aerospace primes, tier 1 suppliers, and specialist engineering firms seeking additional machining capacity. For subcontract machine shops, precision engineering firms, and component manufacturers, this creates opportunities that didn't exist a few years ago.

Increased Demand Doesn't Equal Increased Capacity

For production managers, the issue is rarely a shortage of work. More often, it's finding enough productive machining hours to meet customer expectations. The defence and aerospace sectors expect reliable lead times, consistent quality, and the ability to respond quickly when requirements change. Delivering on those expectations can be difficult when skilled CNC operators remain in short supply.

A machine can be available for an entire shift, but that doesn't mean it spends all of that time cutting

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Most subcontract manufacturers need systems that fit into existing production environments and can be operated by current shop-floor teams.



Source: Tezmaksan

metal. Operators load raw material, unload finished parts, carry out inspections, and prepare for the next job. Each task is necessary, but every interruption reduces available machining time. Viewed individually, these delays may seem insignificant. Across multiple machines and shifts, however, they quickly add up. Recent research from Fortune Business Insights highlights growing demand for CNC technologies that improve efficiency, provide greater production visibility, and support automation across manufacturing operations. The result is capacity that exists on paper but can be difficult to access in practice. For many manufacturers, the first step is automated machine tending. Rather than waiting for an operator to load and unload every component, a robotic system can transfer parts between machining cycles, keeping production moving with minimal interruption. Even small reductions in non-cutting time can create additional machining hours across the week. Automation allows skilled opera-

tors to focus on tasks where their expertise delivers the greatest value. Programming, setup verification, quality control, and process optimization all require experience and technical knowledge. Loading and unloading components does not. As a result, many manufacturers are looking at ways to enable one operator to oversee multiple machines. In an environment where recruitment remains challenging, this flexibility can have a significant impact on output. Ease of implementation is equally important. Most subcontract manufacturers are not looking for complex automation projects that require specialist robotics knowledge or months of training. They need systems that fit into existing production environments and can be operated by current shop floor teams. This is one reason why modular automation systems are gaining attention. CubeBOX™ CNC automation systems, for example, combine collaborative robotics with CNC machine tending in a format that can be integrated without extensive changes to machine lay-

outs or production processes. For many machine shops, that lowers the barrier to automation and allows productivity gains to be realised much more quickly. Some manufacturers are already extending this approach further. Automated machine tending can support unattended production during breaks, between shifts, and overnight. Instead of sitting idle, machines continue producing parts, increasing spindle utilization, and helping manufacturers respond to growing demand without proportionally increasing labor requirements. As defence and aerospace demand continues to grow, the manufacturers best positioned to benefit may not be those with the largest workshops or the greatest number of machine tools. They will be the businesses that make the most effective use of every available spindle hour. For production managers, the challenge is no longer simply adding capacity. It's finding smarter ways to create it. CNC automation is proving to be one of the most practical ways to achieve exactly that. 



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Soumili Biswas

9154392514 / sb@hitex.co.in

DEFINING INDIA'S NEXT-GENERATION FACTORY

The 9th Symposium on Automation & Robotics organized by the Indian Machine Tool Manufacturers' Association (IMTMA) will bring together manufacturing leaders, technology providers, policymakers, and solution specialists to explore how automation, robotics, and artificial intelligence are reshaping India's industrial future. Scheduled to be held from August 13-14, 2026, at the Conference Centre, Bangalore International Exhibition Centre (BIEC), Bengaluru, the event will be held under the theme 'Automation, Intelligence and the Human Edge – Building India's Next-Generation Factory.'



An insightful session held at the last edition of the Symposium on Automation & Robotics in Pune.

Designed as a combined conference and technology exhibition, the annual symposium focuses on accelerating the adoption of practical automation solutions by discrete manufacturing companies in India. The event addresses the industry's evolving needs through keynote pre-

sentations, expert panel discussions, technical sessions, live technology showcases, and networking opportunities, with a particular emphasis on helping manufacturers improve productivity, quality, and global competitiveness. This year's edition places special emphasis on the practical imple-

mentation of automation, particularly for MSMEs, addressing key manufacturing challenges such as machine utilization, material movement, quality consistency, labor shortages, and shopfloor intelligence. The program aims to provide manufacturers with actionable strategies to modernize operations, move beyond

Source: IMTMA

Source: IMTMA

legacy systems, and strengthen their position as global suppliers.

Building a Strong Industry Platform

Over the past eight editions, the Symposium on Automation & Robotics has established itself as one of India's leading knowledge-sharing platforms for smart manufacturing. Collectively, the event has featured more than 130 expert speakers, attracted participation from over 950 companies, and welcomed more than 3,150 delegates representing a broad cross-section of India's manufacturing ecosystem.

The symposium attracts participation from industries including aerospace and defence, automotive and automotive components, construction equipment, heavy engineering, machine tools, electrical and electronics, iron and steel, power and renewable energy, consumer durables, research institutions, public sector enterprises, academia, and general engineering.

Two-day Program Highlights

The conference agenda has been designed to address both strategic and operational aspects of manufacturing automation.

Day One: Optimizing Shop-floor Efficiency and Competitiveness

The opening day of the symposium focuses on driving operational excellence and global market readiness, kicking off with a keynote session on building export competitiveness to help manufacturers align production with strict international expectations. Subsequent tracks delve into the mechanics of the connected factory, exploring practical strategies for downtime reduction through CNC tending, automated value

Event Details

Event: The 9th Symposium on Automation & Robotics – Conference & Exhibition

Dates: August 13–14, 2026

Venue: Conference Centre, Bangalore International Exhibition Centre (BIEC), Bengaluru

Theme: Automation, Intelligence and the Human Edge – Building India's Next-Generation Factory

chains, and real-time production visibility. Delegates will also gain critical insights into achieving zero-defect manufacturing and seamless material movement, spotlighting advanced technologies like automated gauging, machine vision, and clean-table assembly. The day rounds out with a visionary panel discussion on unlocking Industry 5.0 productivity through human-machine synergy, concluding with a targeted session on deploying collaborative robots (cobots) and flexible robotic cells to effectively mitigate manufacturing labour shortages.

Day Two: From Implementation to Measurable Returns

The second day shifts the narrative toward execution, scale, and bottom-line impact, starting with an insightful keynote that addresses how to successfully bridge the gap between technology acquisition and shopfloor deployment. Real-world blueprints take center stage during a case study on "Lights-Out Automation," which breaks down the budgeting and performance outcomes of fully automated facilities, followed by a fireside discussion analyzing how both MSMEs and large enterprises scale

automation plantwide. The afternoon introduces the digital frontier, demonstrating how Artificial Intelligence and automated analytics can streamline shopfloor decision-making and eliminate the administrative burden of daily alignment meetings. The program concludes with a high-stakes panel discussion on payback cost versus labor, giving decision-makers a clear framework to evaluate automation investments by balancing immediate labour dynamics against long-term productivity and ROI.

Advanced Manufacturing Solutions on the Showcase

Complementing the conference program, the exhibition will feature live demonstrations of next-gen automation tools, vision systems, and AI frameworks, designed to improve efficiency, quality, and operational flexibility.

Visitors will have the opportunity to interact directly with technology providers and explore practical solutions suitable for both MSMEs and large manufacturing enterprises.

Learning, Networking, and Business Opportunities

The symposium offers delegates an opportunity to gain insights from industry experts, understand proven approaches to overcoming operational challenges such as machine downtime and labor management, evaluate emerging technologies, and connect with manufacturers, technology providers, and solution partners from across the country. Expected to bring together more than 1,250 manufacturing professionals, the event will provide a valuable platform for knowledge exchange, business networking, and exploring the next generation of factory automation. 

Over the past eight editions, the Symposium on Automation & Robotics has established itself as one of India's leading knowledge-sharing platforms for smart manufacturing, attracting participation from more than 130 expert speakers, over 950 companies, and over 3,150 delegates from India's manufacturing ecosystem.

ADVANCED MANUFACTURING TECHNOLOGIES BRING NEW OPPORTUNITIES

Indian Machine Tool Manufacturers' Association (IMTMA) will organize the 4th edition of Pune Machine Tool Expo (PMTX 2026) and the co-located 3rd edition of Factory Equipment Expo (FACTEQ 2026) from September 7 – 10, 2026, at the Pune International Exhibition and Convention Centre (PIECC), Moshi, Pune.



Source: Magic Wand Media

The twin exhibitions are among the region's most anticipated showcases for manufacturing technology and factory solutions.

PMTX 2026 will showcase the latest machine tools and manufacturing technologies, while FACTEQ 2026 will focus on factory equipment, automation, material handling, storage systems and plant infrastructure solutions. Together, the exhibitions will bring the entire manufacturing ecosystem under one roof, creating a vibrant platform for business, innovation, and industrial collaboration.

The expos will feature over 175 exhibitors across 11,000 sq mt of exhibition space and are expected to draw 18,000 visitors and 300 trade delegations from key manufacturing sectors. PMTX 2026

and FACTEQ 2026 are expected to attract visitors from major industrial clusters in the western region, as well as from several other manufacturing hubs across the country. Visitors will have the opportunity to explore cutting-edge technologies in metal cutting, metal forming, automation, metrology, quality control, factory infrastructure, and allied manufacturing solutions aimed at enhancing productivity, precision, and competitiveness.

Speaking about the forthcoming edition, Mohini Kelkar, President, IMTMA, said, "Pune is one of India's most vibrant manufacturing hubs, with a strong presence across the automotive, engineering, aerospace, defence, and allied sectors. PMTX 2026 and FACTEQ 2026 will provide a valuable platform for manufac-

turers to explore advanced technologies, forge new partnerships, and enhance their competitiveness. We look forward to welcoming the industry to PMTX 2026 and FACTEQ 2026."

Highlighting the significance of the expos, Jibak Dasgupta, Director General & CEO, IMTMA, said, "The continued growth of PMTX reflects the manufacturing industry's confidence and its growing appetite for advanced technologies. With leading solution providers and focused trade delegations under one roof, PMTX 2026 and FACTEQ 2026 will create valuable opportunities for industry networking and business growth."

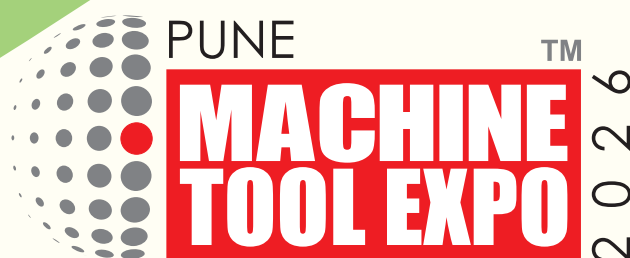


For more information, visit www.mtx.co.in and www.facteq.in.

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Venue:
**Pune International Exhibition and
Convention Centre, Moshi, Pune**

Highlights from Pune Machine Tool Expo 2024



11,000
Sq. mts

Exhibition
Space



220+

Exhibitors



Witness LIVE
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FACTEQ 2026
Factory Equipment Expo

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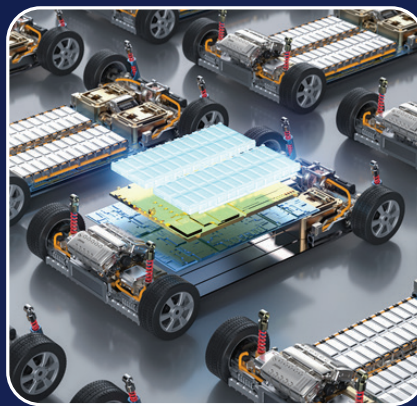
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