VOL 9, ISSUE 2 -JULY-AUGUST 2025

# MODERN MANUFACTURING INDIA

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The Official Magazine of
Indian Machine Tool Manufacturers' Association
In Association with
Modern Machine Shop

EMO HANNOVER 22–26/09/2025

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# IMPRINT


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Dear Readers,

I am pleased to present the July–August edition of Modern Manufacturing India (MMI) magazine.

As we navigate through an era characterized by headwinds such as rising input costs for raw materials, trade barriers affecting global dynamics, policy changes, and other uncertainties, a volatile atmosphere is being created.

The Indian machine tool industry has shown significant growth, with production in FY 2024–25 estimated to have increased by 7 percent to reach INR 14,566 crore (US$ 1.7 billion), while consumption is estimated to have increased by 17 percent to reach INR 31,781 crore (US$ 3.7 billion). The Indian machine tool industry ranks 9th in machine tool production and 4th in consumption.

The industry has continued to strengthen its ties with the automotive sector, which currently accounts for around 56 percent of its market share. Gradually, we are broadening our presence into other sectors, including Electronics Manufacturing, Aerospace, Defence, Renewable Energy, and Consumer Durables.

**RAJENDRA S RAJAMANE**
**PRESIDENT**
**IMTMA**

*As India progresses towards its goal of becoming a US$ 5 trillion economy, empowering manufacturing industries with the right technology is no longer optional but essential.*

As India progresses towards its goal of becoming a US$ 5 trillion economy, empowering manufacturing industries with the right technology is no longer optional but essential.

This will be achieved when the machine tool industry identifies and develops new products, adopts sustainable practices, and accelerates technology through research, development, and innovation to meet demand.

I hope you find this issue of MMI insightful and engaging.

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JIBAK DASGUPTA
DIRECTOR GENERAL & CEO
INDIAN MACHINE TOOL MANUFACTURERS' ASSOCIATION
BANGALORE INTERNATIONAL EXHIBITION CENTRE

Dear Readers,

The adage 'Health is wealth' holds greater relevance today as the world grapples with challenges such as pandemics and other illnesses, underscoring the dire need for more advanced medical devices. For India to become a global center for medical equipment manufacturing, the Machine Tool industry must align its capabilities with the high standards demanded by the Healthcare sector.

With rapid advances in healthcare, the demand for highly precise surgical medical devices is surging. Hence, the Indian Machine Tool industry is working to cater to the precision and reliability expected in medical applications. While we have built a strong foundation in engineering and automation, the next major step will occur when the Machine Tool industry develops ultra-precision technologies.

This journey goes beyond building machines—it's about enabling life-saving innovations. From surgical implants to diagnostic instruments, every medical device requires micron-level precision, sterile environments, and strict quality standards.

*Industry-academia collaboration, combined with domestic and global strategic partnerships, can bring about evolutionary change. It is an opportune time for deeper collaborations to drive research in manufacturing that creates better medical equipment and improved healthcare with real-world impact.*

To achieve this, the Machine Tool industry must leverage the extensive knowledge within India's academic and research institutions. Young engineers and technocrats are eager to contribute to technology and innovation. Industry-academia collaboration, combined with domestic and global strategic partnerships, can bring about evolutionary change. It is an opportune time for deeper collaborations to drive research in manufacturing that creates better medical equipment and improved healthcare with real-world impact.

The Indian Machine Tool industry will then be able not only to produce machines but also to build trust, uphold quality, and inspire hope. This edition of *Modern Manufacturing India (MMI)* features an article from the Indian Machine Tool Manufacturers' Association (IMTMA) on how the Indian Machine Tool industry needs to prepare itself to meet the needs of medical equipment manufacturers.

Readers are encouraged to share their feedback and suggestions for features or improvements to enhance this magazine. Wishing you an insightful and engaging read of this edition of MMI.

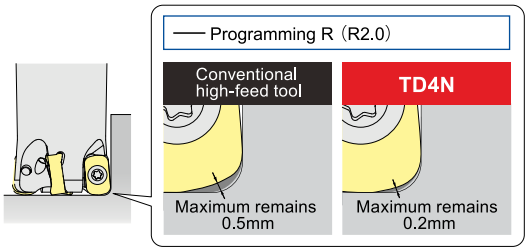
MOLDINO Tool Engineering, Ltd.

MOLDINO
The Edge To Innovation

# TD4N type

## Radius Mill TD4N

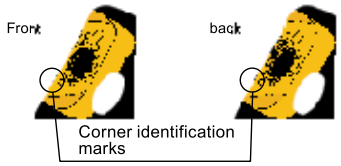
***Lineup expanded with insert for high-hardness materials***



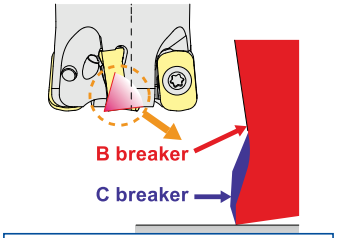

## Features 01 Reduces uncut remnants on work pieces

**The cutting edge shape was reviewed for TD4N so that uncut remnants are reduced.
This enables the load on the next process to be reduced by up to 40% compared to conventional products.**

## Features 02 Economical 4-corner inserts with chip breakers for various applications



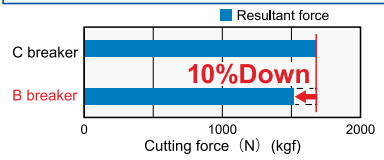

Positive rake angle



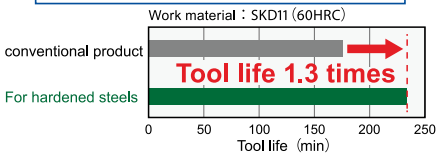

Magnified view of cutting edge cross section

By making it possible to use both the front and back sides of inserts, 4 corners can be used. The inserts are provided with a large rake angle which exhibits an excellent cutting force reduction effect even when compared to general positive-shape inserts.

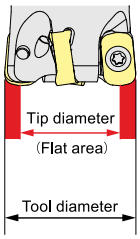
Comparison of cutting force



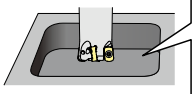

Tool life comparison with conventional products

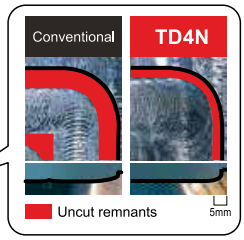



## Features 03 Large tip diameter for excellent handling



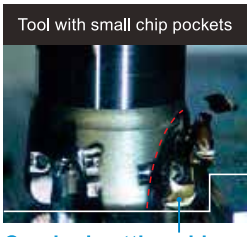

Photograph of machined surface at corner (viewed from above)




Compared to conventional high-feed tools, TD4N has a large tip diameter, which suppresses the generation of uncut remnants which easily occur on the bottom surface of machined areas. In addition, since the cutting width (ae) can be set to a large value, this is also effective for improving machining efficiency.

## Features 04 Excellent chip discharge characteristics




Crushed cutting chips


Cutting chips which were discharged well

Reduces the occurrence of sudden problems due to jamming of cutting chips. In addition, good chip removal makes it possible to further improve cutting performance.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# WHERE INDUSTRY CONNECTS, INNOVATES, AND INSPIRES

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

Earlier this month, Frankfurt offered more than just familiar charm; it pulsed with the energy of innovation and global exchange. The EMO Hannover Preview, held at VDW Headquarters, brought the spotlight squarely onto the evolving role of international trade fairs as drivers of industrial progress.

The gathering witnessed a convergence of global manufacturing leaders, each providing an insightful glimpse at the technologies and trends set to take center stage at EMO Hannover 2025. Far more than just a showcase of machines, the event underscored the cultural and collaborative power of such platforms. With journalists from over 24 countries in attendance, the Preview was a platform where ideas met and stories resonated.

As EMO Hannover continues to redefine trade fairs, it can certainly be stated that the show is a launchpad for innovation, strategic alliances, and industrial transformation. On the one hand it provides a wide range of opportunities to companies to demonstrate technological leadership, connect with decision-makers, and compete on a global stage. On the other, it offers an immersive, first-hand look at the next frontier of manufacturing to the visitors.

> *"Ultimately, it is the convergence of artificial and human intelligence that will enable manufacturers to achieve a new era of speed, flexibility, efficiency, and connectivity in the 21st century."*
>
> *– Joe Kaeser*

This edition of Modern Manufacturing India captures the spirit of the EMO Preview — a dynamic prologue to the global industrial showcase slated for September 22–26, 2025, in Hannover, Germany. As our coverage continues, we at MMI remain committed to spotlighting the stories that state how the manufacturing industry is shaping the journey forward. We stand by the belief that the future of manufacturing is more than a matter of engineering; it is a global conversation — shared, shaped, and celebrated on world stages like EMO Hannover.

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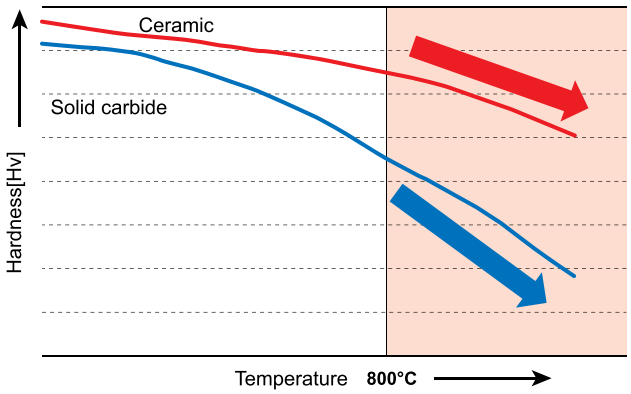
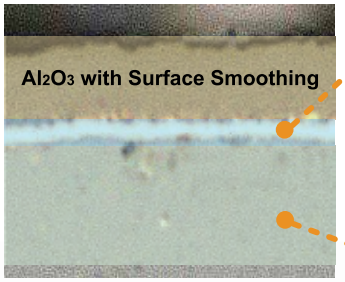
## THE STRENGTH OF CERAMICS ALLOWS FOR STABLE MACHINING EVEN WHEN CUTTING AT HIGH-SPEEDS.

### High Temperature Hardness of Cemented Carbide and Ceramic



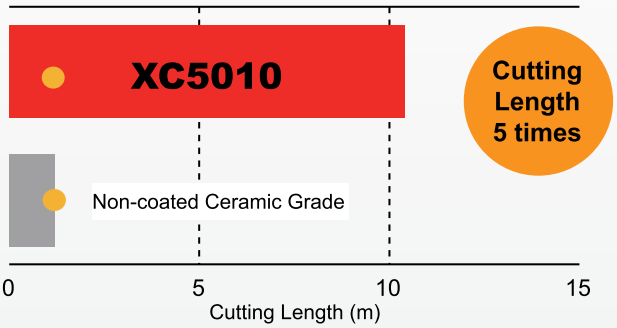

### Surface-smoothing Al2O3 coating suppresses the transmission of cutting heat




**Technology Improves Adhesion Strength**

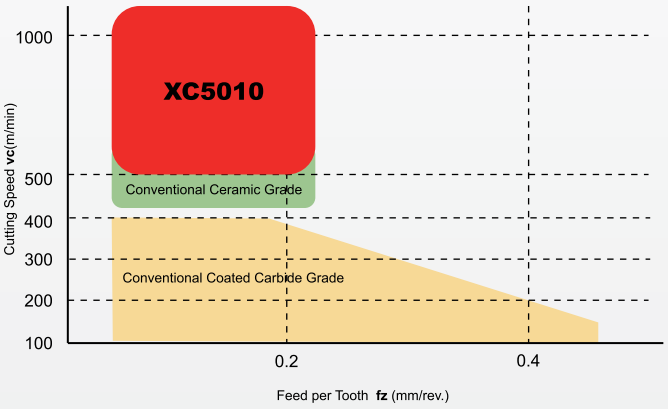
**Silicon Nitride Ceramic Substrate**

### Achieves 5 times the cutting length of carbide when used at high-speeds




<Cutting Conditions>
Workpiece Material : JIS FCD600
Tool : AHX640S DC=80mm
Cutting Speed : vc=1000m/min
Feed per Tooth : fz=0.1mm/t
Depth of Cut : ap=2.0mm
ae=50mm
Cutting Mode : Dry Cutting

### The combination of the unique shape and the coated ceramic grade achieves stable machining even at a cutting speeds of 1000 m/min.

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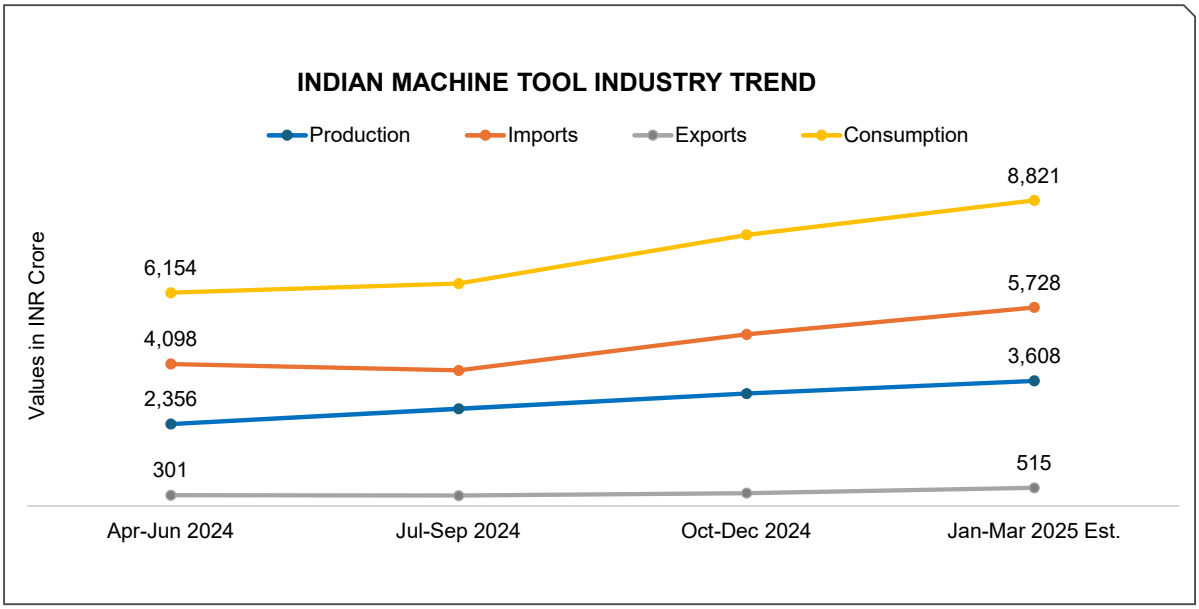
YOUR GLOBAL CRAFTSMAN STUDIO

# POISED FOR EXPANSION

India's machine tool industry is riding a growth wave, buoyed by domestic consumption and rising infrastructure. While exports dipped, strong production growth, rising imports, and consumption suggest increased local demand and industrial activity.




Source: IMTMA

Table 1. Indian Machine Tool Industry Trend

In FY2024–25, real GDP growth stood at 6.5 percent. Growth momentum strengthened in the final quarter, with Q4FY25 GDP rising to a four-quarter high of 7.4 percent, up from 6.4 percent in Q3FY25. However, indicators such as the manufacturing PMI (Purchasing Managers' Index) eased to 57.6, though it remained above its long-run average of 54.1. The services PMI continued to remain at a high level of 58.8. IIP (Index of Industrial Production) growth moderated to 2.7 percent in April 2025, driven by weaker growth in manufacturing and electricity output.

## Inflation Trends

Inflation trends continued to ease, with CPI (Consumer Price Index) inflation falling to a 75-month low of 2.8 percent in May 2025, largely due to lower food prices. Core CPI also moderated slightly to 4.3 percent, down from 4.4 percent in April 2025. WPI (Wholesale Price Index) inflation declined to 0.4 percent in May 2025, its lowest level since May 2024, driven by a drop in prices of food items, metals, and mineral oils.

On the fiscal front, the Government of India's fiscal deficit stood at 4.8 percent of GDP, aligning with the FY25 Revised Estimates (RE). The revenue deficit improved to 1.7 percent of GDP, compared to 1.9 percent projected in the FY25 RE.

## External Sector and Crude Prices

On the external front, merchandise exports and imports showed a contraction of (-)2.2 percent and (-)1.7 percent in May 2025, as compared to growth rates of 9.0 percent and 19.1 percent in April 2025. The merchandise trade deficit eased to US$ 21.9 billion in May 2025 from a five-month high of US$ 26.4 billion in April 2025.

In May 2025, the average global crude price fell to US$ 62.7/bbl, its lowest level since February 2021, amid escalating US tariffs and larger-than-expected output hikes by OPEC+. More recently, heightened geopolitical tensions due to the Israel-Iran conflict pushed the daily Brent crude price to a peak of US$ 77.08/bbl.

## Indian Machine Tool Industry Outlook

According to inputs from CECIMO on the World Machine Tool Industry Outlook, India is ranked

Source: Data & Policy Team, IMTMA

9th globally in production and 4th in consumption in CY2024. As per revised estimates from IMTMA (Indian Machine Tool Manufacturers' Association), Indian Machine Tool industry production in FY25 is estimated to have increased by around 7 percent year-on-year, reaching about INR 14,566 crore (US$ 1.7 B). The industry's imports in FY25 saw a rise of 22 percent year-on-year, amounting to INR 18,686 crore (US$ 2.2 B). Machine tool exports from India during FY25 reported an 11 percent degrowth, totalling INR 1,472 crore (US$ 173 M), and consumption is estimated to have increased by about 17 percent to reach INR 31,781 crore (US$ 3.7 B) in FY25.

### Import Composition - Q1 FY26

In Q1 FY26, Japan (26%), China (24%), and Germany (15%) emerged as the top countries for imports to India, contributing to 65 percent of the total machine tools imports. Presses (21%), VMCs (17%), and HMCs (8%) were the top three machinery types imported, valued at INR 2,616 crore (US$ 306 M), constituting about 46 percent of total machine tool imports during the period. Imports from Asian nations like China, Japan, South Korea, and Taiwan contributed 62 percent of total imports during Q1 FY26.

### Export Trends - Q1 FY26

In exports, Russia (48%), China (9%), and UAE (6%) emerged as the major destination, collectively representing 63 percent of total machine tool exports in Q1 FY26, amounting to a total export value of INR 625 crore (US$ 73 M). Among the machinery types, VMCs (47%), Lathes (9%), and Presses (9%) stood out as the top three machinery types exported, with a combined value of INR 409 crore (US$ 48 M), accounting for about 65 percent of total machine tool exports during Q1 FY26.

**In exports, Russia (48%), China (9%), and UAE (6%) emerged as the major destinations, collectively representing 63 percent of total machine tool exports in Q1 FY26, amounting to a total export value of INR 625 crore (US$ 73 M).**

POWERED BY
Indian Machine Tool Manufacturers' Association

# EMPOWERING HEALTHCARE

Backed by PLI schemes and the 'Make in India' initiative, Indian manufacturers are strengthening their capabilities. This presents a wide window of opportunity for the Machine Tool sector to become a reliable supplier of precision equipment to the Healthcare industry.

India is on the verge of a healthcare manufacturing revolution, ranking among the top 20 medical device markets globally and fourth in Asia, after Japan, China, and South Korea.

As the country aims for a remarkable transformation—with a bold goal of capturing around 10 percent of the global medical device market—it envisions the Indian market growing to US$ 50 billion by 2030, at a CAGR of 16.4 percent, according to the Ministry of Commerce and Industry, Government of India. Strong policy frameworks and innovation-led expansion are expected to continue driving this momentum.

## A Policy Push for Progress

*The Strategy Document on National Medical Devices Policy 2023,* released by the Department of Pharmaceuticals, Ministry of Chemicals & Fertilizers, aims to accelerate the sector's growth while focusing on evolving healthcare needs.

The primary objective of the policy is to build an innovative and globally competitive industry, strengthening self-reliance through automation, digital integration, and favorable policy interventions.

Recognizing its strategic importance, the Government has designated medical devices as a 'champion sector'. The Production Linked Incentive (PLI) scheme, with an allocation of INR 3,420 crore, aims to support domestic manufacturing in critical categories such as cancer care, radiology, renal devices, and implants.

Source: IMTMA

Source: Magic Wand Media

### Infrastructure and Investment Initiatives

To further industrial growth, the policy allows 100 percent Foreign Direct Investment (FDI) via the automatic route for medical device manufacturing—encouraging foreign collaborations and investments.

As part of its infrastructure push, the Ministry of Chemicals and Fertilizers has launched an INR 400 crore scheme to develop world-class medical device parks. These parks—emerging in Tamil Nadu, Himachal Pradesh, Madhya Pradesh, Uttar Pradesh, Andhra Pradesh, Telangana, and Kerala—offer shared testing facilities, reduced costs, and strong logistical support.

### A Turning Point

The global pandemic was a defining moment, revealing gaps in India's medical device manufacturing ecosystem. The surge in demand for ventilators, imaging devices, PPE kits, and surgical adhesives spotlighted the urgency of local innovation and production.

At the heart of this effort was the Machine Tool industry—crucial for producing high-precision equipment across materials and applications.

### The Role of the Machine Tool Industry

To meet the Healthcare sector's rising needs, the Machine Tool industry must adapt quickly to deliver high-precision, multi-material manufacturing solutions. This includes machines capable of handling biocompatible and exotic materials such as titanium, polymers, and ceramics.

Manufacturers are seeking machine tools for producing various types of implants and components, such as:

**Orthopaedic implants** (for repairing or replacing damaged bones and joints, such as hip and knee replacements, bone plates, screws, and cartilage implants).

**Cardiovascular implants** (for pacemakers and implantable cardioverter defibrillators (ICDs) that monitor and regulate heart rhythm).

**Neurological implants** (for devices like deep brain stimulators for conditions like Parkinson's disease and spinal cord stimulators for pain management).

Dental implants (for replacing missing teeth).

**Sensory implants** (cochlear implants for hearing restoration and ocular implants for vision correction).

**Drug delivery implants** (for controlled release of medications, like insulin pumps or drug-eluting stents).

**Surgical implants** (meshes for hernia repair, breast implants, and tissue expanders).

**Furniture** (machine tools required for cutting, shaping, and finishing materials like metal, wood, and plastics).

### Toward Self-Reliance

Currently, India imports a large share of high-end surgical and diagnostic devices. However, with strategic manufacturing and localization efforts, domestic production is both viable and essential.

Backed by PLI schemes and the 'Make in India' initiative, Indian manufacturers are strengthening their capabilities. This presents a wide window of opportunity for the Machine Tool sector to become a reliable supplier of precision equipment to the Healthcare industry.

### Tech Advancements Needed

To stay ahead, the Machine Tool industry must adopt advanced technologies such as CNC machining centers (5-axis), CNC lathes, EDM machines, laser cutting/welding systems, high-precision injection molding machines, metrology and inspection tools, and other related equipment.

Additionally, investments in additive manufacturing, robotics, AI, and Industrial IoT will play a crucial role in improving traceability, quality assurance, and real-time decision-making.

### Bridging Innovation and Manufacturing

Research institutions and the Medical Device Manufacturing industry need to collaborate more closely to close the gap between innovation and product development in the medical device manufacturing process, thereby accelerating the goal of self-reliance.

Trade fairs like IMTEX serve as vital platforms to showcase innovations and accelerate India's ambitions in this sector. In this symphony of progress, the Indian Machine Tool industry can play a pivotal role of enabling the medical manufacturing ecosystem to shift from import dependency to self-sufficiency, all while driving excellence and innovation in production.

**As part of its infrastructure push, the Ministry of Chemicals and Fertilizers has launched an INR 400 crore scheme to develop world-class medical device parks in several states. These parks offer shared testing facilities, reduced costs, and strong logistical support.**

# AUTOMATION & ROBOTICS: CURRENT & FUTURE OUTLOOK

India's manufacturing sector is rapidly adopting automation and robotics to enhance productivity, improve quality, and remain globally competitive. This article examines current adoption trends, key challenges, and the strategic roadmap for future growth. The insights presented are based on contributions from NRI's Nishant Shekhar (Principal), Prabhod Mudlapur (Senior Consultant), and Mohit Agarwal (DSC), along with Ashim Sharma.

Source: Magic Wand Media

ASHIM SHARMA
Senior Partner &
Business Unit Head
Business Performance Improvement
(Auto, Engineering & Logistics)
Nomura Research Institute Consulting and Solutions India Pvt Ltd (NRI)

India stands at the cusp of a major industrial transformation, and we are targeting an increase in the share of manufacturing in the economy—from approximately 13 percent in 2024 to 25 percent by 2047—as part of our quest to become a developed nation. We also aim to grow our share of global exports to 10 percent. India's manufacturing output is currently growing at a CAGR of 8 percent, while merchandise exports are increasing at 10 percent. To sustain this growth, achieve our targets, and enhance our competitiveness against global peers, Indian manufacturers must embrace cutting-edge technologies like automation. This adoption is not merely a response to global trends but a proactive step toward fostering innovation, increasing productivity, improving quality, and enhancing worker safety.

## Automation in Manufacturing Activities

The following are key areas within the manufacturing process where automation technologies can be effectively applied.

***Material Handling:***
Systems like conveyors, AGVs, and robotic arms are used to transport raw materials and components within the facility to improve speed and reduce human effort.

***Machining Process:***
CNC machines and robotic machining centers are being deployed to perform high-precision tasks such as cutting and drilling.

***Fabrication and Joining:***
Robotic welding machines are increasingly being used in Indian manufacturing com-

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Concurrent Show

**IPPEX 2026**
Plastics & Polymers Exhibition
2 - 6 APRIL 2026
Chennai Trade Centre, Chennai, India
MOULDS & DIES - PROCESS & RAW MATERIALS

**IMTOF 2026**
INTERNATIONAL MACHINE TOOL FAIR
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panies to ensure consistent weld quality and speed up the welding process.

***Surface Treatment and Coating:***
Robotic arms and automated spraying systems are used for coating applications.

***Assembly:***
Robotic assembly lines, collaborative robots, and automated screwdrivers are used to streamline final assembly processes.

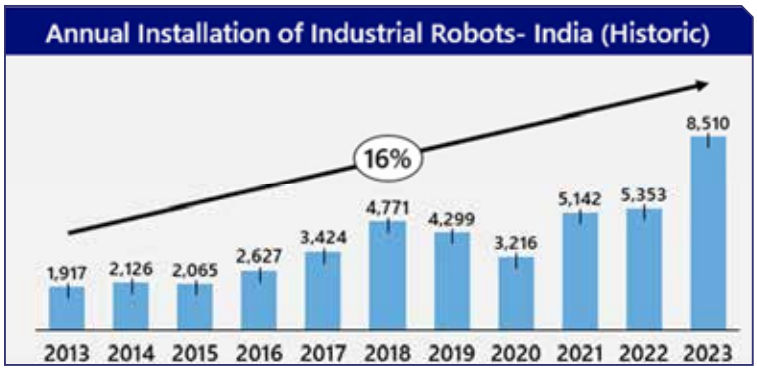
***Maintenance and Utility Management:***
IoT-enabled sensors can be used for predictive maintenance and real-time monitoring of equipment health.

***Production Planning and Control:***
Advanced ERP, Distributed Control Systems (DCS), and AI-based forecasting tools enable dynamic production planning and efficient inventory management.

***Material Storage and Retrieval:***
Automated storage and retrieval systems (ASRS), RFID tracking, and warehouse robots help improve inventory management and warehouse efficiency.

***Packaging:***
Robotic arms and automated labelling systems ensure speed and consistency in packaging.

***Inspection and Quality Control:***
Vision-guided robotic systems and advanced camera technologies are used to detect defects and ensure that finished goods meet quality standards.




Source: International Federation of Robotics

## Current State of Automation in India

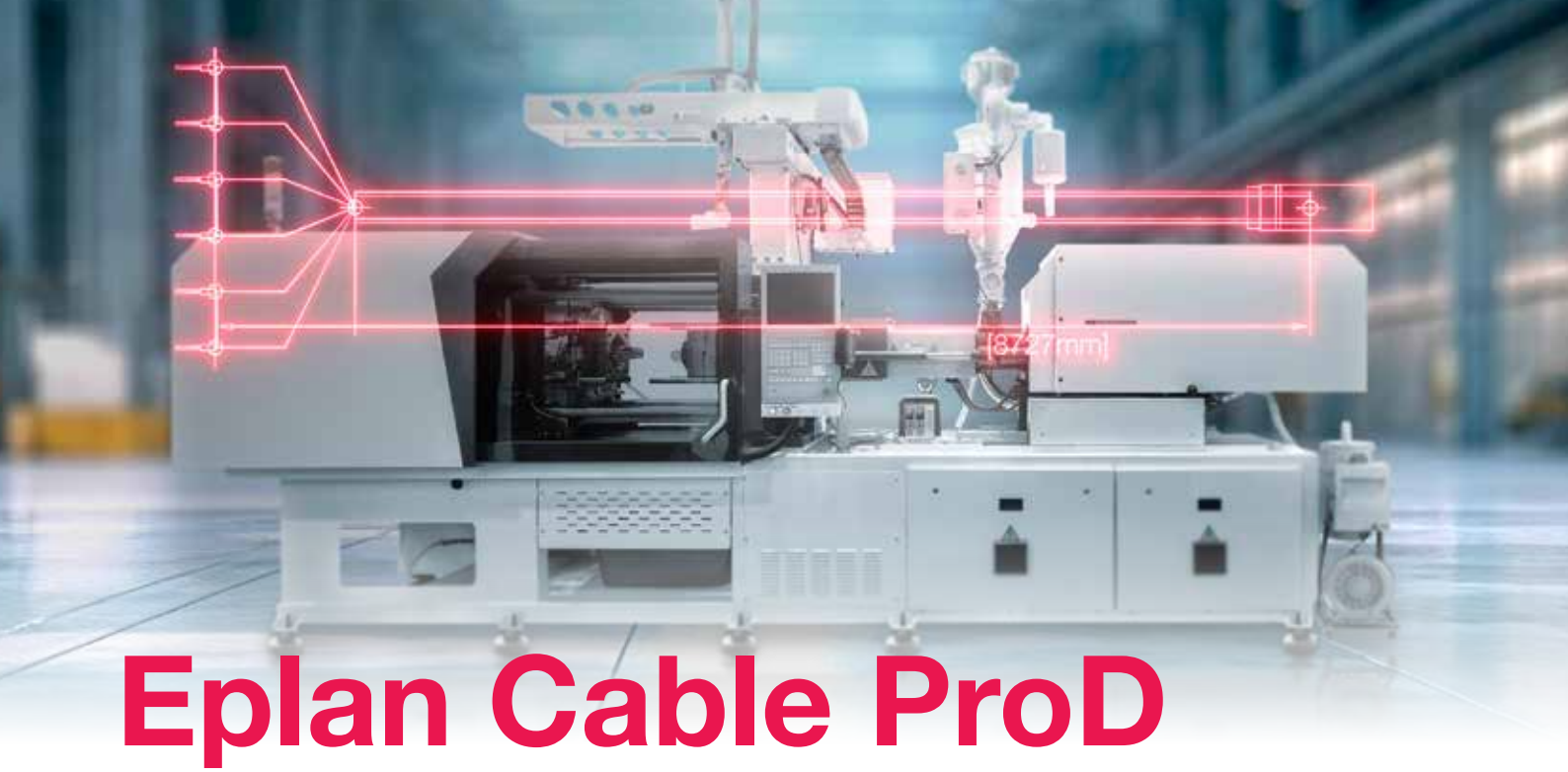
The annual installation of industrial robots in India recorded a CAGR of 16 percent between 2013 and 2023, with 8,510 robots installed in 2023 alone. This growth is expected to continue at a similar rate until 2033, driven by ongoing technological advancements and declining costs in robotics.

India's industrial automation market is currently valued at approximately US$ 15 billion and is projected to grow at a 12 percent CAGR, reaching around US$ 40 billion by 2033. This expansion is supported by national initiatives such as Digital India and Make in India, along with rapid developments in AI technologies.

To further accelerate the adoption of automation, the Government of India has launched SAMARTH Udyog Bharat 4.0 (Smart Advanced Manufacturing and Rapid Transformation Hub), promoting Industry 4.0 and smart manufacturing. A draft of the National Strategy for Robotics is also under review, prioritizing the use of robots in sectors like Manufacturing, Healthcare, Agriculture, and National Security.

In addition, policy initiatives such as Make in India, the

**The annual installation of industrial robots in India recorded a CAGR of 16% between 2013 and 2023, with 8,510 robots installed in 2023 alone. This growth is expected to continue until 2033, due to technological advancements and declining costs in robotics.**



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National Manufacturing Policy, and Production-Linked Incentive (PLI) schemes are focused on boosting India's manufacturing output, thereby encouraging greater adoption of automation technologies across the industry.

## Adoption Trends Across Key Industries in India

According to NRI, the scope for automation and robotics spans across several key sectors in Indian manufacturing:

***Mobility (Automotive):***
Robotic assembly lines can handle repetitive tasks such as screwdriving, windshield installation, and wheel mounting. AI-based vision systems enable inspection and surface quality checks, while collaborative robots (cobots) assist in high-precision tasks like spot welding.

***New Energy:***
The automation trend will increase with the adoption of robotic solar cleaning modules, PLC based SCADA for controlling solar plant, and smart grids to match the supply and demand of electricity in real time.

***Electronics:***
Automation in the form of additive manufacturing can produce complex and miniature designs, thereby reducing waste and saving time. Alternatively, cobots can be used to insert chips into testing machines or perform operations like soldering.

***White Goods (Home Appliances):***
Automated conveyors can be deployed in manufacturing facilities to perform heavy duty tasks. This also prevents collision of material during the movement. Automation of processes like fastening leads to faster cycle time and better torquing in ergonomically unfavorable locations.

***Heavy Equipment:***
Robotic welding increases speed and precision, thereby reducing defects. Alternatively, robotic assembly can boost the efficiency while minimizing manual errors and rework, especially for large scale repetitive tasks.

***Defence & Aerospace:***
Automated conveyors can be used to streamline the movement of heavy parts like fuselage sections or missile casing between workstations. Robotic arms can also be used to precisely fill hazardous components like propellants or explosives.

## Key Challenges in Automation

Despite the growing importance of automation in global manufacturing, Indian players face challenges in adopting and scaling robotics and automation technology. Following are a few:

***Upfront Cost:*** The cost of adopting automation technology is a major hurdle. Investing in industrial robots, supporting software, and enabling infrastructure requires significant upfront capital and expertise.

***Workforce Transition:*** The transition to automated systems is impeded by a lack of skilled manpower. Many shop-floor workers are unfamiliar with operating or troubleshooting advanced automation systems.

***Organizational Resistance:*** Cultural resistance to change, coupled with fears of job losses, often leads to opposition within organizations.

***Inadequate Infrastructure:***
There is a lack of supporting infrastructure, including limited cloud computing capacity, low domestic production of key automation components (such as sensors and robots), and gaps in industrial data management.

***Complex Integration:*** Legacy systems often lack the flexibility or tech capacity to interface with advanced technologies such as the Internet of Things (IoT), Artificial Intelligence (AI), and cloud platforms.

## Way Forward

To support the adoption of automation in the Indian Manufacturing sector, it is essential to develop a holistic and inclusive strategy that addresses financial, infrastructural, and human capital challenges.

***Financial Support:*** To ease the burden of high upfront automation costs—especially for MSMEs—the government and industry bodies should explore providing capital subsidies and interest waivers on equipment purchases. Reducing import duties on automation technologies can further enhance their accessibility for Indian manufacturers.

***Improving Infrastructure:*** Public-private partnerships can be leveraged to develop manufacturing parks with advanced infrastructure and support services. This can help attract investment in automation and create shared infrastructure for players.

***Autonomation (Jidoka):*** A concept in lean manufacturing which refers to 'automation with a human touch'. This approach can help reduce job loss concerns while ensuring human oversight in automated processes.

***Skill Development:*** Employees should be upskilled and reskilled through partnerships between industries and institutions, offering vocational trainings and certification programs focused on automation technologies.

***Assessing Suitability:*** Automation should be prioritized in sectors where Indian companies face disadvantages due to limited domestic resources or a shortage of skilled labor. This can help derive a competitive advantage and improve overall efficiency.

**To further accelerate the adoption of automation, the Government of India has launched SAMARTH Udyog Bharat 4.0 (Smart Advanced Manufacturing and Rapid Transformation Hub), promoting Industry 4.0 and smart manufacturing.**








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# INDIA TIGHTENS QUALITY CONTROL

With mandatory BIS certification, covering a wider range of products, Indian manufacturers must ensure compliance or face serious legal and financial consequences.

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The Bureau of Indian Standards (BIS) is the national standards body of India established under the BIS Act, 2016, with the authority to ensure product safety, quality, and reliability. BIS operates through various certification schemes to evaluate the conformity of products as prescribed by applicable Indian Standards. Its role is to safeguard consumer interests and promote fair competition in the market. BIS certification, though largely voluntary, becomes mandatory through legal notifications called Quality Control Orders (QCOs). These are issued by Government ministries, mandating that certain products bear the BIS Standard Mark before sale, import, or distribution in India. With over 750 products now covered under such QCOs, non-compliance is not an option for manufacturers looking to enter the Indian market.

## Scheme X and Its Importance

Among the key schemes under BIS, Scheme X is highly relevant to machinery and electrical equipment, especially those imported into India by foreign manufacturers. It is governed by the BIS (Conformity Assessment) Regulations, 2018 and implemented through QCOs, mainly the Machinery and Electrical Equipment Safety (Omnibus Technical Regulation) Order, 2024.

This Order, issued by the Ministry of Heavy Industries, mandates BIS certification for over 20 product categories, including pumps, switchgear devices, transformers, power converters, cranes, diesel generators, and filtration equipment.

On June 12, 2025, the Government extended the enforcement date for certain categories to September 1, 2026, offering temporary relief but reinforcing that compliance is inevitable. The Order applies to both Indian and foreign manufacturers, and certification is factory-specific, meaning separate applications are needed for multiple production sites.

## July 2025 Guidelines: Enhanced Clarity for Scheme X and Metal Cutting Machines

In July 2025, BIS released two documents clarifying certification procedures under Scheme X, especially for machinery under the Omnibus Technical Regulation (OTR), 2024.

The general certification procedure dated July 11, 2025 and the category-specific framework dated July 16 for metal cutting machines are now pivotal for manufacturers targeting compliance and uninterrupted market entry.

The July 11 guidelines outline two certification pathways: the Licence to Use the Standard Mark and the Certificate of Conformity (CoC). The former applies to ongoing production units, while the latter is for limited runs or prototypes. Applications must include a technical file with product details, model variants, applicable Indian Standards, photographs, safety diagrams, and comprehensive product compliance reports.

BIS also mandates documentation of manufacturing processes, safety validations, and in-house quality assurance mechanisms. A multi-stage assessment follows, starting with a desk audit and a mandatory site audit conducted by a BIS-qualified team. This audit verifies physical and functional safety and inspects the conformity of control systems, such as stroke limiters, interlocks, and grounding measures.

The July 16 guidelines offer direction for manufacturers of metal cutting machines, including milling, turning, sawing, EDM (electro-discharge), and pressing machines. Where a Type C standard is available, it must be used alongside Type A and B standards. In its absence, manufacturers must follow IS 16819 (Type A) and relevant B-level standards like IS 16504-1 for electrical safety.

A key requirement is the 'family of models' concept. Manufacturers can group machines under a shared risk profile using a lead model that represents the highest safety benchmark. For example, a milling machine series with minor variations may be grouped under one license, provided the lead model meets compliance requirements. Risk assessments must include mechanical, electrical, and thermal benchmarks. Labeling and marking norms have also been rede-

## Penalties for Non-Compliance with BIS Regulations

- Jail term of up to 2 years
- Fines starting at INR 2 lakh (INR 5 lakh for repeat offenses)
- Fines can go up to 10× the product's value
- Company directors can be held personally liable
- BIS and police can seize products without a warrant
- Companies must compensate customers if certified goods cause harm

fined. All certified machines must visibly bear the BIS Standard Mark and list essential information such as model numbers, batch details, and safety instructions at least in English.

### Penalties and Consequences for Non-compliance

Non-compliance with BIS regulations, especially for QCO-covered products, carries steep consequences. Under Section 29 of the BIS Act, violators may face up to two years of imprisonment and a fine starting from INR 2 lakh for first-time offences escalating to INR 5 lakh for repeat violations. Additionally, fines can reach up to 10 times the value of non-compliant goods. Section 30 extends liability to directors and responsible officers, while Section 31 obligates licensees to compensate consumers for damages from substandard certified goods. Section 28 authorizes BIS and police officers to conduct searches and seizures without a warrant if credible evidence exists.

### Conclusion

The regulatory landscape remains dynamic. Guidelines for the product categories under the Omnibus Technical Regulation are still awaited for other machinery, and industry players are advised to monitor updates closely. Given the complexity and evolving nature of the BIS framework, manufacturers must take a proactive approach to certification to avoid disruption and secure market access.

**Labeling and marking norms have also been redefined. All certified machines must visibly bear the BIS Standard Mark and list essential information such as model numbers, batch details, and safety instructions at least in English.**

# FROM PROTOTYPE TO PRODUCTION

Additive Manufacturing, also known as 3D printing, has developed from its initial status as a laboratory rapid prototyping tool into an essential group of production machine tools that deliver industrial-grade end-use components. The development of 3D printing machines signifies more than innovation; it transforms how we approach manufacturing.

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### The Origins: Layer-by-Layer Thinking (1980s-1990s)

The concept of additive manufacturing (AM) emerged through a revolutionary notion which proposed that objects should be constructed through sequential layer additions of material.

In 1984, Charles Hull developed stereolithography (SLA), the first commercial 3D printing process, which uses UV laser light to solidify photopolymer resin into three-dimensional objects through sequential layer formation.

The invention stands as the initial commercial 3D printing technology that established the principle of sequential layer construction. The photopolymer resin transforms into solid form after UV light exposure. The laser beam focuses UV energy on selected resin areas to create solidification while the process builds layers through laser-guided cross-sectional tracing.

In the early 1990s Fused Deposition Modeling (FDM) emerged as a 3D printing technology through Stratasys because it provided lower costs than other rapid prototyping systems.

The material extrusion process of Fused Deposition Modeling creates 3D objects by heating thermoplastic filament that is then extruded through a nozzle to form successive layers. FDM operates by utilizing thermoplastic filaments that come from spools that the printer uses as feedstock.

The introduction of FDM technology made 3D printing more budget-friendly than stereolithography and other early prototyping techniques. Since its introduction, FDM has become one of

Source: Magic Wand Media

the most popular 3D printing technologies, finding applications in various fields like Automotive, Biomedical, and Textiles.

## Additive Manufacturing Systems Gain Factory-Worthiness

3D printing systems achieved improved precision and reproducibility through advancements in CAD, CAM, and motion control technologies, as well as closed-loop feedback, servo motors, and multi-axis control. The use of heated build chambers together with better environmental controls helped resolve problems with polymer warping and delamination. The proprietary slicer software developed better path optimization techniques which led to enhanced build reliability.

Additive Manufacturing systems gained factory-worthiness through rigorous machine design implementations from major industrial players and machine tool manufacturers.

## The Rise of Metal Additive Manufacturing (2010s)

Additive Manufacturing technology experienced a fundamental transformation when Powder Bed Fusion (PBF) and Directed Energy Deposition (DED) emerged as metal manufacturing techniques.

### *Powder Bed Fusion*

Laser Powder Bed Fusion machines took over the leading position for aerospace, dental, and medical applications. Machines progressed from using single-laser systems to adopting multi-laser high-speed scan arrays with melt-pool monitoring through closed-loop systems.

Standardization of inert gas handling systems, recoating reliability features, and real-time process analytics became mandatory.

### *Directed Energy Deposition*

The combination of robotic arms and high-power lasers in DED technology allowed large-scale metal part repairs and hybrid Additive Manufacturing-subtractive workflows. CNC manufacturers installed DED heads onto their 5-axis machines to merge additive and subtractive manufacturing capabilities into a single platform.

## 3D Printing Machines Enter The Production Line (2020s)

The past five years have established Additive Manufacturing systems as factory-floor production machines that perform complete manufacturing tasks instead of only creating prototypes.

The introduction of multi-material extrusion and voxel-level control systems made it possible to produce functional gradient materials and embed electronics directly into parts. Additive Manufacturing systems gained Industry 4.0 compatibility through automated part removal functions, in-situ inspection, and integration features with manufacturing extrusion systems. Machine tool companies Mazak, TRUMPF and Hermle created hybrid machines by uniting CNC milling with metal AM that improved operational efficiency.

The process of treating Additive Manufacturing has evolved to include de-powdering, heat treatment, and CNC finishing operations, all functioning as an integrated system.

## Development of Printable Materials Drives Continuous Advancements

The growth of printable materials forced corresponding advancements in machine design development. The manufacturing of PEEK and ULTEM high-temperature polymers demanded heated nozzles with vacuum beds that required enclosure temperatures to exceed 200°C. The emergence of ceramic printing techniques (slurry-based or binder jet) established new standards for powder management systems and sintering regulation methods.

The evolution of bio-printing machines included the introduction of capabilities to handle soft gels and cells while maintaining sterile environments.

**The past five years have established Additive Manufacturing systems as factory-floor production machines that perform complete manufacturing tasks instead of only creating prototypes.**

## Key Milestones in Additive Manufacturing Machine Tool Development

| Year | Milestone | Technology |
|---|---|---|
| 1984 | Stereolithography invented by Charles Hull | Photopolymerization |
| 1991 | First Selective Laser Sintering machine commercialized | Powder Fusion |
| 2000 | Electro Optical Systems introduces metal laser sintering | Laser Powder Bed Fusion (LPBF) |
| 2012 | GE acquires Additive Manufacturing firms for aviation | Metal PBF |
| 2016 | HP releases Multi Jet Fusion | Polymer Binder Jet |
| 2016 | Hybrid CNC-Additive Manufacturing goes mainstream | Directed Energy Deposition (DED)+CNC |

Each material innovation has required rethinking extrusion mechanics, thermal control, and motion accuracy.

### The Future: Micro, Macro, and Multiscale

Additive Manufacturing machines are moving toward three independent yet supportive paths of advancement:

**Micro-Additive Manufacturing:** The combination of two-photon lithography with electrohydrodynamic jetting and nano-scale inkjet printing achieves resolution at sub-micron levels.

The technology serves applications that include microfluidics alongside photonics and biomedical scaffold development.

**Large-Format Additive Manufacturing:** The combination of robotic extrusion systems with wire arc additive manufacturing technology produces boat hulls, pressure vessels, and architectural structures.

Real-time monitoring of thermal distortion, together with layer alignment, represents the primary difficulty to overcome.

**Multiscale, Multimaterial Systems:** Printers now enable users to combine different material types in a single construction process including soft and rigid components and electronic structures and metal-polymer hybrid sections.

The 3D printing method of Volumetric printing together with computed axial lithography uses light patterns to create complete parts simultaneously.

Additive machine tools have evolved dramatically from their initial status as laboratory curiosities into essential industrial production tools. The future of Additive Manufacturing systems will develop into factory-like machines that optimize build processes while validating quality and adapting in real-time. The additive machine tool represents a digital descendant of traditional machining rather than a direct competitor to it.

**Additive machine tools have evolved dramatically from their initial status as laboratory curiosities into essential industrial production tools. The future of Additive Manufacturing systems will develop into factory-like machines that optimize build processes while validating quality and adapting in real-time.**

Source: Magic Wand Media

*Tech Talks is a column by industry veteran and journalist Reji Varghese that talks about the latest advancements in Machine Tools, provides snippets from history, interesting facts, etc. about the Machine Tool industry.*


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# INTELLIGENT MANUFACTURING Transforming Industrial Ecosystems

Source: Magic Wand Media

**Here's exploring how manufacturing leaders can leverage AI as a transformative force. The future belongs to those who recognize that Artificial intelligence (AI) is no longer just about automation. It's about autonomy, intelligence, integration and a new more effective way of working.**

Source: KPMG International Ltd

Artificial intelligence (AI) is reshaping every facet of manufacturing. From design to production, supply chains to sales, and workforce management, AI is unlocking new efficiencies and enabling smarter, more agile operations. It's also powering sustainability, helping manufacturers minimize waste and optimize energy use.

The potential is vast, but so are the challenges. AI adoption remains fragmented and functionally driven. Many manufacturers are deploying AI in silos — production floors are embracing AI-driven automation and predictive maintenance, while back-office functions remain largely unintegrated and lacking automation. This disjointed approach limits AI's full potential, preventing the industry from achieving true enterprise-wide transformation.

The sector also presents a stark contrast in maturity levels. Smart industrials are leading the charge, embedding AI deeply into their operations. More traditional manufacturers are still experimenting with localized AI use cases, hesitant to commit to full-scale transformation. Meanwhile, agentic AI, the next frontier in intelligent tools, waits in the wings.

By enabling self-optimizing supply chains, autonomous production lines and real-time coordination across business functions, agentic AI paves the way for a truly intelligent, end-to-end manufacturing model. But to fully realize its potential, manufacturers should move beyond isolated AI implementations and embrace a connected, enterprise-wide approach.

## A Transformational Shift

This report from KPMG explores how manufacturing leaders can leverage AI as a transformative force. AI leaders in the sector recognize that embracing AI is no longer optional but a strategic necessity — 93 percent believe that organizations that fully integrate AI will gain a significant competitive edge over those that do not.

It is quickly becoming integral to operations: 20 percent of manufacturers consider AI a core component across all departments. Furthermore, 26 percent have embedded AI into their organizational culture and operations, using it to drive innovation, create new business models, and explore untapped markets.

## Agile and Hybrid Organizational Models

To support AI adoption, manufacturing firms are rethinking their organizational structures. Nineteen percent have adopted an agile approach, where teams are cross-functional, adaptable and focused on specific projects or goals to ensure rapid iteration and delivery. However, 50 percent have implemented a hybrid model, blending multiple approaches such as functional and agile structures to optimize flexibility and efficiency.

## Cloud, On-Premises

While 60 percent have predominantly cloud-based IT systems, AI adoption remains rooted in both cloud and on-premises infrastructure; in fact, 84 percent are leveraging on-premises AI

**Many manufacturers are deploying AI in silos — production floors are embracing AI-driven automation and predictive maintenance, while back-office functions remain largely unintegrated and lacking automation.**

Source: Magic Wand Media

solutions. The ability to manage and integrate data effectively is also a priority, with 52 percent implementing cross-platform data integration or intelligent data fabrics, and 74 percent making significant use of AI-powered data platforms.

### Advanced AI Capabilities In Manufacturing

AI applications in industrial manufacturing are rapidly expanding. Seventy-four percent of organizations are utilizing machine learning, while 72 percent are leveraging predictive analytics. Process automation is also a key focus, with 67 percent integrating AI with RPA. Notably, 67 percent are using agentic AI, with an additional 20 percent planning to expand its use. Confidence in AI's decision-making capabilities is high: 91 percent are comfortable allowing AI to make end-to-end autonomous decisions for specific processes.

**Investment in AI is accelerating, with 36% of manufacturers allocating over 10% of their total IT budget to AI.**

### Impact On Key Business Functions

AI adoption is having the greatest impact on R&D and IT functions, according to 77 percent of industry leaders. However, its influence extends across the value chain, with 70 percent citing significant operational improvements as AI becomes embedded into core business functions.

### Investment Trends And Budget Prioritization

Investment in AI is accelerating, with 36 percent of manufacturers allocating over 10 percent of their total IT budget to AI. Looking ahead, 77 percent plan to increase AI investments over the next year, with 71 percent expecting growth of more than 10 percent. The primary objectives of these investments are clear: 72 percent aim to enhance efficiency, with 52 percent focused on process automation and 77 percent using AI to drive business growth.

### Measuring AI's Business Impact

The benefits of AI adoption are already materializing. Ninety-six percent of organizations have reported operational and efficiency gains, while 45 percent have experienced measurable financial improvements. Return on investment (ROI) is a key metric, with 62 percent achieving an ROI greater than 10 percent and 31 percent expecting AI investments to yield a return of over 30 percent in the next 12 months.

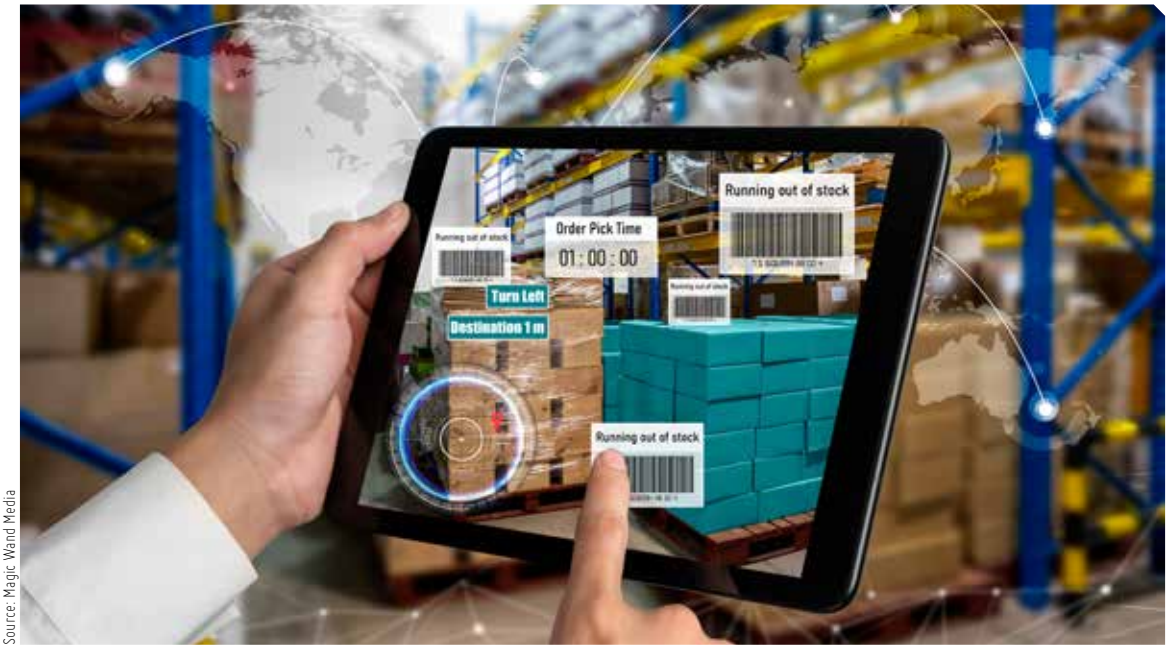
### AI Upskilling and Workforce Readiness

Workforce preparedness is a critical enabler of AI adoption. Recognizing this, 80 percent of organizations have invested in AI knowledge and skills training, while 72 percent have focused on building a comprehensive business AI strategy. Encouragingly, 89 percent believe employees are quickly adapting to AI tools and technologies, supporting widespread adoption across the workforce. Encouraging cross-functional collaboration between AI specialists, engineers and frontline workers helps ensure that AI adoption uplifts workforces.

### Balancing AI with Sustainability Goals

While AI adoption is accelerating, manufacturers are also conscious of its broader implications.


Source: Magic Wand Media




Source: Magic Wand Media

Seventy-eight percent believe meeting sustainability targets is more important than AI, highlighting the sector's commitment to responsible innovation. Additionally, 85 percent have strategies in place to mitigate AI's increasing energy demands, ensuring AI adoption aligns with long-term sustainability goals.

## Create a Sustainable Technology

Maximizing value from AI depends on integrated, scalable and secure data infrastructure. Organizations should build a connected data ecosystem that integrates research and development (R&D), production and field service data. Cloud-based AI platforms, intelligent edge computing and cross-platform data fabrics enable real-time AI-driven insights and interoperability across legacy systems and new digital technologies.

## Transformative Role of Agentic Autonomous Agents

Agentic autonomous AI — AI-driven systems capable of independent reasoning, decision-making and goal-oriented execution — can fundamentally reshape industrial manufacturing. These AI agents can proactively manage complex processes, adapt to changing conditions and collaborate with humans and other systems to drive efficiency, innovation and resilience. Agentic AI can introduce self-directed, goal-oriented decision-making across various manufacturing processes. Key areas of future transformation include:

### *Autonomous Production Lines*

AI agents can optimize production schedules in real time based on demand, resource availability and machine performance. They can detect and correct defects proactively, reducing waste and enhancing quality control. Self-optimizing robotic systems can collaborate with human workers to enhance efficiency while maintaining flexibility. It can track process parameters and adjust other machine parameters to maximize yield to optimize costs and drive consistency.

### *Self-Optimizing Supply Chains*

AI agents can drive intelligent commodity forecasting by tracking multiple market indices in real time and adjust procurement strategies dynamically to optimize costs and balance risks. AI agents can also optimize the share of business (SOB) processes by identifying cost-saving opportunities, flagging anomalies and streamlining approvals — driving greater efficiency, compliance and value across the procurement value chain.

### *Asset Management*

AI-driven agents can predict and prevent equipment failures by continuously analyzing sensor data. Autonomous systems can schedule and execute maintenance tasks without human intervention, minimizing downtime. Digital twins, powered by agentic AI, can simulate wear and tear, testing different maintenance strategies to extend machine lifespan. AI agents also help in understanding failure patterns of equipment, identify critical spares, redesign spare

**Agentic autonomous AI — AI-driven systems capable of independent reasoning, decision-making and goal-oriented execution — can fundamentally reshape industrial manufacturing.**

## AI Maturity Model Through Three Key Stages

**Enabling workforces and building AI foundations**

Establishing the data integration, governance and skills necessary for responsible AI adoption

**Embedding AI across the enterprise**

Scaling AI solutions beyond production into supply chains, procurement and business operations to drive holistic transformation

**Evolving operating models and ecosystems**

Moving toward agentic AI-powered manufacturing that fosters end-to-end connectivity, self-optimizing production systems and AI-driven decision-making across the enterprise.

**Leaders need to think through how processes will change post AI implementations and how humans and AI should work together in a new way.**

part policies and release auto purchase orders based on minimum inventory thereby enabling minimum downtime.

### *Human-AI Collaboration in Decision-Making*

AI agents can assist production managers by analyzing complex scenarios and proposing optimized strategies. Intelligent copilots can provide real-time recommendations to factory workers on the shop floor, improving decision-making speed and accuracy. AI-driven training simulations can provide personalized learning experiences, accelerating workforce upskilling.

### *Circular Economy and Sustainable Manufacturing*

AI agents can help optimize material usage and recycling efforts by identifying waste reduction opportunities across the production cycle. Autonomous systems can track carbon emissions in real time, ensuring compliance with environmental regulations. AI-driven energy management systems can dynamically adjust power consumption to help minimize costs and environmental impact.

## Data Problem in Manufacturing

Manufacturing generates vast amounts of data — from R&D labs to the shop floor to field service operations. However, this data is often fragmented, siloed and disconnected, hiding insights and limiting its potential value. Manufacturers can unlock real value by integrating R&D, production and field service data into a closed-loop system. Without this integration, manufacturers struggle to turn data into actionable insights, missing opportunities for efficiency, innovation and cost reduction.

Manufacturing data is not just siloed — it is also highly heterogeneous. Products vary widely in complexity, requiring different data structures and analytics approaches. Ownership of data is fragmented across multiple stakeholders — including manufacturers, customers, distributors, dealers and third-party service providers.

Data formats and standards vary across different production lines, making integration a technical challenge. Without a unified data strategy, manufacturers struggle to extract meaningful insights. They remain reactive rather than predictive, limiting their ability to optimize performance, enhance quality and accelerate innovation.

## Addressing the Challenge

To help maximize AI's potential, manufacturers should move from disconnected data silos to a fully integrated, AI-powered ecosystem. By creating a closed-loop data framework that connects R&D, production and field service, manufacturers can continuously optimize product design based on real-world performance, enable predictive maintenance and reduce unplanned downtime and improve supply chain efficiency by aligning production with demand signals from field data.

AI-driven, cross-functional data integration is the key to transforming manufacturing from a reactive industry to a proactive, intelligent ecosystem.

## In Conclusion

AI adoption in manufacturing is not just about efficiency — it is about long-term growth and transformation. This structured approach ensures AI investments align with business objectives, paving the way for sustained competitive advantage.

Manufacturers should develop a blueprint for implementing AI across the enterprise with a focus on AI applications that have a high business impact and provide operational benefits, such as predictive maintenance, defect detection production optimization and AI-driven supply chain forecasting.

AI should augment human expertise, not replace it. Leaders need to think through how processes will change post AI implementations and how humans and AI should work together in a new way. Manufacturers should reskill employees, integrate AI into factory operations and decision-making processes, and create a culture where AI enhances efficiency, safety and innovation.

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# EXPLORING NEW HORIZONS

In this compelling conversation with MMI Editor-in-Chief Soumi Mitra, Manu J Nair, Co-Founder & CEO, Ethereal Exploration Guild (EtherealX), reveals what drove the bold leap into private space tech, the vision behind the company's game-changing launch vehicle Razor Crest Mk-1, and the critical shifts India must embrace to elevate its position in the global space ecosystem.


Source: Ethereal Exploration Guild

**L to R - Prashanth Sharma, Co-Founder & Chief Technology Officer, EtherealX; Manu J Nair, Co-Founder & Chief Executive Officer, EtherealX; and Shubhayu Sardar, Co-Founder & Chief Operation Officer, EtherealX.**

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**From ISRO to EtherealX: What inspired you and your co-founders to take the leap into private space tech entrepreneurship, and how has the journey been since 2022?**

It all began in January 2020 when I, Manu J Nair, met Shubhayu Sardar (Co-Founder & COO), during the final days of my university stint. I had the rare opportunity to work with ISRO's Human Space Flight Centre as its first-ever R&D associate. Shubhayu, with nearly a decade at the organization, was assigned as my mentor. We clicked immediately—our problem-solving styles were different but deeply complementary. Working on the Life Support Systems for astronauts in microgravity together forged not just a productive work dynamic but also a strong personal bond. Later in 2020, I joined Manastu Space as part of their executive team. That's where I met Prashanth Sharma (Co-Founder & CTO) who led the propulsion division. Sharp, witty, and extremely resourceful, he brought a pragmatism that balanced our idealism. After helping Manastu close a multi-million-dollar overseas deal, I made the difficult choice to leave in January 2022 to pursue this larger vision. I brought Prashant with me to Bengaluru, where he met Shubhayu. The three of us spent the next six months researching, talking to domain experts, challenging our assumptions, and refining our approach.

Eventually, we reached a turning point—both in our conviction and clarity. We persuaded

"Razor Crest Mk-1 is our flagship vehicle, being built to be the world's first fully reusable medium-lift rocket. While most reusability programs focus on recovering the booster, Razor Crest Mk-1 is designed to recover both the booster and the upper stage. That's a significant leap, as in the past five decades, no one has attempted to create a new rocket-engine feed cycle."

**Manu J Nair**
**Co-Founder & CEO**
**Ethereal Exploration Guild**

Source: Ethereal Exploration Guild

Shubhayu to take the ultimate leap of faith and leave his decade-long tenure at ISRO to join us. Our vision is straightforward: to catalyze civilizational progress by creating a multi-polar space launch access.

**EtherealX is developing the world's first fully reusable medium-lift launch vehicle. What makes Razor Crest Mk-1 a first-of-its-kind globally, and how does it compare with other reusable rockets on the market?**

Razor Crest Mk-1 is our flagship vehicle, being built to be the world's first fully reusable medium-lift rocket. While most reusability programs—including SpaceX's Falcon 9, Rocket Lab's Neutron, Blue Origin's New Glenn, and ISRO's NGLV—focus on recovering the booster, Razor Crest Mk-1 is designed to recover both the booster and the upper stage. That's a significant leap, as in the past five decades, no one has attempted to create a new rocket-engine feed cycle. Its capacities to orbit in different configurations are: 24.8 tonne to LEO (expendable), 22.8 tonne to LEO (partially reusable), and 8 tonne to LEO (fully reusable).

**You are targeting launch costs between US$ 350–US$ 2,000 per kilogram—almost 1/50th of the global average. What engineering or design breakthroughs are enabling this level of affordability, and how do you plan to sustain it commercially?**

The tipping point came from a mix of hard economics and engineering realism. Most people associate space with cutting-edge tech, but orbital launch today is still a single-use industry. Launching a rocket and letting it fall into the ocean is like building a Boeing 747, flying it once, and scrapping it. That doesn't scale.

We recognized early that true reusability—not just partial booster recovery—is what shifts the equation. The economies of scale, particularly in the medium-lift segment, which currently accounts for 91 percent of the commercial market, made the decision clear. By designing Razor Crest Mk-1 with full reusability in mind from day one and integrating modular development strategies, we are able to reduce the cost per flight drastically.

The key features of the rocket that enable long-term commercial demand are:

**US$ 350-US$ 2000 per kg:** 1/35$^{th}$ [or] 1/6$^{th}$ of the Global Launch Price Average.

**72 to 96 Hour(s) Turnaround Time:** This aims for rapid turnaround time for refurbishment, partial replacement, and propellant loading will position us as a game-changer.

**16 Orbit Insertions:** This will enable us to operate with multiple customers in a single launch, allowing them to avoid the need for deployment at a specific orbit.

**You operate from a 700,000 sq ft facility dedicated to Upper Stage Engine Testing, which is going to be India's largest privately developed Engine Testing Facility. How is it helping speed up development and validation cycles?**

These facilities are critical to our vision of rapid turnaround and rigorous testing. Having in-house access to a full-scale upper-stage engine testing setup has enabled faster subsystem validation and a compressed iteration loop, directly improving our readiness timelines. In particular, the capability to run high-pressure RP-1/LOX engines at scale has been a bottleneck across India's private sector. This type of infrastructure simply doesn't exist anywhere else in the country today. As part of our development, we've

**India is on a strong upward trajectory. With the opening of the space sector, a new wave of private space companies has emerged, backed by progressive policy moves, like the establishment of IN-SPACe, liberalization of FDI norms, and clearer regulatory pathways around launch operations and satellite licensing.**

**Most people associate space with cutting-edge tech, but orbital launch today is still a single-use industry. Launching a rocket and letting it fall into the ocean is like building a Boeing 747, flying it once, and scrapping it. That doesn't scale.**

already built the highest pressure-rated RP-1 skid in India, tailored specifically for our upper-stage engine needs. This not only gives us full control over the test environment but also dramatically reduces dependency on external facilities, enabling week-on-week progress rather than month-on-month cycles.

**India currently holds about 2 percent of the global space economy. In your view, what are the most crucial policies, technology, or infrastructure shifts needed to push this to 10 percent by 2030?**

India is on a strong upward trajectory. With the opening of the Space sector, a new wave of private space companies has emerged, backed by progressive policy moves, like the establishment of IN-SPACe, liberalization of FDI norms, and clearer regulatory pathways around launch operations and satellite licensing.

The next leap will come from strengthening infrastructure and supply chain readiness. The ecosystem needs more high-throughput manufacturing, testing, and AIT facilities that can support diverse private missions. That momentum has already started, whether it's new testbeds, private launchpad plans, or specialized industrial parks in progress.

Overall, the foundation is being laid well. The focus now is on scaling capacity and executing at speed, and we believe India has all the ingredients to make that leap from 2 percent to 10 percent.

**What role do you see EtherealX playing in the broader ecosystem of launch infrastructure in India, particularly in creating scalable and diversified access to orbit?**

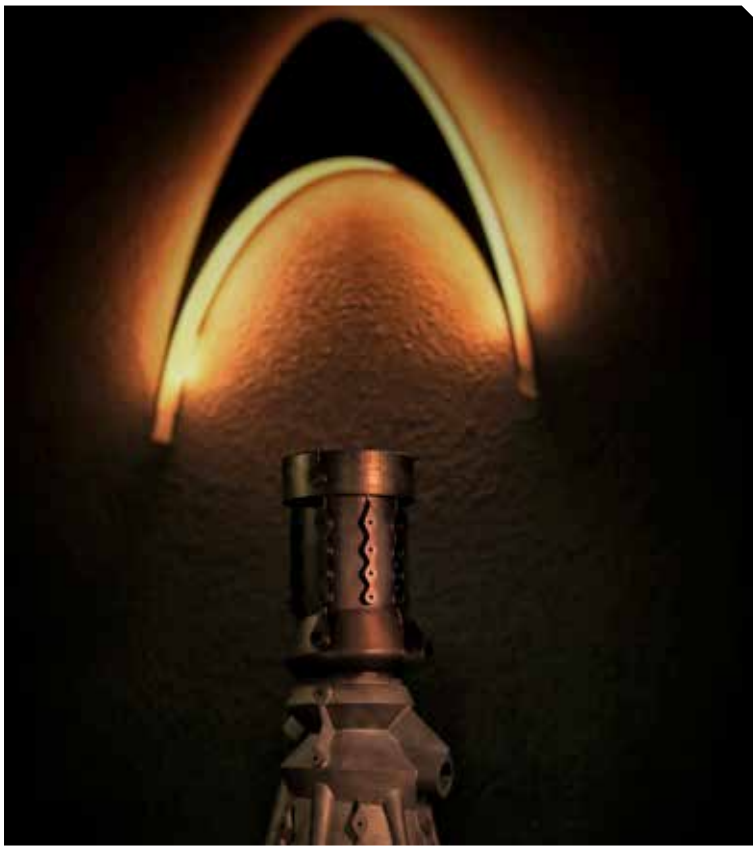
> "The opportunity for India's Machine Tool industry is massive, especially in areas like high-speed CNCs, additive manufacturing for propulsion components, and automated composite layups. As the demand for reusability and rapid turnaround grows, these capabilities will become core to India's competitive edge in the global space economy."
>
> **Manu J Nair**
> **Co-Founder & CEO**
> **Ethereal Exploration Guild**

EtherealX is building core infrastructure for Razor Crest Mk-1, including India's largest privately developed engine testing facility and a full-scale Assembly, Integration, and Testing (AIT) facility pipeline. These are not just internal assets—they're foundational pieces of national infrastructure.

Once operational, we intend to lease out these facilities to other space companies as well, enabling shared access to high-quality infrastructure. This is key to growing India's space-tech ecosystem in a capital-efficient way—reducing duplication while increasing throughput and mission diversity.

Our role is to enable fast, affordable, and frequent launches—and to help create the physical infrastructure that makes space more accessible for everyone building in this sector.

**There's increasing discussion around the ineffectiveness of current space education systems in India. What gaps have you observed, and what kind of educational reforms or partnerships would you like to see?**



Source: Ethereal Exploration Guild

India's First Reusable Rocket Engine

Source: Ethereal Exploration Guild

India's Highest Pressure Rated RP-1 Test Setup

India has a strong academic base in science and engineering, but space education still needs to grow beyond theoretical knowledge to match the complexity and pace of the evolving spacetech sector. While institutions like IITs, IISc, and ISRO-linked programs continue to produce high-quality talent, greater emphasis is needed on hands-on learning, real-world engineering challenges, and cross-disciplinary exposure.

With the rise of startup activity and media buzz, there's also a growing tendency to prioritize marketing narratives over a deep understanding of core systems, physics, and engineering rigor. As companies mature, the reality of what works will become clearer, but education must stay anchored in fundamentals. It should equip students to critically evaluate technologies, not just for their relevance or hype, but for their technical soundness, feasibility, and alignment with broader regulatory and operational frameworks.

> "While institutions like IITs, IISc, and ISRO-linked programs continue to produce high-quality talent, greater emphasis is needed on hands-on learning, real-world engineering challenges, and cross-disciplinary exposure."
>
> **Manu J Nair**
> **Co-Founder & CEO**
> **Ethereal Exploration Guild**

**What should we expect from EtherealX in the next 12–18 months—any upcoming tests, partnerships, or key breakthroughs you would like to share with our readers?**

We're currently deep into testing and subsystem validation, with propulsion and recovery systems at the forefront. Multiple partnerships are already in the pipeline, across sovereign customers, key supply chain players, and insurance stakeholders. We've also secured over US$ 130 million in commercial launch agreements—well ahead of our first flight. The coming year will see major expansions in testing infrastructure, regulatory clearances, and the setup of our private AIT and launch preparation systems.

**Could you please shed light on the kind of machining or precision engineering capabilities you're deploying, and what opportunities this creates for India's Machine Tool industry?**

We haven't yet invested in in-house machining or heavy manufacturing, as much of our precision engineering is currently outsourced, largely outside India. However, as we move towards production scale, we're working closely with both domestic and international partners to bring this capability home.

The opportunity for India's Machine Tool industry is massive, especially in areas like high-speed CNCs, additive manufacturing for propulsion components, and automated composite layups. As the demand for reusability and rapid turnaround grows, these capabilities will become core to India's competitive edge in the global space economy.

**EtherealX is building core infrastructure for Razor Crest Mk-1, including India's largest privately developed engine testing facility and a full-scale Assembly, Integration, and Testing (AIT) facility pipeline. These are not just internal assets but also foundational pieces of national infrastructure.**

# SPINNING SUCCESS

One of India's most trusted names in spindle manufacturing and repair, Setco Spindles India Pvt Ltd has grown both in capability and confidence, driven by commitment to precision and an unwavering belief in doing things right.

Source: Setco Spindles India Pvt Ltd

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Setco Spindles India Pvt Ltd began its journey in 2002 under the name Ultra Precision Spindles, operating out of a modest 400 sq ft workshop with a primary focus on grinding spindle repairs. Over time, the company steadily expanded its service portfolio to include the repair of machining center spindles, turning center spindles, woodworking spindles, PCB spindles, and other high-RPM spindles across various applications. "Though the business was originally founded to service belt-driven spindles, it evolved to rebuild direct-drive and high-end built-in motor spindles within just a few years of its inception," explains Rajesh Mandlik, Managing Director, Setco Spindles India Pvt Ltd.

In 2012, Ultra Precision was acquired by Setco (USA), marking a significant milestone in its growth. The company expanded operations to Chennai in 2015 and Manesar in 2018. Alongside enhancing its spindle rebuilding capabilities, Setco India also began manufacturing new spindles for the Indian market, catering primarily to milling and grinding machines. "Today, Setco Spindles India operates from three facilities covering a combined 40,000 sq ft of operational space and employs 190 people," Mandlik shares. The company rebuilds approximately 200 spindles and manufactures over 100 new spindles each month. With a robust sales network comprising both in-house representatives and dedicated partners, Setco maintains a strong presence across all major industrial cities in India.

## Local Roots, National Reach

Setco Spindles recognized a critical need to offer localized spindle repair services in India. "Previously, customers from South and North India had to send their spindles to our Pune facility, which involved 10 days of transit time alone," shares Mandlik. "This resulted in a total machine downtime of 15 to 18 days—a major challenge, especially for small- and medium-sized machine shop owners."

To address this, the company established regional service centers in Chennai and Manesar. Today, its Pune unit serves customers from Western, Central, and Eastern India. The Chennai center caters to the Southern region and the Manesar facility supports clients in Northern India—effectively covering the entire nation. "Currently, we

Source: Setco Spindles India Pvt Ltd

> "Beyond our recent supply to Korea, we regularly export spindles to our principal in the US, adhering to stringent quality requirements. We have also delivered products to customers in the Middle East and Southeast Asia."
>
> **Rajesh Mandlik**
> **Managing Director**
> **Setco Spindles India Pvt Ltd**

manufacture new spindles at our Pune facility. We are aware that India's Machine Tool industry is primarily concentrated in Karnataka and Gujarat," he adds. "As we scale up our manufacturing volumes, we are considering a future plan to produce spindle components in Pune and assemble kits in Bangalore and Rajkot." This strategy, however, is still under feasibility assessment and will be implemented based on thorough company evaluation.

## Crossing Borders with Confidence

Setco Spindles primarily serves the domestic market with its range of new spindles, entering a space that was long dominated by Taiwanese manufacturers. It took time and focused effort for Setco India to reach world-class quality standards. "However, through strategic investments in high-end grinding machines and advanced metrology equipment, our products now compete globally in terms of quality," notes Mandlik.

This relentless pursuit of excellence has led to a proud milestone for the company—its first commercial export order. "It is a deeply fulfilling moment for us. What began as a spindle reconditioning service for the domestic market has now evolved into a company aspiring to become a global spindle supplier," he says.

While exports currently represent a modest share of the company's business, Setco India is committed to growing this segment significantly in the years ahead. "Beyond our recent supply to Korea, we regularly export spindles to our principal in the US, adhering to stringent quality requirements," he reveals. "We have also delivered products to customers in the Middle East and Southeast Asia."

These international shipments are paving the way for the company to enter high-end spindle manufacturing, including built-in motor spindles and eventually, milling heads. "This is a step toward realizing our vision of becoming a global player in precision spindle solutions," he adds.

## A Country Catching Up

In India, Mandlik points out, spindles have traditionally not been treated as outsourced components, unlike in countries such as Taiwan and China. "Most leading Indian machine tool builders manufacture their own spindles, as the spindle is often regarded as the heart of the machine. As a result, spindles have remained outside the typical external supply chain in the Indian Machine Tool industry," he notes.

This stands in stark contrast to Taiwan, he adds, where Taichung, a city with a population of just 2.2 million, is home to at least 25 independent spindle manufacturers. In India, however, we have yet to see a single company emerge at that level of specialization.

**Setco Spindles India, which began operations in a modest 400 sq ft workshop, has evolved into a multi city footprint in India operating from three facilities covering a combined 40,000 sq ft of operational space and employing 190 people.**

Source: Setco Spindles India Pvt Ltd

Source: Setco Spindles India Pvt Ltd

> "Many of our engineers and technicians have undergone specialized training at our global facilities in Taiwan and the United States, focusing on spindle assembly, design, and milling head technology."
>
> **Rajesh Mandlik**
> **Managing Director**
> **Setco Spindles India Pvt Ltd**

**Setco India has expanded its offerings to include the repair and rebuilding of milling heads, and is actively enhancing its technical expertise to support the rebuilding of high-end, precision milling heads.**

"The disparity becomes even more apparent when we consider China, where 5 – 7 spindle manufacturers each produce 4,000 – 5,000 spindles per month, and Taiwan, where 2 – 3 companies operate at a similar scale. India, unfortunately, has no spindle manufacturer approaching these figures," he further adds.

Hence, India must significantly step up its efforts to develop spindles as a strategic, bought-out component. "Until this shift happens, the backward supply chain—including forging of housings, shafts, high-precision bearings, disc springs, and collets—will remain underdeveloped. Even today, component manufacturing for spindles is a scarce capability in the country," he notes.

If India aspires to be part of the global machine tool supply chain, the domestic industry must first build confidence in the local spindle manufacturing ecosystem. This requires nurturing interested vendors, enhancing their capabilities and capacities, and recognizing spindle manufacturing as a critical and independent domain.

## Smart Spindles for Smart Factories

While the Industry 4.0 movement is still in the process of being fully democratized, Setco has taken a meaningful step forward with the introduction of its latest offering—Vibe Pro. "Recently, Setco USA acquired GTI Spindles, a company that developed Vibe Pro, an advanced system capable of capturing real-time spindle data related to vibration and thermography," Mandlik shares. "The solution includes vibration sensors, integrated hardware, built-in software, and a user-friendly dashboard, offering powerful diagnostics and analytics."

At present, Setco India is actively using Vibe Pro at its service locations to perform dynamic spindle testing, enabling a deeper understanding of spindle health and performance. "Setco is now undergoing a structured training program to leverage Vibe Pro as a key Industry 4.0 tool, capturing real-time spindle performance parameters," he shares. "The next evolution of this technology involves integrating the sensors directly into the spindle design itself." While currently Vibe Pro functions as an external attachment, the vision is to embed it within the spindle architecture, making smart spindles a standard offering soon.

This initiative marks an important milestone in digitizing spindle diagnostics, improving predictive maintenance and enhancing machine uptime—paving the way for a more intelligent and connected manufacturing ecosystem.

## Building a Leaner, Smarter Setco

One of India's leading machine tool companies recommended that Setco India adopt Total Productive Maintenance (TPM) to strengthen its operational excellence. True to its culture of openness and continuous improvement, Setco

Source: Setco Spindles India Pvt Ltd

embraced the idea and initiated TPM implementation with guidance from CII (Confederation of Indian Industry). "The journey so far has been enriching and impactful, leading to measurable improvements across several operational areas—such as reduction in supplier and in-house rejections, improved delivery performance, and fewer external customer complaints," stresses Mandlik.

Most notably, people's involvement in implementing 5S principles—the MD continues—has brought a visible transformation in workplace organization and the quality of end products. "TPM, as we believe, is not a one-time initiative but a continuous journey, and Setco is committed to making it a way of life, aligned with world-class manufacturing practices," he adds. "Another significant milestone in our operational journey has been the successful implementation of Epicor ERP. This integrated enterprise solution, already in use across Setco Global, is now empowering Setco India to track individual job orders, manage inventory more effectively, and improve visibility across the value chain."

Together, the twin initiatives of TPM and Epicor ERP are enabling Setco India to build a leaner, more agile organization with enhanced control over operations—ultimately contributing to stronger operational performance and improved profitability.

## Atmanirbhar Bharat: More Than a Slogan

As the world increasingly looks to India as a manufacturing hub for emerging sectors such as Aerospace, Defence, Railways, and Electronics, a wealth of opportunities is now at the nation's doorstep. "Setco Spindles is proactively responding to this shift by strengthening both its core business areas—spindle repairs and spindle manufacturing," Mandlik notes.

In the service domain, Setco India has expanded its offerings to include the repair and rebuilding of milling heads, which are widely used in double column VMCs. Like spindles, milling heads come in various types—manual, semi-automatic, automatic, and servo-based. Setco is actively enhancing its technical expertise to support the rebuilding of high-end, precision milling heads.

On the manufacturing front, the company has invested heavily in world-class infrastructure, building robust in-house capabilities for machining and metrology. Recent acquisitions include e-Tech CNC ID and OD grinding machines, significantly improving both capacity and quality benchmarks. In addition, advanced metrology tools such as CMMs and Taylor Hobson's roundness testers have been installed to ensure sub-micron accuracy in component inspection.

Setco has also developed a balanced model of in-house production and outsourced manufacturing, which has helped cultivate a strong vendor ecosystem for spindle component production—further strengthening the backward supply chain. "To support both verticals—repair services and new spindle manufacturing—Setco India has heavily invested in manpower training," he reveals. "Many of our engineers and technicians have undergone specialized training at our global facilities in Taiwan and the United States, focusing on spindle assembly, design, and milling head technology."

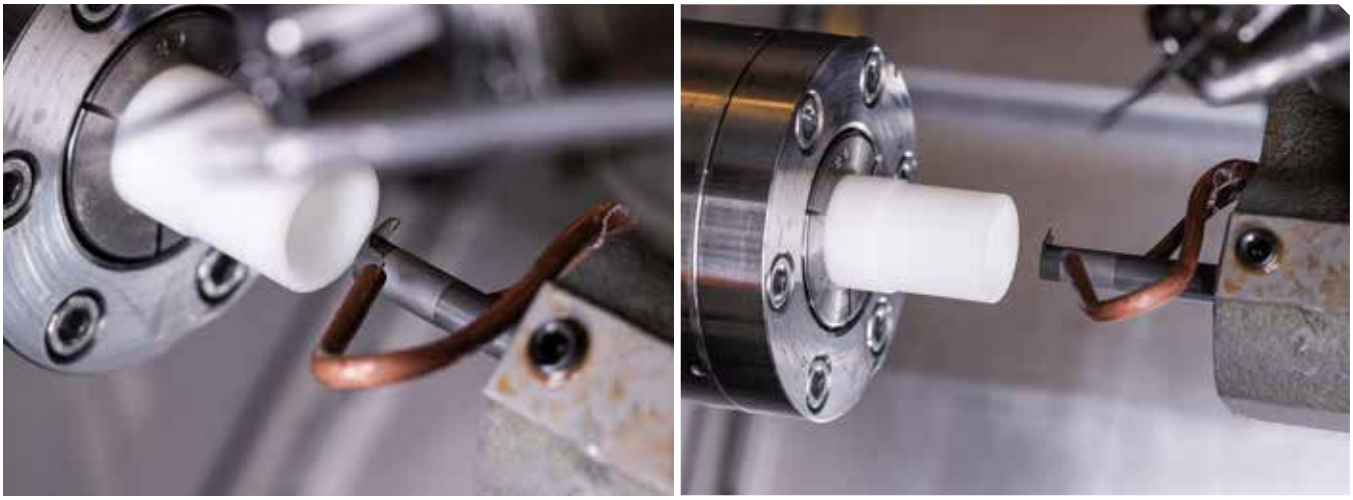
The company's customer base reflects this versatility. In spindle repairs, it services industry giants like Craftsman Automation Ltd, Bharat Forge Ltd, Mahindra & Mahindra Ltd, Hyundai Motor India Ltd, Maruti Suzuki India Ltd, and Rico Auto Industries Limited—over 3,000 customers in total. For spindle manufacturing, its clientele includes Macpower CNC Machines Ltd, Jaewoo Machines Pvt Ltd, Global CNC Pvt Ltd, Hi-Life Machine Tools Ltd, Cosmos Impex India Pvt Ltd, and Friction Welding Technologies Pvt Ltd (FWT).

## Next Milestones in Motion

Since its inception, Setco Spindles India has maintained an impressive track record of approximately 20 percent compound annual growth rate (CAGR). The company aims to sustain and accelerate this momentum over the next five years. With world-class capabilities in both repair services and new spindle manufacturing, Setco is well-positioned to support the evolving needs of the Indian and global Machine Tool industries with precision, reliability, and innovation.

**Setco Spindles India closed the last fiscal year with a turnover of INR 43 crore and is targeting INR 51 crore for the next. It is future-ready, with world-class capabilities in both repair services and new spindle manufacturing.**

Source: Setco Spindles India Pvt Ltd



When machining the ring from an abrasive plastic, a PCD grade is essential.

Source: Horn/NNCEA

# PRECISION IS A PASSION

Precision tooling expert HORN, in collaboration with Febametal, plays a vital role in the production of life-saving aortic valve implants at Italian medical manufacturer Corcym. With micron-level accuracy, diamond-tipped tools, and customized solutions like the Mini and Supermini systems, HORN ensures flawless machining of complex materials.

NIKHIL NAYAK
Managing Director
NN Combined Engineering Agencies Pvt Ltd

Shortness of breath, dizziness, and a feeling of pressure in the chest — if the pockets or leaflets of the aortic valve no longer open sufficiently for blood to flow, it is known as aortic valve stenosis. This heart defect can only be treated with an artificial aortic valve. The Italian company Corcym from Saluggia uses its extensive expertise to produce these implants, helping people improve their quality of life and saving lives. Tolerances in the micron range and materials that are difficult to machine are the order of the day in the production of these small marvels. To machine them productively, the company relies on tools from HORN and technical advice from Febametal.

One of the most common heart defects is aortic valve stenosis — a narrowing of the aortic valve. As a result, the flow of blood from the left ventricle into the aorta is impaired. If the narrowing is severe, symptoms such as shortness of breath, chest pressure, dizziness, and even loss of consciousness can occur. The disease is usually caused by wear-and-tear processes, such as calcification and hardening of the tissue. Aortic valve stenosis typically occurs only in old age and cannot be treated with medication. Depending on the clinical picture, an implant may be required to replace the valve. The patient's individual condition determines whether the valve is inserted minimally invasively through the femoral artery or conventionally via an opening in the sternum.

## Flaps Made from Bovine Tissue

The implants differ in terms of structure and material. For minimally invasive surgery (TAVI procedure), the implant must be movable and expandable so that the surgeon can manoeuvre it through the blood vessels into the heart. Due to their short shelf life of 10 to 15 years, biological aortic valves are given to elderly people or patients who cannot undergo open-heart surgery for health reasons. The construction of a biological implant is complex. The artificial valve, made of biological material, is sewn by hand around an expandable wire mesh. At Corcym, this material is

obtained from bovine tissue. The tissue, sourced from specially bred cattle, is processed so that it no longer contains any DNA or living cells, reducing the chance of rejection by the body.

The other option is the use of a mechanical aortic valve prosthesis. Mechanical valves are known for their lifelong durability, meaning a repeat operation is unlikely. The implant is inserted into an open heart while the patient is connected to a heart-lung machine during the operation. The design is simple: two movable flaps are mounted in a plastic ring that will open and close with the blood flow. A synthetic fabric is stretched around the ring. The surgeon sutures this tissue to the aorta during insertion. Even though the structure and function seem simple, the production of a mechanical aortic valve is highly complex.

Source: Horn/NNCEA

The Mini type HORN system is used for boring.

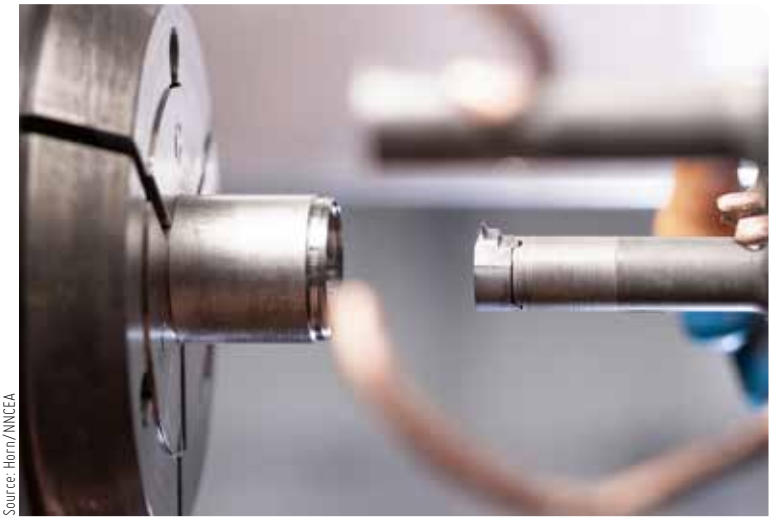
## Stringent Requirements

"The production of the mechanical components is very complex. We check every manufactured component under a microscope at 20x magnification," explains Davide Ricchiari, Process Engineer, Corcym. The components must not have any scratches or burrs. Any imperfection, no matter how small, could lead to a stress fracture or harbor germs. Rough surfaces could also lead to calcification of the components, which would impair their function. "To ensure perfect function, all components are manufactured to tolerances of just a few microns. These tolerances are also required for implant certification. A human life depends on these components, which is why we work with the utmost care," says Ricchiari.

The outer ring of the mechanical implant is made from a special plastic. Achieving micron-level tolerances when internally turning plastics requires a high degree of expertise. Roundness and diameter tolerance are critical. If these are not met, the two inserted valves will not seal tightly. As a result, blood could flow back into the heart due to the patient's blood pressure. Corcym uses PCD-tipped inserts from HORN's Mini range to bore the rings. "The material is highly abrasive. A sharp carbide cutting edge becomes dull after just a few components," explains Andrea Panichi, Application Engineer, Febametal.

That was precisely the reason for switching to the diamond PCD grade. Before switching to the new special material, the rings were made from a less abrasive plastic. "The production of the rings was very time-consuming. After roughing, we had to heat-treat the parts to relieve stresses in the material. Otherwise, we wouldn't have been able to maintain the tight roundness tolerances during finishing," says Ricchiari. With the new PCD grade, the same performance was achieved as with carbide on the older material. Heat treatment before finishing is no longer necessary with the new plastic, but the material is not easy to machine. "A sharp insert is very important," says Panichi. Excessive cutting pressure can deform the thin-walled ring and result in ovality.

**The production of mechanical aortic valve components demands micron-level tolerances and flawless surfaces. The slightest imperfection can compromise function, introduce contamination, or lead to stress fractures—making precision machining and inspection absolutely critical.**



Source: Horn/NNCEA

Source: Horn/NNCEA

A successful collaboration: Barbara Costa (Febametal) with Davide Ricchiari (Corcym), and Andrea Panichi (Febametal).

**The face-clamped inserts of the Mini type are one of HORN's core products. The tool system is mainly used for turning applications. These precision tools have proven themselves in internal turning and grooving.**

## Titanium Lock Ring

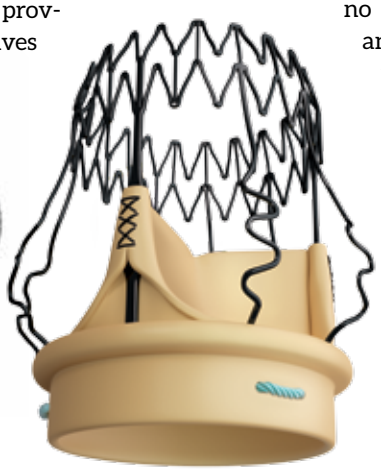
Another important component of the mechanical aortic valve is the lock ring made from a titanium alloy. This ring tensions the tissue layer — which is sewn to the aorta — to the plastic ring. Put simply, it functions like a locking ring in mechanical engineering. If it fails, the ring with plastic flaps could come loose and travel up the aorta with the blood flow. Great care is required in manufacturing this ring. "The rings must be perfectly round on the flanks. Burrs or sharp transitions could damage the synthetic fabric when it's tensioned. The rings are subjected to 100 percent inspection under a microscope," explains Ricchiari. A Mini 108 insert is also used for boring. It is precision-ground with a special profile that also allows it to be used for parting off the ring. During the production process, the machine pre-turns the rings on the outside and inside. Several rings are turned, connected by a narrow web. The rings are then parted off.

## Extensive Portfolio

The face-clamped inserts of the Mini type are one of HORN's core products. The tool system is mainly used for turning applications. These precision tools have proven themselves in internal turning and grooving. With vibration-damped carbide tool holders, the inserts produce smooth surface finishes even with long overhangs and ensure highly reliable processes. The Mini system's extensive portfolio includes inserts in various sizes for different internal diameters, geometries, and substrates, as well as CBN or diamond coatings. Corcym has relied on HORN tool solutions for over 15 years. In addition to the Mini systems, numerous Supermini types are used for boring. "We regularly test various tool systems from different manufacturers. So far, no others have delivered anywhere near as convincing a performance as the HORN products. Moreover, Febametal's technical advice is always a great support for us," says Ricchiari.

Source: Horn/NNCEA

The mechanical aortic valve opens and closes with the patient's blood flow.



A small miracle: the biological prosthesis can be folded up, manoeuvred through the blood vessels and unfolded again in the heart.

## HORN in India

*Precision Tooling Solutions for the Medical Industries from Paul Horn GmbH are available in India via NN Combined Engineering Agencies Pvt Ltd (NNCEA). NNCEA provides complete manufacturing solutions, including logistics and supply chain management, for a wide range of industries in the Indian market.*

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# BALANCING EFFICIENCY AND ENVIRONMENTAL RESPONSIBILITY

Source: Magic Wand Media

Built on the backbone of Industry 4.0 technologies like Artificial Intelligence (AI), the Internet of Things (IoT), and digital twins, sustainable smart manufacturing offers a roadmap where operational excellence aligns with green goals.

PANDARINATH SIDDINENI
Domain Head
Systems & Software
Tata Elxsi

In the face of climate urgency and increasing pressure on industries to reduce their environmental impact, manufacturers today find themselves at the crossroads of innovation and responsibility. The emergence of sustainable smart manufacturing is a compelling response to this challenge—an approach that not only drives efficiency but also embraces environmental stewardship.

## Integrating AI and IoT for Energy-Efficient Production

Smart manufacturing thrives on the seamless integration of machines, data, and decision-making. At the heart of this ecosystem lie Artificial Intelligence (AI) and the Internet of Things (IoT), working together to revolutionize energy management and operational efficiency.

Modern factories are no longer in the dark about their resource consumption. Equipped with IoT sensors that capture real-time data from the shop floor and AI algorithms that analyze this data for actionable insights, manufacturers are unlocking new opportunities to optimize energy usage. From adjusting machinery operations based on load forecasts to identifying and reducing idle time, the combined power of AI and IoT is enabling efficiency gains without sacrificing productivity.

The adoption of advanced platforms such as digital twins—virtual replicas of physical systems—further strengthens operational visibility and control. In energy-intensive sectors like Battery Manufacturing, digital twin technology facilitates real-time simulation and optimization of energy flows, helping manufacturers achieve maximum output with minimal resource input.

## Reducing Carbon Footprint with Smart Supply Chain Management

Sustainability isn't confined to the factory floor; it extends across the supply chain. Optimizing raw material sourcing, transport, and logistics is crucial to lowering a company's overall carbon footprint.

AI-driven supply chain analytics now empower manufacturers to do just that. By aligning

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Source: Magic Wand Media

demand with supply through rough-cut capacity planning, businesses can operate with leaner inventories, avoid overproduction, and reduce waste. Predictive models also allow manufacturers to proactively respond to supply chain disruptions, minimizing the need for energy-intensive, last-minute solutions.

In real-world applications, connected factory ecosystems allow central monitoring and optimization across multiple plants. This not only standardizes efficiency but also enhances resource sharing. In one such case, connecting over two dozen factories enabled a steel manufacturing group to reduce scrap wastage by 60 percent, significantly improving material utilization.

## AI-Based Waste Reduction and Lean Manufacturing Strategies

Waste in manufacturing goes far beyond material scraps—it includes inefficiencies, unplanned downtime, and underutilized assets. AI is playing a transformative and highly practical role in addressing these challenges.

Predictive maintenance is a prime example. By analyzing machinery performance data, AI algorithms can identify early signs of potential failures, allowing manufacturers to take preventive action. This not only reduces equipment downtime but also mitigates the environmental impact associated with emergency repairs and part replacements.

AI is also enabling more sustainable product design. Advanced tools can now detect the presence of harmful or outdated materials—such as PFAS compounds—and suggest environmentally friendly alternatives. These proactive interventions support circular economy goals and ensure compliance with evolving global regulations.

Additionally, AI is reinvigorating lean manufacturing practices. With real-time data visibility, manufacturers can make agile decisions—adjusting production schedules and reallocating resources as needed. This ensures that production aligns precisely with demand, minimizing waste and maximizing efficiency.

## Looking Ahead: A Human-Centric Industrial Revolution

As we reimagine the future of manufacturing, one truth stands out: the next industrial revolution must be human-centric. Sustainability, at its core, isn't a technical goal but a societal one. It's about creating systems that respect planetary boundaries while enhancing business resilience.

To realize this vision, it's imperative that the private and public sectors work hand-in-hand. While manufacturers invest in future-ready infrastructure and intelligent platforms, continued policy support and regulatory clarity will be key to accelerating this transformation.

Smart manufacturing is no longer a concept of the future; it is a necessity of the present. In addition, when powered by AI, IoT, and an unwavering commitment to sustainability, it holds the promise of industries that thrive, responsibly.

**Sustainability isn't confined to the factory floor; it extends across the supply chain. Optimizing raw material sourcing, transport, and logistics is crucial to lowering a company's overall carbon footprint.**

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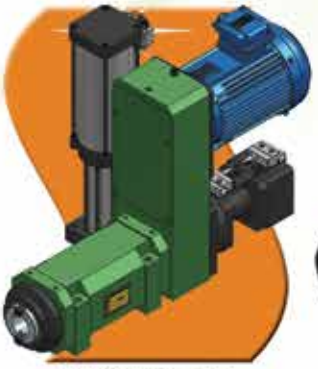
CNC Drilling Tapping Spindle

Facing Surfacing Spindle - Linear Rail Type



Auto Clamp Spindle

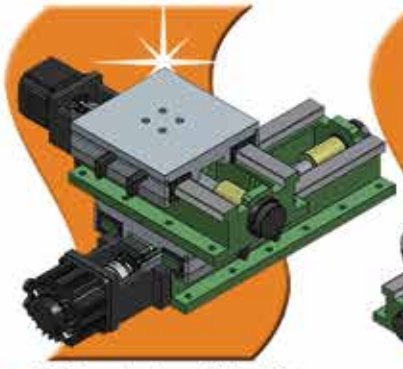
Direct Magnetic Servo Motor Spindle

Built-in Spindle

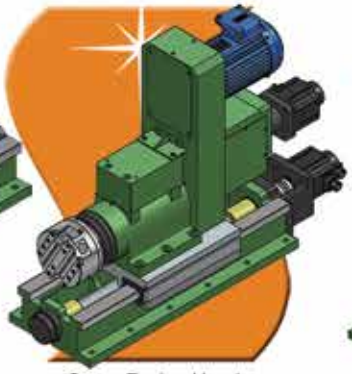
Belt Driven Spindle

Belt Driven Spindle Coolant

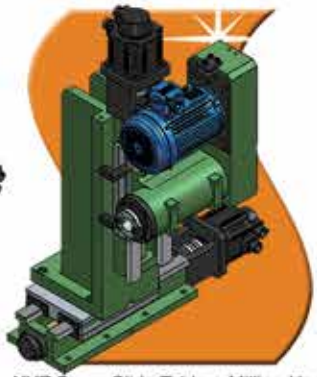
Direct Drive Spindle



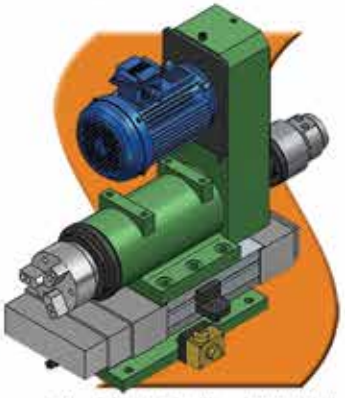
XY Servo Hardness Slide Unit



Servo Facing Head +
Servo Ball Screw Slide Unit



XYZ Servo Slide Table + Milling Head



3-Jaw Chuck Spindle + Slide Unit

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# WHY MODSIM IS THE FUTURE OF MANUFACTURING

With innovation cycles becoming shorter and product complexity increasing in today's era, the old ways in manufacturing and engineering are proving to be suboptimal. By dissolving the traditional divide between modeling and simulation, embedding artificial intelligence (AI), and drawing from insights of past projects, companies are unlocking new levels of speed, accuracy, and efficiency.

Source: Dassault Systèmes

PRAVEEN MYSORE
Technical Director
Dassault Systèmes
India

A few years ago, an automotive startup found itself in a bind. They had a bold vision for an electric vehicle that could disrupt the market, but their design and engineering teams were using separate tools and working in silos. Every time the design changed—a new regulation, a new material here, a geometry tweak there—the simulation team had to start from scratch. Weeks were lost in back-and-forth adjustments, and errors crept in due to inconsistent data. Despite the team's talent, the product missed its launch window by several months, costing them both investor confidence and market momentum. This scenario, unfortunately, isn't unique—and it underscores the urgent need for a more integrated approach to product development.

With innovation cycles becoming shorter and product complexity increasing in today's era, the old ways of modeling and simulation in manufacturing and engineering are proving to be suboptimal. While most industries have shifted from 2D

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to 3D design environments, the advantages of doing so are frequently offset by disconnected processes and siloed teams. More than ever, the need to integrate modeling and simulation seamlessly on a single platform is no longer a dream but a business necessity. This is where modeling and simulation solutions powered by the strength of generative experiences come in handy.

This shift is redefining how organizations conceptualize, validate, and launch new products. By dissolving the traditional divide between modeling and simulation, embedding artificial intelligence (AI), and drawing from insights of past projects, companies are unlocking new levels of speed, accuracy, and efficiency. Yet in many organizations, product workflows still remain disjointed. Engineers model products in one software and then manually transfer data for simulation in another, resulting in data compatibility and data repair issues. This introduces time-consuming steps and opens the door to errors. This process is not only time-consuming but also prone to errors due to multiple data translations.

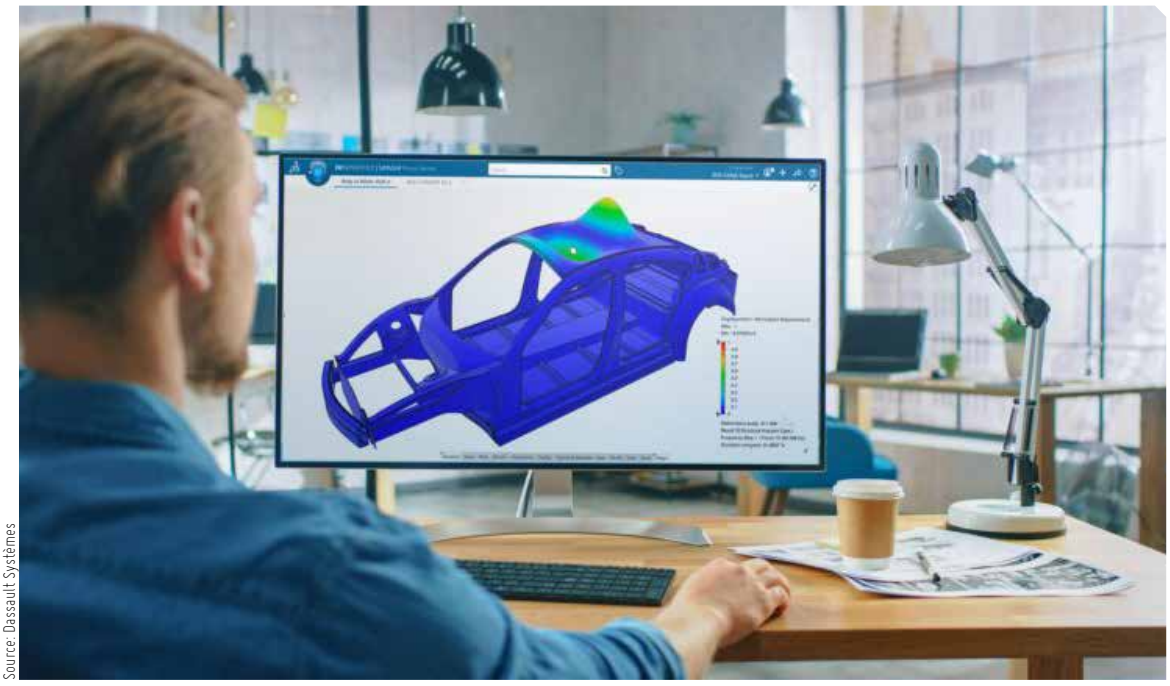
Simulation teams, operating independently, often receive models that require significant rework to prepare them for analysis. They may need to remodel or simplify components, losing valuable time and sometimes introducing inconsistencies. Furthermore, when changes occur in the design, the simulation model must be manually updated, leading to inefficiencies, delays, and miscommunication.

Technology brands like Dassault Systèmes address these challenges by enabling modeling and simulation to operate on the same platform and share a single data model. This revolutionary step eliminates duplication and ensures real-time associativity. Whenever a design change occurs, the simulation model automatically reflects the change. This associativity provides a huge benefit because it allows engineers to analyze the model and make confident decisions more quickly. Just think of a case where a product team is going through design iterations in real time, and every change—whether in geometry, material properties, or manufacturing method—is validated instantaneously for strength, durability, thermal performance, and any other engineering requirement. This process allows a company to reduce development timeframes from days to hours to minutes, and also improves product quality by catching potential issues earlier in the design process.

### The Power of Generative Experiences

While integration addresses the issue of disconnected workflows, generative experiences elevate MODSIM to an entirely new level. These experiences harness the power of AI, historical data, and simulation intelligence to offer pre-validated design recommendations. Rather than beginning from scratch, engineers can start with designs that have already been simulated under similar constraints.

**Technology brands like Dassault Systèmes address numerous challenges by enabling modeling and simulation to operate on the same platform and share a single data model.**



Source: Dassault Systèmes

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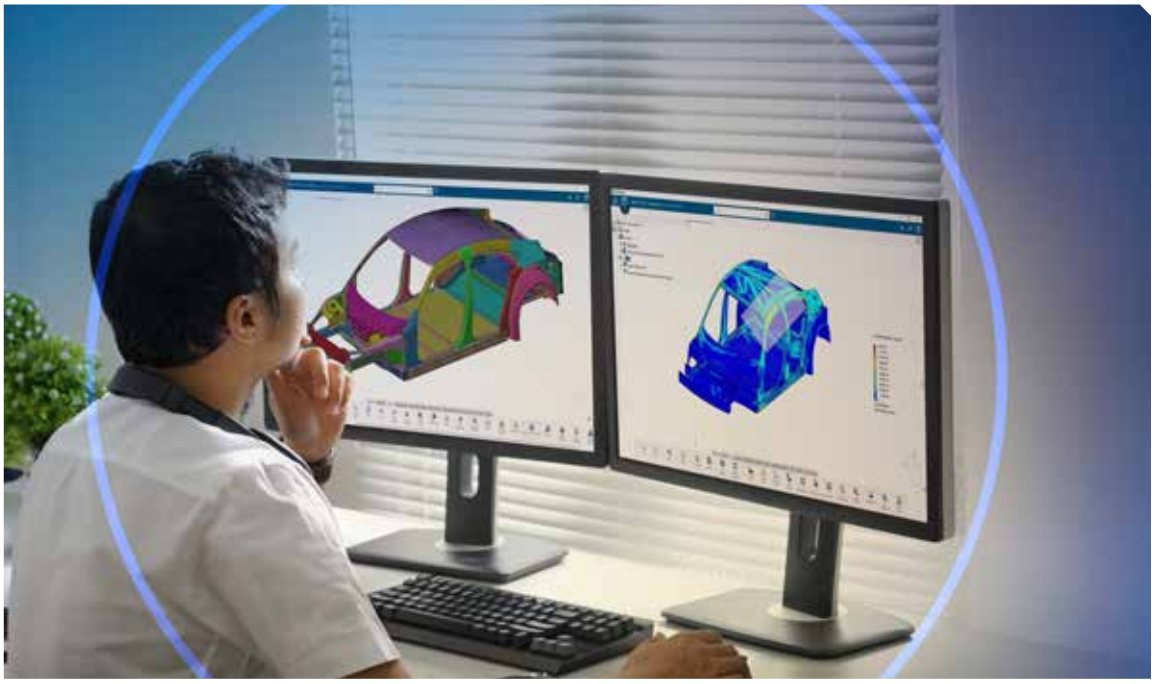


Source: Dassault Systèmes

**Organizations that embrace the full spectrum of MODSIM transformation are better positioned to manage increasing product complexity and navigate volatile market demands.**

Generative experiences are based on learning from the past to define the future. Through the use of large libraries of pre-validated models, businesses can speed up design iteration cycles, eliminate the repetition involved in setting up simulations, and drive performance with known solutions. This method considerably reduces time to market and enables teams to focus on creativity and innovation rather than mundane, manual tasks.

## From Siloed to Seamless - The Evolution of MODSIM

The evolution of MODSIM can be categorized into three distinct levels. The first is siloed modeling and simulation, where legacy systems operate with modeling and simulation conducted on different platforms by separate teams, resulting in fragmented workflows. The second level is integrated MODSIM, in which both disciplines converge on a single platform, leveraging a unified data model to enable seamless design-validation loops. The most advanced stage is generative MODSIM, where AI and machine learning capabilities are harnessed to generate and validate designs, simulations, and workflows.

Each step in this progression significantly enhances efficiency, collaboration, and decision-making. Organizations that embrace the full spectrum of MODSIM transformation are better positioned to manage increasing product complexity and navigate volatile market demands.

## Real-World Application

A powerful public reference for MODSIM implementation is Honda, which has been using this approach for over a decade. By integrating modeling and simulation into a single environment, Honda significantly compressed its vehicle development timelines.

The firm brought out more models in a shorter duration—by almost 30 percent—achieved a competitive advantage, and enhanced market responsiveness. This was only possible by removing simulation bottlenecks, automating iterative analysis, and facilitating real-time collaboration between design and engineering teams.

While the Automobile sector leads the adoption of MODSIM, the influence of MODSIM fueled by generative experiences goes well beyond this market. In Aerospace and Defence, it facilitates simulation-based verification for safety, endurance, and mission-critical performance. In the Semiconductor industry, it aids in the design of small-footprint architectures optimized for thermal, electromagnetic, and material efficiency. The High-Tech sector benefits from its ability to manage complex electronics and embedded systems through multi-domain simulation. In Industrial Equipment, MODSIM ensures manufacturability and performance under real-world conditions. Meanwhile, in the Energy sector, it aids in designing renewable energy systems and infrastructure with a focus

on resilience and sustainability. These industries, driven by market pressures and regulatory expectations, are actively looking to compress timelines, reduce physical prototyping, and enhance product reliability. MODSIM is not just a tool but a strategy.

### Reducing Time and Cost: The Bottom Line

Time and cost reduction is one of the major benefits of MODSIM and generative experiences. Organizations that implement these technologies can decrease development cycles by 30 to 50 percent, reduce prototype expenses by up to 70 percent, and improve first-right results, which minimize waste and rework costs. MODSIM also enables cross-functional teams to collaborate in parallel rather than sequentially, resulting in faster market entry, better resource utilization, and a more robust competitive edge.

Besides cost savings and cost-effectiveness, MODSIM also provides excellent compatibility with circular economy and sustainability strategies. Through simulation design before production, companies can reduce material waste, energy consumption, and greenhouse gas emissions. Generative MODSIM also supports design for disassembly, recyclability, and lifecycle extension—key circular economy principles. Companies can simulate how a product functions at each lifecycle stage, how it is repaired or refurbished, and what happens to it at end-of-life. This forward-thinking approach is essential as industries shift toward net-zero goals and sustainable development targets.

In India, companies are beginning to understand the transformative potential of MODSIM. Automotive OEMs are racing to match global development cycles, semiconductor firms are innovating under global supply constraints, and emerging EV startups are embracing digital-first strategies.

Many technology brands are actively working with Indian enterprises to implement MODSIM solutions tailored to local market needs. The demand for quicker, more cost-effective product development is not just a business challenge but a national imperative as India strengthens its position as a global manufacturing and innovation hub.

### Preparing for the Future

The future of MODSIM is not just about speeding up development; it's about creating intelligence-based product ecosystems. With time, digital twins will advance further, and generative experiences will become more context-aware, allowing for real-time decision-making throughout engineering, production, and operations. NETVIBES-type tools are integral to such an evolution, enabling firms to access industry viewpoints, translate intuition into real-world results via virtual twin experiences, and leverage collective know-how for data-driven decision-making.

Firms adopting this practice will have the capacity to simulate supply chain disruptions, forecast maintenance requirements, place customer insights in design loops, and personalize products at scale with low overhead. This represents the true promise of MODSIM in the era of Industry 4.0 and digital transformation.

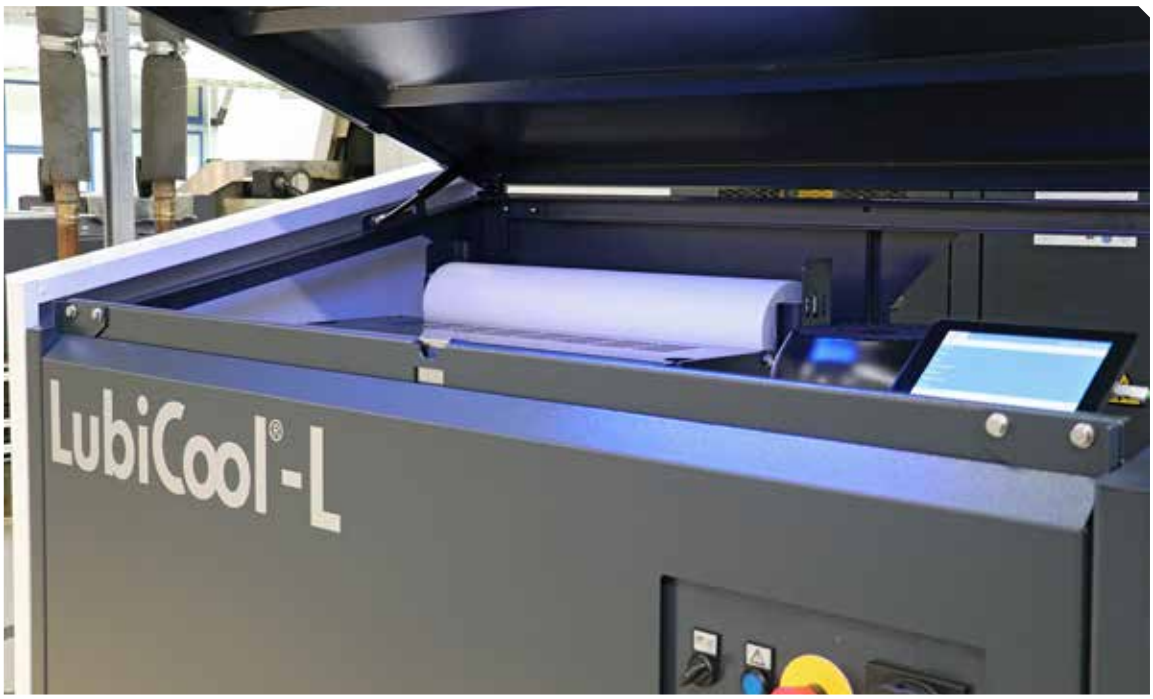
MODSIM is no longer just an engineering function; it is a business enabler. By collapsing the silos between modeling and simulation, and layering in the intelligence of generative experiences, MODSIM is helping companies around the world reimagine how products are designed, validated, and brought to life.

Whether one is building the next electric vehicle, aerospace component, or smart infrastructure, the future lies in adopting a unified, intelligent, and generative MODSIM strategy. The question for leaders is not *'Should we transform?'* but *'How fast can we get there?'*

**The future of MODSIM is not just about speeding up development; it's about creating intelligence-based product ecosystems.**

# ENSURING RELIABLE PRECISION MACHINING

In order to manufacture complex, rotationally symmetrical precision components with deep bores and fine internal contours, the machines must be equipped with a high-pressure cooling lubricant (KSS) supply – especially if they are to run unattended.




Source: KNOLL Machinenbau GmbH

TROKAMED had the new LubiCool®-L high-pressure station retrofitted on a large turning/milling center. The cover conceals a powerful pump, an efficient belt filter, and the touchpad for the user-friendly control system.

Medical technology manufacturer TROKAMED swears by the retrofittable units in the LubiCool® series from KNOLL Maschinenbau, which contribute to maximum process reliability with high-pressure pumps and belt filters. "We supply 80 percent of the medical technology sector," explains Mauriz Ostendorp, Junior Production Manager, TROKAMED GmbH in Geisingen. "We primarily develop and manufacture endoscopic product solutions for the fields of laparoscopy, gynaecology, and urology, which we sell worldwide under our own name, as well as part of customer-specific developments."

TROKAMED has particular manufacturing strengths in tube processing. This expertise is required, for example, for the manufacture of trocars and similar medical instruments that are used to create and maintain access to the body. This requires tubes in a wide variety of shapes, some with flush holes, etc.

This know-how is required for precision engineering orders, which account for the remaining 20 percent of sales. "For high-precision components such as customer-specific thermal and measuring sensors, we have to machine thin-walled tubes with complex geometries to the highest precision," says Ostendorp.

Whether for medical or precision engineering products, all components that are crucial for precision and reliability are produced in-house at TROKAMED. To this end, the company has at its disposal 13 CNC-controlled manufacturing centers, five laser labeling machines, assembly and cleaning systems, as well as a clean room on a production area of 3,000 sq mt.

Yasin Kaya is responsible for the CNC section and pre-assembly: "On our modern sliding and fixed

NIKHIL NAYAK
Managing Director
NN Combined Engineering Agencies Pvt Ltd


Source: KNOLL Maschinenbau GmbH

TROKAMED uses the Nakamura Super NTJX turning/milling center to manufacture complex, rotationally symmetrical components for medical instruments, as well as precision engineered special parts.

The new KNOLL LubiCool®-L (front left) was easily retrofitted on the Nakamura turning/milling center.

headstock lathes, milling-turning and turning-milling centers, as well as EDM machines, we can machine components with diameters ranging from 4 mm to 63 mm with high precision. This means that we can maintain shape, position, and dimensional tolerances of up to 4 µm during machining and can even perform high-gloss turning."

## High-pressure Supply Essential

A high-pressure supply is essential in many cases. The CNC department manager attaches particular importance to the high-pressure cooling lubricant supply: "It ensures optimum chip removal, especially for deep drilling and fine machining. Tool wear and heat generation are reduced, which has a positive effect on the dimensional accuracy, repeatability, and the surface quality of our components. This enables us to ensure consistently high quality, even for demanding geometries and small tools."

As a partner for KSS management, TROKAMED relies primarily on KNOLL Maschinenbau in Bad Saulgau. 'It is part of our philosophy to purchase locally wherever possible. 'Made in Germany' may cost a little more, but the quality is right and we have a contact person who advises us well and provides fast service when needed. This is 100 percent the case with KNOLL," says Kaya.


Source: KNOLL Maschinenbau GmbH

(L-R): Mauriz Ostendorp and Yasin Kaya emphasize the cooperative partnership with KNOLL (represented here by Matthias Wachter).

According to him, this was an important reason why TROKAMED decided in 2020 to have two new Miyano-Citizen fixed headstock lathes delivered, each with a LubiCool®-L high-pressure unit. TROKAMED also had the two SP-23 and SV-20R automatic sliding headstock lathes, purchased from Star Micronics in 2023 and 2024, equipped with LubiCool® units, but these were in size M.

## Cleaned Cooling Lubricant

Matthias Wachter, the KNOLL sales representative responsible for TROKAMED, explains: "Since 2019, we have been offering LubiCool®-M mobile high-pressure station for use on metal-cutting machine tools, especially for automatic fixed and sliding headstock lathes." This system cleans the KSS – whether oil or emulsion – using the efficient KNOLL KF belt filter. With a filter fineness of up to 25 µm, it ensures the purity of the cooling lubricant required for high-pressure applications and its high filter quality prevents the concentration of ultra-fine particles in the medium circuit.

LubiCool®-M supplies the lathe with high pressure. "For the supply, we use a KNOLL KTS screw pump, which provides pressure up to 150 bar and a flow rate of up to 30 l/min," says Wachter.

**To manufacture complex, rotationally symmetrical precision components with deep bores and fine internal contours, machines must be equipped with a high-pressure cooling lubricant (KSS) supply—especially if they are to run unattended.**

Retired: This high-pressure station with a flat bed filter had to make way for the significantly more compact and powerful KNOLL LubiCool®-L.

LubiCool®-M units supply the two SP-23 and SV-20R automatic sliding headstock lathes from Star Micronics with cooling lubricant as required.

Source: KNOLL Maschinenbau GmbH

**The high-pressure units—compact, retrofittable, and easy to integrate—ensure reliable chip removal and cooling directly at the cutting edge. TROKAMED has equipped several of its machining centers with LubiCool® units.**

"We produce 12,000 KTS pumps per year. This pump has proven itself many times over and ensures an extremely long service life as well as process reliability."

The KNOLL LubiCool® family also includes the smaller S-size units and the large L variants, which are installed at TROKAMED on the Miyano automatic fixed headstock lathes. The latter are designed according to the same principle as the LubiCool®-M but offer a larger tank capacity and a flow rate of up to 100 l/min when machining with oil.

## An All-Around Clean Solution

Mauriz Ostendorp, who is responsible for production, is impressed by the LubiCool® units used: "Along with the high-pressure supply, the compact design is also important for us because space is at a premium in our production facility." He also mentions the attractive housing of the units and the tight-fitting cover, which only needs to be opened for service and maintenance purposes: "This ensures cleanliness in the hall."

This industrial engineer sees another strength in the compact filter with filter fleece, which is suitable for all materials. "We process stainless steel, titanium, brass, aluminum, and plastics. Lightweight materials are particularly problematic when using filter cartridges or bag filters, as these have to be replaced very frequently, often after just a few weeks. This is not the case with filter fleece."

Kaya agrees and reports from practical experience: "Our SP23 sliding headstock lathe has been running around the clock for nine months, machining brass and stainless steel parts. Only 25 m of the 80 m filter roll has been used. But even with the other LubiCool® units, we only have to change the fleece perhaps once a year, which means only about five minutes of machine downtime."

## Worthwhile Retrofitting

All KNOLL LubiCool® units are not only suitable for original machine equipment, but also for retrofitting. "We have a somewhat older Nakamura turning/milling center, a Super NTJX, which was previously equipped with three different, unregulated high-pressure pumps and a flat bed filter," reports Kaya. "This system was no longer state-of-the-art, so we wanted to replace it with a LubiCool® system. When we contacted KNOLL, they suggested that we become a test customer for the new LubiCool®-L."

Wachter explains the background: "Last year, we further improved the functionality of the LubiCool®-L in order to better supply larger machines, such as turning/milling centers. This means that the system is equipped with a larger compact filter, which provides more filter surface area. We have also increased the tank capacity by 40 litres to what is now 430 litres. In addition, there is the option of using a second high-pressure pump."

TROKAMED was happy to test the new LubiCool®-L variant, as according to Kaya, it fits the requirements profile perfectly and can be seamlessly integrated into existing processes.

In addition to a high-pressure pump, those responsible opted for an additional low-pressure

The integrated touchpad enables the monitoring and visualization of the most important operating data for the system.

Source: KNOLL Maschinenbau GmbH

Source: TROKAMED

TROKAMED produces sophisticated components for medical technology, such as this automatic trocar sleeve (left) or the resectoscope working element (right).

pump for flushing as optional equipment. “We have also integrated cooling via plate heat exchangers,” mentions machining specialist Kaya. "This is essential for us. Since our workforce operates in a single shift and our machines run unmanned overnight, a stable temperature of the cooling lubricant is crucial for process reliability and dimensional accuracy."

Ostendorp points out another aspect: “The integrated solution with plate heat exchangers not only ensures constant cooling, but also supports our combined heat and power plant by feeding back the waste heat – which makes both ecological and economic sense.”

## Proven Results and Measurable Gains

The integration of the new LubiCool®-L into the Nakamura Super NTJX went smoothly, virtually plug & play. “Our goal was to increase process reliability, optimize tool service life, and to further improve the quality of the components,” explains Kaya. “We have definitely achieved that. We have also saved a lot of space compared to the previous solution. Our oil is now much cleaner, and there is also no oil sludge in the tank."

Wachter adds, “We were able to verify the improvements in our Bad Saulgau laboratory. The residual dirt in the dirt tank fell from 123 mg/l to 37 mg/l and in the clean tank from 46 mg/l to 23 mg/l."

Machining specialist Kaya highlights the seven freely selectable pressure stages in the NC program as a particular advantage: “They allow us to select the optimum pressure from 10 to 80 bar for every machining operation and every tool, which improves cutting values and saves energy.” This requires the optional pump frequency control offered by KNOLL. According to Kaya, it is definitely an investment that pays off. He expressly praises the overall package – the quality of the components used, the user-friendliness, the low maintenance requirements, and “the exemplary service offering. From the initial consultation to the ongoing support, we feel that KNOLL provides us with excellent support at all times.”


Source: KNOLL Machinenbau GmbH

For milling centers that require a larger volume of cooling lubricant, KNOLL offers an open high-pressure system with a greater filter and tank capacity. TROKAMED had the recently delivered automated Häberle Robodrill Plus-K equipped with this system.

## KNOLL in India

Coolant Pumps, Coolant Filtration Systems and Chip Conveyor Solutions from KNOLL Machinenbau GmbH, Germany are available in India via NN Combined Engineering Agencies Pvt Ltd (NNCEA). NNCEA provides complete manufacturing solutions including logistics and supply chain management solutions for a wide variety of manufacturing industries in the Indian market.

**The LubiCool® series stands out for its modularity and intuitive operation. KNOLL offers various models that can be adapted to different machine sizes and performance requirements.**

Indian Machine Tool Manufacturers' Association

# TRANSFORMING INDIA'S MANUFACTURING LANDSCAPE

Organized by Indian Machine Tool Manufacturers' Association (IMTMA), the 8th edition of Symposium on Automation and Robotics, held on June 4-5, 2025, was a power-packed event that brought together over 600 attendees eager to shape the future. Despite a heavy downpour, the enthusiasm of the participants and momentum of technological progress remained undeterred at Auto Cluster Exhibition Centre, Pune.


Source: Magic Wand Media

Themed 'Trends & Insights for Tomorrow: Shaping the Future', this year's Symposium focused on emerging technologies while also issuing a call to action for India's Manufacturing sector. OEMs, MSMEs, technology providers, academics, and policy stakeholders actively participated in technical sessions, observed live demonstrations, and explored strategic partnerships.

Making a notable appearance and presiding over the inauguration was Chief Guest Ashwin Shastri, Chief Transformation Officer, Tata Autocomp. The keynote speakers included Yuki Kita, Chief Executive Officer, FANUC India Pvt Ltd; Dr Asim Tewari, Professor (HAG), Indian Institute of Technology (IIT)-Bombay; and Rajesh Mandlik, Chairman, Regional Council West, IMTMA.

Jibak Dasgupta, Director General & CEO, IMTMA, noted, "The Symposium acts as an essential platform for sharing ideas and monitoring the latest trends shaping our industry." He also added, "While countries like Germany and Japan have labor productivity levels nearing 95 percent or more, India still hovers around 70 percent. This gap is eroding the cost arbitrage advantage for India. To close this gap, we must adopt digital technologies along with investing in upskilling our workforce. Events like these are crucial in accelerating the adoption of Industry 4.0 and digitalization across manufacturing sectors."

Echoing this sense of urgency, Mandlik shared statistics and urged industries to embrace robotics and automation as early as possible to remain competitive on the global stage. Dr Tewari added, "Digital isn't the future anymore—it's the present and is non-negotiable."

Kita remarked on India's growth prospects and on the adoption of automation and robotics and stressed how 'robots improve safety, productivity, and quality

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and promote sustainable growth'. Shastri, in the session titled 'Data the Heart of AI: Road Map for MSMEs for Complete Digitization', advised MSMEs to 'measure first and then automate'.

Source: Magic Wand Media

## India Enters the Automation Age

A technical session on 'India's Automation Ascent: Scaling Potential to Performance' by Ashim Sharma, Senior Partner & Business Unit Head, Business Performance Improvement (Auto, Engineering & Logistics), Nomura Research Institute Consulting and Solutions India Pvt Ltd, acknowledged challenges in the adoption of automation. "Organizations should consider a holistic view when assessing the types of tasks to automate, prioritizing maximum benefits while minimizing costs and risks," suggested Sharma.

## Precision Engineering & Modular Automation

Chua Yeong Tu 'Mike', Vice President, Application Engineering, Akribis Systems, in his session titled 'Use of Direct Drive in Machines to Increase UPH & Precision,' offered an insight into the use of Direct Drive Technology to enhance precision and increase Units Per Hour (UPH)—a critical productivity metric—in manufacturing. To measure this effectively, he emphasized the role of Overall Equipment Effectiveness (OEE), a composite score that evaluates availability, performance, and quality.

Venkatesan M, Associate Vice President & Business Head, Titan Engineering & Automation Ltd (TEAL), showcased Turnkey Assembly and Testing Solutions tailored for varied industries from EVs to med tech. "Where the processes demand high quality, we deploy robots. Where efficiency and flexibility is key, we opt for cobots," he noted. "To make a machine smart for a smart factory, we need an integrated combination of hardware and software."

## Scalable Robotics and Additive Manufacturing

Marking Festo India's centenary, Tapan Upadhyay, Head - Application Engineering, Business Region India, Festo India, spoke on 'Reimagining Factories with Scalable Robotic Solutions and Flexible EOAT' and introduced plug-and-play Cartesian robots. These robots require no coding and offer scalable palletizing solutions that can be quickly deployed and configured. In the area of End-of-Arm Tooling (EOAT), Upadhyay revealed that the company is furthering servo pneumatic systems powered by Piezo technology and concluded with a brief on Festo AX – Motion Insight Pneumatics.

In 'Accelerating the Adoption of Additive Manufacturing in Smart Automation', Mukesh Kumar, Deputy General Manager, Redington Ltd, highlighted how AM technology is evolving beyond its traditional role. Stressing on-demand manufacturing, he emphasized continuous improvization without investing in new tools. He called attention to the need for better cost evaluation, thoughtful selection, and a stronger focus on post-processing—steps that are often overlooked but critical to integrating AM into mainstream production.

Source: Magic Wand Media

## Converging Technologies for Modern Manufacturing

A Panel Discussion 'Convergence of Al, ML and IoT into Modern Manufacturing' assembled leading names from the industry exploring the tech's transformative power. Uday Narang, Founder, Omega Seiki Mobility, declared, "AI and IoT are the top investments for firms. Everyone — from large companies to MSMEs — will start adopting AI."

Addressing MSME challenges, Upadhyay added, "For MSMEs

**The symposium delved into India's automation ascent, the use of direct drive in machines, cybersecurity, and scalable robotic solutions.**

to stay competitive globally, digitizing is the first step that requires long-term planning and measuring, as data is the heart of AI, ML, etc." Zeroing in on 'digitization or digitalization', Kavita Kaushik, Head Quality and Six Sigma India Region, Cummins India, shared practical insights from digitizing shop floors, revealing, "Our machines' OEE is now tracked online, helping us improve expense management and reduce downtime. The payback is faster than most expect." Striking a crucial balance between innovation and sustainability, Dr Ravindra Utgikar, Vice President, Wilo Group, emphasized, "Harnessing digital advancements is non-negotiable. Data is the foundation, and AI enables predictive maintenance that eliminates future costs." Bringing the discussion full circle, A Ramasubramanian, Chief Technology Officer, Blue Energy Motors, summarized the evolution of data. He noted, "Today, there is Big Data, and our ability to handle it as humans is nil. However, by leveraging AI, we can analyze disparate data, build patterns, and bring in various solutions."

**The Symposium featured sessions on VR-based technologies, cobots, automated inspection and gauging, sustainable automation, and smart factory of Industry 4.0.**

## Cobots, Quality, and India's Readiness

'Precision and Performance - Robotics in Next-Gen Manufacturing' by Vishal Patil, Product Leader – Robot, Western Region, Mitsubishi Electric, was another standout session. Ajay Sable, Regional Head of Robot Sales, FANUC, delved into 'Collaborative Robotics (Cobots) in Smart Factories'. "They're smaller, cost-effective, easier to program, and safe—perfect for human-machine collaboration," he said, citing FANUC's CRX series.

Nitin Sinha, BDM - Asia & Middle East, Leuze Electronic Pvt Ltd, focused on sensor solutions, proving automation excellence begins with rock-solid safety.

Source: IMTMA

Cosimo Cereda, Sales Director, Marposs, championed quality assurance over control during his session on 'Automated Inspection and Gauging'. "Quality isn't automatic with machines. It's proactive monitoring," he stated, presenting Marposs' GEMCPU solution—an intelligent module for zero-defect manufacturing.

## Where Does India Stand?

A panel 'The Future of Automation & Robotics — Where Does India Stand?' industry comprised of Dr Sandhya Pande, Senior Director, Philips India Ltd; Rajeev Solanki, Head - Central Process Engineering, Legrand; Mahendra Patil, National Head-Robotics & Tech Support, FANUC India Pvt Ltd; Yash Sultania, Director - India, Akribis Systems; Sarvadnya Kulkarni, CEO, General Instruments Consortium; and Santosh Kulkarni, Vice President, Bajaj Auto Ltd.

Dr Pande emphasized, "Automation and robotics are essential if India is to compete globally, especially as we shift toward Industry 5.0." Solanki spoke candidly about Legrand's gradual automation journey and reminded the audience that automation doesn't eliminate humans; it supports them and extends beyond the shopfloor to design and beyond.

Patil brought a data-backed and comparative perspective of the robots sold, placing India 7th globally, giving room for huge potential, especially if India accelerates its adoption across sectors. Clarifying that Machine Learning is more relevant for companies like his, Sultania pointed out that MSMEs are slowly adopting automation, particularly collaborative robots.

Sharing a personal perspective spanning three generations, Sarvadnya opined that MSMEs are more open to AI and highlighted the evolution from manual work to CNC to AI-driven systems. With insights from Santosh, who stressed the need to prioritize before adopting and shared Bajaj Auto Ltd's sub-cluster approach, the panel concluded with a call for 'appropriate automation'—flexible, scalable, and future-ready.

## A Blueprint for Change

In addition to sessions on Cybersecurity, VR-Based Factory Layout Planning, Sustainable Automation, and Smart Factory of Industry 4.0, the symposium also featured an exhibition area at the end of each day to bring into the spotlight advanced automation and robotics technologies. Innovations that support MSMEs were put into focus as the participants discussed partnership and pilot projects.

In line with IMTMA's unwavering commitment to bolstering India's Manufacturing industry, the 8th Symposium on Automation & Robotics stood as a wake-up call for India's manufacturers to embrace intelligent automation as a way forward.

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# GLOBAL MOMENTUM BUILDS AT EMO 2025 PREVIEW

In early July this year, Frankfurt pulsed with the energy of innovation as it played host to EMO Hannover 2025 Preview, an exclusive curtain-raiser to the world's most prestigious trade fair for production technology. Organized by VDW (German Machine Tool Builders' Association), the event, held on July 10, 2025, at the VDW headquarters, brought together a gathering of manufacturing thought leaders, pioneering exhibitors and international journalists.

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Set against Frankfurt's cosmopolitan backdrop, EMO Hannover 2025 Preview offered a compelling glimpse into the future of metalworking and advanced production systems, ahead of the main event slated for September 22–26, 2025, in Hannover. The atmosphere was electric as industry leaders unveiled cutting-edge innovations, reinforcing EMO Hannover's position as the global epicenter of industrial advancement. As manufacturing stands on the brink of its next transformation, all eyes are now on EMO Hannover 2025. "This year, EMO runs from September 22 to 26—five days instead of six," shared Dr Markus Heering, Executive Director, VDW. Themed 'Innovate Manufacturing', the show will spotlight intelligent production, AI-driven processes, advanced automation, precision machining, and integrated digital ecosystems.

EMO Hannover Preview brought together 26 exhibi-


Source: Magic Wand Media

"The 'magic triangle' of EMO 2025—three interconnected themes defining the future of manufacturing: AI, automation, and sustainability—aren't standalone trends. Together, they're transforming how we make things, from smarter production chains to greener processes."

**Dr Markus Heering**
**Executive Director**
**German Machine Tool Builders' Association (VDW)**

tors and over 150 participants from 24 countries, including China, India, the US, South Africa, Mexico, Brazil, and across Europe. The dynamic agenda fused rapid-fire 90-second pitches, engaging Q&A sessions, insightful panel discussions, and in-depth interviews, creating a vibrant forum of ideas.

Source: Magic Wand Media

A curated ETA factory tour in Darmstadt added a real-world dimension to the experience.

## A Message of Confidence

Kicking off the event, Sven Krause, moderator at EMO Preview 2025, invited Dr Heering to reflect on the 'EMO Hannover 2025 World Tour', a six-month outreach spanning 30 countries. Dr Heering responded with marked enthusiasm, commending the remarkable preparedness and engagement of the international manufacturing community. "Nowhere else can guests encounter such a wealth of international expertise as at EMO," he emphasized. Underscoring the event's role as a premier platform for global industry dialogue, he remarked, "EMO is expected to send out strong signals. Exhibitors and visitors alike arrive expecting to leave in a more confident, optimistic frame of mind."

Highlighting India's momentum, Dr Heering noted the country's strong economic trajectory and added, "EMO is perfectly timed to meet the industry's evolving demands. It's where cutting-edge innovation takes center stage for those shaping the future of manufacturing."

## Tomorrow's Manufacturing

Artificial Intelligence made its presence felt as a practical force, already embedded in real-world systems for quality assurance, predictive maintenance, and beyond. This momentum echoed powerfully during the electrifying panel discussion, 'Perspectives on Artificial Intelligence in Manufacturing: How Will We Surprise

Source: Magic Wand Media

**Canada has been named the first-ever Alliance Country for EMO Hannover—a milestone in international collaboration that underscores the nation's deep commitment to advanced manufacturing and its active role in shaping global industrial discourse.**

Source: Magic Wand Media

> "Visitors to the Canadian pavilion will benefit from a cutting-edge AI-powered platform, giving them instant access to over 2,000 machine tool, automation, and AI companies in NGen's network."
>
> **Jayson Myers**
> **CEO**
> **Next Generation Manufacturing Canada (NGen)**

**The event blended fast-paced 90-second pitching rounds from 26 exhibitors, Q&A sessions, panel discussions, and face-to-face interviews and conversations into a vibrant showcase of ideas, as well as a factory tour.**

Our Customers in the Next Five Years?' featuring Prof Michael Zäh, Chair of Machine Tools and Manufacturing Technology at the Technical University of Munich, and Sebastian Heinz, Founder & CEO, Statworxs, Frankfurt.

According to them, European companies need to significantly increase the pace of innovation in AI in order to keep up with Asian and US providers. This is particularly true of small and medium-sized companies, which have so far been very cautious. There should be good prospects in quality assurance and predictive maintenance in particular.

Both experts emphasized AI's transformative potential and the urgency of its adoption. "Not using AI is not an option," asserted Prof Zäh. "Others are already leveraging it and those who don't will inevitably fall behind."

## Canada Makes History

As the first Alliance Country for EMO Hannover, Canada's presence is both symbolic and strategic. Canada is making a confident stride into AI-driven manufacturing, with nearly 20 pioneering companies set to showcase their innovations at a dedicated Canadian Pavilion at EMO Hannover.

"AI is part of the solution—it's embedded in everything we do," remarked Jayson Myers, CEO, Next Generation Manufacturing Canada (NGen). With over 180 AI-powered projects and an impressive 32X return on investment, Canada's delegation will spotlight how AI is reinventing business models and opening new frontiers of opportunity across the industrial landscape.

## Innovations every 90 seconds

Dr Heering introduced the concept of 'Magic Triangle' of EMO 2025: Artificial Intelligence, Automation, and Sustainability. "These are not isolated trends. Together, they are reshaping the way we manufacture—from smarter production chains to more sustainable, future-ready operations," he pointed out.

This was also confirmed by the 26 exhibitors present at the Preview. In 90-second pitches, they described to the audience what visitors can expect to see at their EMO stand in September. Many of the pitches revolved around new machines and features, tools, automation or quick-change systems. It was all about process optimization and the use of robots with intelligent software or autonomous transport systems in the factory. Sustainability concepts were discussed, with long-lasting machines and retrofitting for a second life, as

Source: Magic Wand Media

Source: Magic Wand Media

> "With EMO Hannover taking place from September 22–26, we've packed five days with as much innovation, collaboration, and energy as ever. With running machinery, and the latest in AI and Automation, it's going to feel like five very full days."
>
> **Christian Pfeiffer**
> **Senior Vice President Sales and Member of the Management Board**
> **Deutsche Messe AG**

well as the question of how the carbon footprint of machines can be reduced.

The exhibitors and speakers at the Preview made it clear that tomorrow's machines must work longer, waste less, and consume smarter—underscoring that sustainability does not have to be just a feature, but a key performance metric.

## Greener, Smarter Shops

3nine GmbH impressed with its Apex Series oil mist separation systems, a sustainability-leading solution capturing mist, recycling the fluid, and extending the lifespan of HEPA filters to several years. Theofil Hoffmann, Head of Sales Europe, 3nine GmbH, emphasized, "Our proven 'disc stack technology' captures oil mist and emulsion directly at the source, leading to significantly reduced maintenance intervals—a commitment to cleaner workspaces and lower maintenance."

Urma AG Werkzeugfabrik is pushing for material efficiency with its modular milling and honing solutions. "The latest is the CBN milling cutter," added Markus Probst, Manager Sales & Application, Urma. "We have CBN cutting in CBN tipping for cast iron, steel, and more." The company will showcase the MX Boronite, MX Diamond milling cutters, and the innovative RH Reamhone at EMO Hannover in September.

## Automation Takes Center Stage

The fast-paced Pitching Round revealed a wave of innovations geared toward scalable, intelligent manufacturing systems. Huron Graffenstaden SAS is transforming its expansive booth in Hall 15 into a 'Town of Technology'—a live experience of high-speed machining, multitasking centers, and Industry 5.0-ready automation. "We'll display around ten machines from compact turning centers to large multitasking 5-axis systems," shared Jonathan Philipps, Director Commercial - Sales, Huron. "Four models will make their European debut."

On the digital front, Huron is unveiling software solutions designed for Industry 4.0/5.0 integration, with features like AI-powered collision prevention, tool life optimization, and remote diagnostics—marking a bold step toward autonomous, intelligent manufacturing.

Maschinenfabrik Berthold HERMLE AG is set to showcase its cutting-edge GEN2 series of 5-axis machining centers, alongside the next-gen RS 2 GEN2 robot system and HS Flex hybrid automation.

From ANCA CNC Machines's MicroX grinding platform, which delivers nanometer-level control

**EMO Preview 2025 hosted 26 exhibitors and 150 participants from 24 countries—including China, India, the US, South Africa, Mexico, Brazil, and several European nations—alongside international media.**


Source: Magic Wand Media


Source: Magic Wand Media

Source: Magic Wand Media

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Source: Magic Wand Media

for ultra-small tools, to Renishaw GmbH's Equator–X dual-mode gauging system that enables automated part inspection and traceability, smart systems are closing the gap between machines and humans.

Joachim Jäckl, European Marketing and Communications Manager, ANCA CNC Machines, said, "We're back at EMO in Hannover with a lot of new machines, new software, new connectivity, new automation solutions. We're taking precision to a whole new level." The company is extending the limits of automation, with its 'AIMS Connect' system that allows manufacturers to plan, manage, and guide remote operators digitally.

Similarly, speaking about the system, Rainer Lotz, President EMEA, Renishaw GmbH, stated, "We have a new mechanical construction which allows us to measure with 250 mm/sec in Absolute Mode and 500 mm/sec in Compare Mode." He explained, "Equator–X comes with new software, MODUS™ IM is super easy to use, and can be applied by most staff you have on your shop floor."

**The exhibitors and speakers at the Preview made it clear that tomorrow's machines must work longer, waste less, and consume smarter—underscoring that sustainability does not have to be just a feature, but a key performance metric.**

## Precision with a Pulse

Though automation and AI could accelerate the pace of innovation, accuracy and adaptability remain the main strengths of a productive and successful production system. And there is no better place than EMO 2025 to witness such machining technologies being prepped.

At Okuma, precision meets performance—backed by Japanese technology and tradition. Posing beside an intricately machined snake model—representing Japanese culture and the year of the snake—milled out of an aluminum block, Dorian Wilger, Area Manager, Okuma Europe GmbH, pointed out, "At this year's EMO, we are showcasing state-of-the-art technology that redefines efficiency and keeps you ahead of the competition—redefining craftsmanship."

In a similar spirit, United Machining Solutions, the new identity born from the merger of United Grinding Group and GF Machining Solutions, is making a bold debut. Hailing it as 'a new chapter', Michèle Fahrni, Head of Marketing & Communication, United Machining Solutions Management AG, revealed the future plans of their premiere at EMO Hannover: "We're unveiling eight world premieres and presenting the full force of 15 specialized brands in a single booth."

Joining her, Michèle Zeller, Head of Marketing Communication, Fritz Studer AG, highlighted United Grinding's brand Studer showcase within the group. "We're bringing five machines and a loading system and are excited to reveal a brand-new Studer model at the fair," she said.

## A Preview That Delivered

As EMO Hannover turns 50 this year, Dr Heering underlined the drive behind the event, stating, "My target is for every visitor and exhibitor to leave saying, 'We found new ideas, new business opportunities, and built new bridges for the future.'" Concluding and extending his invitation with a knowing smile, he continued, "See you in Hannover. Let's develop and grow business—against the backdrop of the event's 'Innovate Manufacturing' theme."

Source: Magic Wand Media

Source: Magic Wand Media

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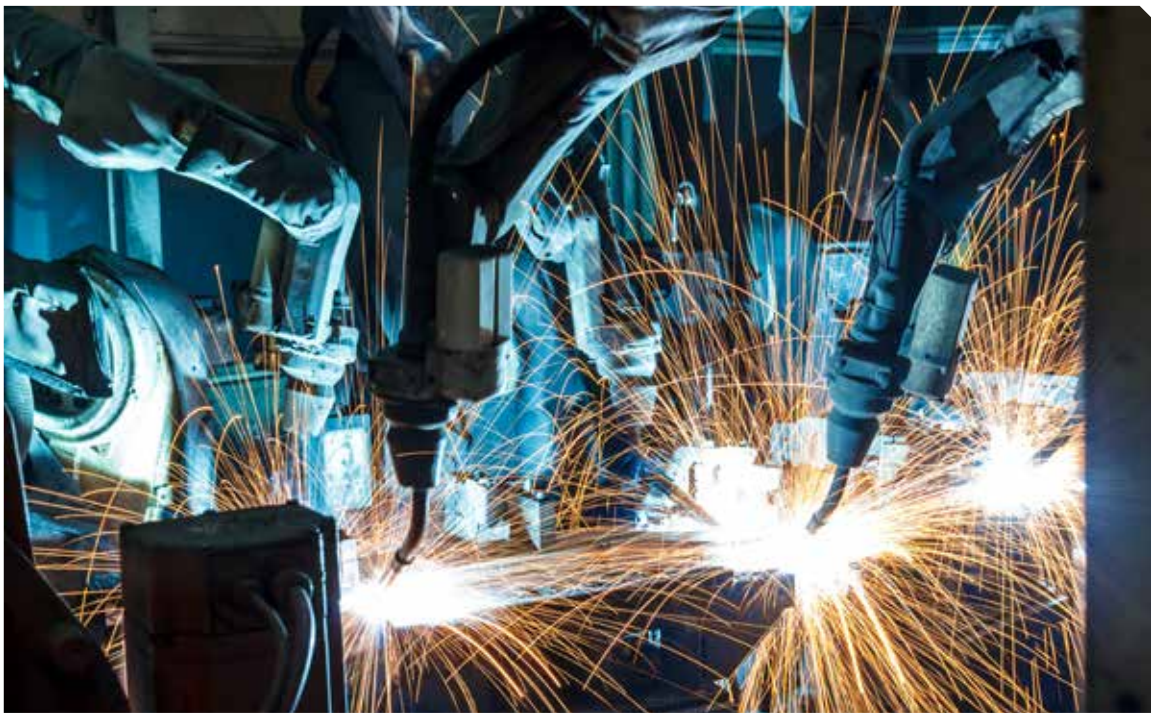
# SPOTLIGHT ON INNOVATION

Returning to MESSE ESSEN from September 15 – 19, 2025, SCHWEISSEN & SCHNEIDEN, the world's leading trade fair for joining, cutting, and surfacing technologies, will be held under the motto 'Join the Future'. Several Indian companies will mark their presence, highlighting the country's growing strength in welding consumables and automation.



Source: Magic Wand Media

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After an earlier-than-usual return just two years after the last edition, Messe Essen GmbH-organized SCHWEISSEN & SCHNEIDEN will resume its four-year cycle from 2025 onwards. As always, the show will serve as the central hub for industry leaders, innovators, and buyers from around the world.

With a strong focus on digitalization, sustainability, and skilled workforce development, the show has two major highlights awaiting attendees: the new Future Hub, offering a platform for trendsetting technologies, and the IF Digital Award, recognizing excellence in digital transformation.

Adding to the forward-looking theme is the 'Young Innovators' stand in Hall 3, dedicated to German start-ups bringing fresh thinking and disruptive solutions to the industry. The event is expected to offer a comprehensive view of the entire value chain—from welding and cutting to automation and materials.

Over 800 exhibitors from 42 countries will be showcasing trends and innovations throughout the MESSE ESSEN exhibition center. The focus is especially on the megatrends of digitalization and interactive automation in welding and surfacing using collaborative robots, sustainable practices and resource efficiency, and recruiting and retaining skilled professionals.

## The Future Hub

The Future Hub is the centrepiece of SCHWEISSEN & SCHNEIDEN 2025. This is where innovation meets networking – in a practical, informative and inspiring setting. The show's partner, DVS e.V., is holding the DVS Congress on September 16 and 17. The 'Young Welders Competition' will take place over the entire duration of the trade fair and is made up of

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the DVS national competition, 'Jugend schweißt' and the 'International Welding Competition'.
The show once again promises a wealth of customized solutions for one's day-to-day operations, a comprehensive overview of the market and an opportunity to forge valuable contacts at the world's leading communication platform for the industry. The highlights of the Future Hub include inspiring presentations, panel discussions, product presentations, best practices, recruiting formats and speed dating, networking events and starting point of the trade fair tours, entertainment and interaction.

**India's growing role in the global welding and materials ecosystem is reflected in the participation of several Indian exhibitors this year. These companies will showcase their capabilities in welding consumables, specialty alloys, and automation solutions.**

## The IF Digital Award

At SCHWEISSEN & SCHNEIDEN 2025, the successful partnership with the non-profit IndustryFusion Foundation and DVS e.V. continues, with the introduction of the IF Digital Award. This new initiative will honor particularly innovative exhibitors who demonstrate the added value of their latest digital products and services. Visitors to the trade fair will have the opportunity to vote for the most forward-thinking solutions using the official SCHWEISSEN & SCHNEIDEN app.
Voting will remain open until 12:00 noon on September 19, and all participants will be entered into a prize draw. The award ceremony is scheduled for 1:00 pm the same day at the IndustryFusion Foundation stand. Prize winners will be contacted individually after the event.

Source: Magic Wand Media

## Indian Presence at the Forefront

India's growing role in the global welding and materials ecosystem is reflected in the participation of several Indian exhibitors this year. These companies will showcase their capabilities in welding consumables, specialty alloys, and automation solutions. Their focus areas are closely aligned with the trade fair's core themes, making India's presence both strategic and impactful.
Confirmed Indian exhibitors include Ador Welding Ltd, Nevatia Steel & Alloys Pvt Ltd, AIM Alloys LLP, D & H India Ltd, Jayesh Industries Ltd, Modi Hitech India Ltd, Royal Welding Wires Pvt Ltd, Schutz Carbon Electrodes Pvt Ltd, Saru Silver Alloys Pvt Ltd, Kamman Group Premier Industrial Corp. Ltd, The Indian Institute of Welding and Indian Machine Tool Manufacturers' Association (IMTMA).
From global exporters to domestic champions and industry institutions, the Indian delegation reflects the country's capabilities in both manufacturing excellence and skill-building.

## Conclusion

SCHWEISSEN & SCHNEIDEN 2025 promises to be more than just a showcase—it will be a convergence point for ideas that shape the future of the industry. With increased focus on sustainability and smart manufacturing, and a strong representation from Indian companies, this year's edition offers a compelling experience for visitors and stakeholders alike.

Source: Magic Wand Media

Source: Magic Wand Media

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