VOL 10, ISSUE 1 - MAY-JUNE 2026

MODERN MANUFACTURING INDIA

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The Official Magazine of

Indian Machine Tool Manufacturers' Association

In Association with

Modern Machine Shop

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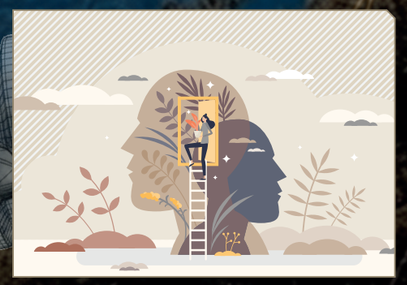
REDEFINING THE GRINDING LANDSCAPE



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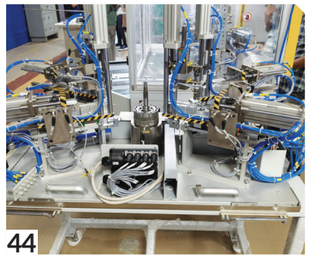

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ADVANCING MANUFACTURING GROWTH

MOHINI KELKAR
PRESIDENT
IMTMA

Dear Readers,

The global economy is undergoing a steady transformation in 2026, shaped by evolving supply chains and shifting economic dynamics. According to the April 2026 edition of the International Monetary Fund's (IMF) World Economic Outlook, growth across major economies remains supported by investments, innovation, and expanding industrial capabilities.

India's Manufacturing sector has maintained encouraging momentum, supported by rising domestic consumption, investment, and expanding industrial capacity. The Purchasing Managers' Index (PMI) rose in April 2026, indicating sustained growth in industrial activity and business confidence.

Amid this evolving landscape, India stands out as one of the world's fastest-growing major economies. The International Monetary Fund (IMF) projects India's GDP growth to be around 6.5 percent over the next two years, supported by strong domestic demand, sustained investment, infrastructure development, and ongoing structural reforms.

The resilience of the Indian economy reflects not merely a cyclical recovery, but a deeper transformation driven by digitalization, manufacturing expansion, and rising industrial competitiveness.

The Indian Machine Tool industry has recorded encouraging progress in FY 2025-26, with growth in production, consumption, and exports, reflecting improved competitiveness and rising confidence in the country's manufacturing capabilities.

For the Indian Machine Tool industry, these developments offer significant opportunities. The industry is becoming more agile and flexible and is exploring new avenues.

The Machine Tool industry has recorded encouraging progress in FY 2025-26, with growth in production, consumption, and exports, reflecting improved competitiveness and rising confidence in Indian manufacturing capabilities.

Indian Machine Tool Manufacturers' Association (IMTMA) remains committed to advancing manufacturing through technology promotion, skill development, and knowledge sharing. Through Modern Manufacturing India, we will continue to bring our readers meaningful insights, emerging trends, and key developments that matter to the manufacturing community.

We sincerely thank our members, partners, contributors, and readers for their continued support and engagement.

Happy Reading.

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

Dear Readers,

Manufacturing today is navigating an era of rapid transformation, driven by technological advancements, evolving supply chains, and shifting global economic realities. Despite uncertainties in the international business environment, India continues to emerge as a resilient and promising manufacturing destination.

The strong emphasis on infrastructure development, digital transformation, and industrial capability-building is creating new opportunities across sectors. India's sustained economic momentum and continued policy focus on manufacturing are encouraging industries to invest in technology, productivity improvements, and capacity expansion.

The Indian machine tool industry has also recorded encouraging growth in FY 2025–26, supported by rising domestic demand, expanding industrial activity, and improved export performance. The industry's growing focus on innovation, automation, precision manufacturing, and localization is further strengthening India's global manufacturing competitiveness.

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This edition focuses on grinding technology and its growing significance in precision manufacturing. The issue also features insightful articles and case studies on automation in electric vehicle manufacturing, lean manufacturing practices, capacity-enhancement strategies, developments in the Indian electronics manufacturing sector, and advancements in component finishing to improve product performance. Alongside these, our regular features on industry leaders, emerging start-ups, and exclusive interviews continue to present diverse perspectives from the manufacturing ecosystem.

As always, we thank our contributors, partners, and readers for their continued support and engagement. We hope this edition offers valuable perspectives and meaningful insights into the evolving manufacturing landscape. We also greatly value the feedback and suggestions of our readers, which help IMTMA continuously enhance the relevance and quality of MMI and serve the manufacturing community more effectively.

SOUMI MITRA
Editor-in-Chief
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MANUFACTURING A SMARTER, GREENER GLOBAL BLUEPRINT

During a recent visit to China, I experienced a seamless integration of robotics into daily life—one existing entirely in harmony with urban ecology. Modern industrial powerhouses offer a refreshing blueprint, where hyper-automation and vibrant greenery grow side by side. For an observer like me, tracking the global industrial race, the journey reveals what happens when a nation treats technology as a societal foundation.

Too often, robotics is compartmentalized into automotive lines or cleanrooms. In China, that boundary has completely dissolved. Automation has spilled into the everyday sphere, driven largely by a highly orchestrated effort to foster early innovation in the classroom. By positioning robotics as the ultimate frontier of student ingenuity, the nation has unlocked a powerful multiplier effect.

Yet, the most unexpected takeaway is the quiet beneath the roar of the machines. Even in mega-cities, the scale of urban greenery is staggering. Vertical gardens scale skyscrapers, multi-tiered canopies line highways, and urban wetlands cut through manufacturing clusters. This strategic ecological engineering acts as a vital counterweight to rapid industrialization.

> *"If everybody else seems to be doing it one way, there might be more opportunity the other way."*
> *– Andrew Scheuermann, Co-Founder of Arch Systems Inc.*

This shift proves that technological dominance and sustainability must go hand in hand. True industrial advancement is not measured by how fast a robotic arm moves; it is defined by an ecosystem where high-velocity technology and a green environment thrive as one. For the future of global production, this balance is non-negotiable.

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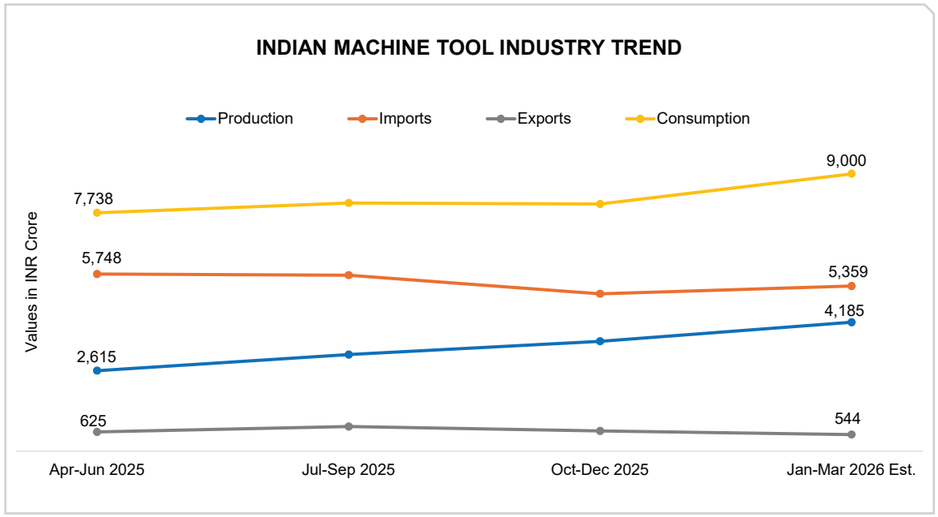
GROWTH AMID GLOBAL TURBULENCE

Despite inflationary pressures, geopolitical tensions, and rising crude oil prices, India's economy and machine tool industry demonstrated steady growth, improved investment sentiment, and strong export performance in FY2025–26.



Source: IMTMA

Source: Data & Policy Team, IMTMA

In March 2026, India's macroeconomic landscape exhibited a moderation in momentum as manufacturing and services PMI declined to multi-month lows of 53.9 and 57.5, respectively, amid rising input costs driven by the West Asian crisis.

Industrial Activity Remains Stable

Industrial activity remained broadly stable, with IIP (Index of Industrial Production) growth at 5.2 percent in February 2026 (vs. 5.1% in January). However, inflationary pressures edged higher, as CPI (Consumer Price Index) inflation rose to 3.4 percent in March 2026 from 3.2 percent in February, largely reflecting cost-push pressures from elevated energy prices linked to the ongoing geopolitical tensions in West Asia.

Meanwhile, headline WPI (Wholesale Price Index) inflation rose sharply to 3.9 percent from 2.1 percent over the same period, indicating a strong pick-up in wholesale price momentum led by energy-linked and manufactured goods prices.

Fiscal Position Supported by Tax Revenue Growth

On the fiscal front, during April–February FY2025–26, the Government of India's (GoI) gross tax revenues (GTR) grew by 6.7 percent, supported by a 5.9 percent increase in direct taxes and an 8.0 percent rise in indirect taxes. During the same period, GoI's fiscal and revenue deficits stood at 80.4 percent and 73.8 percent of their respective annual revised estimates.

External Trade Weakens Amid Global Disruptions

On the external front, merchandise exports and imports contracted sharply by 7.4 percent and 6.5 percent, respectively, in March 2026, reflecting weak external demand and trade disruptions amid the West Asian crisis. Despite this, the merchandise trade deficit narrowed to a nine-month low of US$ 20.7 billion, as the decline in imports outpaced that in exports, partly due to global supply disruptions.

Investor Sentiment Improves

Net FDI (Foreign Direct Investment) and FPI (Foreign Portfolio Investment) recorded inflows of US$ 4.6 billion and US$ 2.9 billion, respectively, in February 2026, compared to outflows of US$ 1.4 billion and US$ 1.9 billion in January 2026. This indicates a cautious recovery in investor sentiment.

Rising Crude Oil Prices Pose Inflationary Risks

Global crude oil prices surged from US$ 68 per barrel in February 2026 to US$ 95.6 per barrel in March 2026 — the highest level since August 2022 — due to supply disruptions linked to the West Asian crisis.

According to the Asian Development Bank (ADB), regional growth is expected to remain steady. However, if crude oil prices rise further to around US$120 per barrel, India's GDP growth could slow to nearly 6 percent, while inflation may rise to approximately 6 percent in FY2026–27.

India Strengthens Position in Global Machine Tool Industry

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

Indian Machine Tool Industry Records Strong Growth

The Indian Machine Tool industry delivered a strong performance in FY2025–26.

Production is estimated to have grown by 13 percent to INR 16,478 crore (US$ 1.9 billion).

Imports increased by 17 percent year-on-year to INR 21,932 crore (US$ 2.5 billion), indicating continued dependence on overseas supply. Exports registered a sharp growth of 79 percent, reaching INR 2,628 crore (US$ 0.3 billion), reflecting improved competitiveness and stronger global demand. Overall industry consumption grew by 13 percent to INR 35,782 crore (US$ 4.0 billion) during FY2025–26.

As global manufacturing undergoes structural shifts, India's Machine Tool industry is expected to play an increasingly strategic role in supporting industrial growth and competitiveness

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

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Source: Magic Wand Media

BUILDING RESILIENT MANUFACTURING SUPPLY CHAINS

Global manufacturing stands at the threshold of a defining transformation, where resilience and reliability are emerging as the new hallmarks of industrial strength, alongside cost competitiveness and economies of scale.

In an era shaped by geopolitical realignments, volatile energy markets, and evolving trade corridors, industries worldwide are reimagining their supply chains with renewed urgency. The focus is shifting toward building robust regional capabilities, diversifying sourcing networks, and creating ecosystems that can withstand disruption while sustaining growth and innovation.

For India, the rapidly evolving global landscape presents a significant opportunity. As one of the world's fastest-growing major economies, India is steadily emerging as a preferred manufacturing destination. Backed by a widening industrial base, sustained infrastructure development, a strong focus on manufacturing, a skilled workforce, policy continuity, and a vibrant domestic market, the country is building momentum across industries and enterprises.

Machine Tools at the Core of Industrial Growth

At the heart of this transformation lies the Machine Tool industry which serves as the backbone of manufacturing. Machine tools play a pivotal role across the Capital Goods, Automotive, Aerospace and Defence, Railways, Electronics, Medical Devices, General Engineering, and other sectors. As industries continue to modernize and expand capacity, advanced machine tools and allied technologies will play an important role in sustaining growth.

Simultaneously, global supply chain realignments are prompting nations to build stronger domestic ecosystems for critical industrial technologies and components. Similar trends are unfolding across industries, with localization and supply chain resilience increasingly emerging as strategic imperatives.

Strengthening Indigenous Capabilities

India's machine tool market has continued to demonstrate encouraging momentum. Industry estimates indicate that the Indian Machine Tool industry recorded production growth of around 10 percent during FY 2025–26, with exports also registering growth, reflecting improving global competitiveness and rising confidence in Indian manufacturing capabilities.

Industry leaders believe that this momentum further underscores the importance of strengthening domestic capabilities and building resilient supply ecosystems for the future.

According to Mohini Kelkar, President, Indian Machine Tool Manufacturers' Association (IMTMA), a deeper focus on indigenous technologies, reliable systems and products, and critical components will further enhance the competitiveness of the Indian Machine Tool industry while laying a stronger foundation for sustained industrial growth.

To realize the vision of Aatmanirbhar Bharat and strengthen India's long-term manufacturing competitiveness, there is a growing need to build indigenous capabilities in CNC controls, servo drives, spindles, tooling, precision castings, and AI-based systems. Nurturing these capabilities locally will strengthen supply chain resilience, accelerate innovation, and support the evolving aspirations of modern manufacturing.

Collaboration and Innovation to Drive the Next Phase

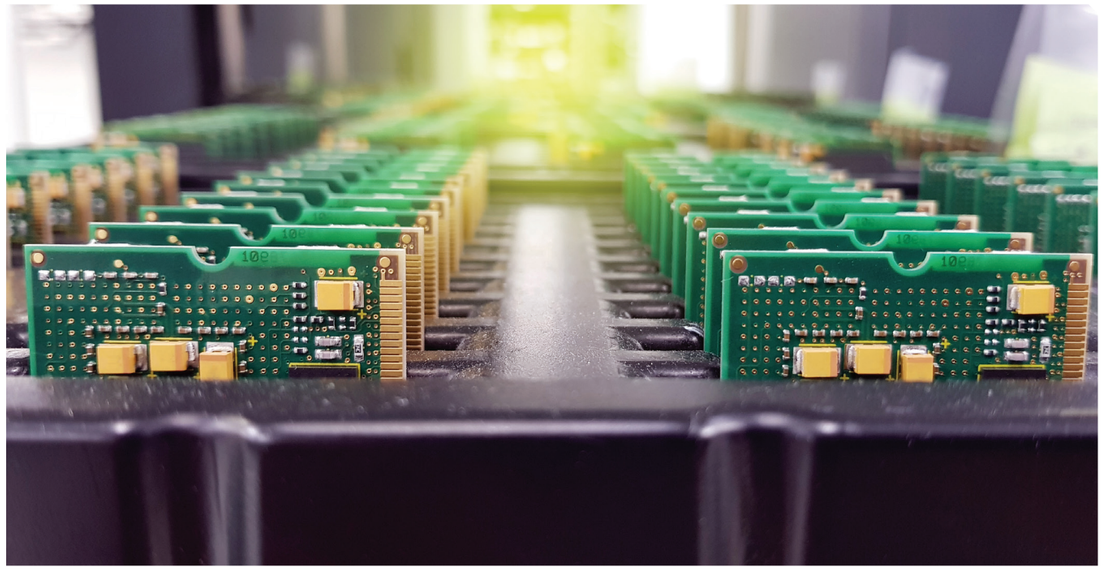
Collaboration across the manufacturing ecosystem is poised to shape the industry's next phase of growth. Jibak Dasgupta, Director General & CEO, IMTMA, notes that the evolving global manufacturing landscape is creating fresh opportunities for India's Machine Tool industry to advance through stronger partnerships, innovation, and technology-led growth.

Greater collaboration between industry and academia, supported by enabling government initiatives, can further accelerate technology development, skill enhancement, and innovation across the Manufacturing sector. For the Machine Tool industry, this is a defining moment to deepen capabilities, foster innovation, and strengthen its contribution to India's manufacturing and export aspirations.

To realize the vision of Aatmanirbhar Bharat and strengthen India's long-term manufacturing competitiveness, there is a growing need to build indigenous capabilities in CNC controls, servo drives, spindles, tooling, precision castings, and AI-based systems.

Source: Magic Wand Media

Source: IMTMA



Source: Magic Wand Media

GLOBAL PRESENCE: A STRATEGIC NECESSITY FOR INDIAN EMS FIRMS

India's Electronics Manufacturing Services (EMS) industry is entering a decisive structural phase. What began as a cost-arbitrage-led, build-to-print sector is steadily transforming into an engineering-driven, globally integrated ecosystem. The inflection point is visible not only in corporate boardrooms but also in national policy frameworks.

According to data published by the Ministry of Electronics and Information Technology (MeitY), India's electronics production has crossed the US$ 100 billion mark in recent years, with exports witnessing consistent growth, particularly in mobile phones and telecom equipment. The government has articulated an ambitious target of US$ 300 billion in electronics manufacturing by 2026. Complementing this, India Cellular and Electronics Association (ICEA) projects that India could achieve US$ 120 billion in electronics exports by the middle of the decade if ecosystem capabilities deepen and value addition increases.

The above numbers are significant. But scale alone does not define global leadership. The global EMS market is estimated at over US$ 600 billion. India's share, while expanding, remains modest compared to established manufacturing hubs such as China, Taiwan, and parts of Southeast Asia. The next phase of growth will not be driven purely by labor cost advantage or domestic consumption. It will be determined by how effectively Indian EMS firms integrate into global value chains.

Structural Shifts Reshaping Global Electronics

Three structural forces are reshaping the global electronics landscape. First, supply chain diversification has become a strategic imperative under "China-Plus-One" and geopolitical risk mitigation strategies. Second, product complexity is rising rapidly as electronics power electric mobility, renewable energy systems, aerospace platforms, and AI-enabled industrial automation. Third, regulatory intensity is increasing across sectors, particularly in Medical Devices, Automotive Electronics, and Defence Systems.

NIRMAL VASANI
Chief Operating Officer
Aimtron Group

These forces are redefining what OEMs expect from EMS partners.

From Assembly Partner to Lifecycle Collaborator

The earlier model positioned Indian manufacturers primarily as efficient assembly hubs. Today, global OEMs are looking for multi-node partners capable of supporting the entire product lifecycle—from design validation to high-volume production—across geographies. Physical presence near innovation centers enables early-stage engineering collaboration, while Indian facilities provide scalable and cost-efficient manufacturing. This integration is strategic, not symbolic.

Why Proximity to OEM Innovation Matters

During the New Product Introduction phase, manufacturing inputs significantly influence cost, compliance timelines, and reliability metrics. In sectors such as Aerospace, Medical Electronics, and EV Power Systems, iterative design feedback can determine commercial viability. Proximity to OEM R&D teams reduces iteration cycles and accelerates certification pathways. Once designs stabilize, production can transition or expand within India's manufacturing corridors supported by PLI schemes.

Moving Up the Value Chain

PLI schemes are designed to move the country up the value chain. Policy discussions have consistently emphasized value addition, technology absorption, and export competitiveness rather than mere assembly volumes. However, policy support alone cannot secure global relevance. Capability integration must follow.

Engineering Depth as India's Core Advantage

India's intrinsic strength lies in engineering depth. The country produces a substantial pool of electronics and software engineers annually, and has developed strong capabilities in embedded systems, firmware development, industrial electronics design, and validation services. This positions India uniquely among emerging manufacturing hubs.

A global footprint amplifies this advantage. Exposure to international compliance regimes—UL, CE, FDA, AS9100, and automotive functional safety standards—builds institutional knowledge. When harmonized through standardized quality management systems and unified ERP platforms, these learnings elevate domestic manufacturing benchmarks. In effect, overseas presence becomes a channel for capability absorption and redistribution.

Supply Chain Resilience as a Strategic Differentiator

The pandemic and subsequent geopolitical tensions exposed vulnerabilities in concentrated sourcing models. Lead times expanded unpredictably, logistics costs spiked, and semiconductor shortages disrupted production worldwide. As a result, supply chain resilience has moved from operational consideration to board-level strategy.

For Indian EMS firms, operating across geographies enables diversified sourcing corridors, tariff optimization, and production load balancing. Multi-node manufacturing networks provide continuity when regional disruptions arise. This resilience is increasingly a qualification criterion for Tier-1 OEM engagements.

Global Expansion and 'Make in India' Imperative

Importantly, international expansion does not dilute the 'Make in India' vision. On the contrary, it strengthens it. Overseas engineering centers and customer-facing facilities act as conduits for technology transfer, advanced compliance exposure, and process benchmarking. The knowledge and systems built abroad flow back into domestic operations, enhancing ecosystem sophistication. Several Indian EMS firms have already begun operationalizing this model by building engineering interfaces in customer markets such as the United States, while anchoring scalable production in India.

From Cost Arbitrage to Capability Arbitrage

The strategic crossroads for Indian EMS firms is therefore clear. Remaining purely domestic manufacturers may limit long-term value creation for firms. As OEM expectations evolve toward lifecycle collaboration, compliance depth, and supply chain resilience, partners must reflect these priorities.

The structural transformation underway signals the coming of age of Indian EMS. The narrative is shifting from cost arbitrage to capability arbitrage. It reflects broader industrial ambition—an India that seeks not only to manufacture at scale, but to influence global product ecosystems.

Glocal Future of Indian EMS

To capture a larger share of the global EMS opportunity, Indian firms must think beyond factory expansion. They must integrate engineering, digital transparency, policy alignment, and international presence into a coherent growth strategy.

The future of Indian EMS lies in being 'Glocal', anchored in India's manufacturing strength while embedded within global innovation and supply networks. In this new paradigm, global footprint is not an optional expansion strategy. It is the foundation of sustainable competitiveness.

**The future of Indian EMS lies in being 'Glocal', anchored in India's manufacturing strength while embedded within global innovation and supply networks. In this new paradigm, global footprint is not an optional expansion strategy.
It is the foundation of sustainable competitiveness.**

ENGINEERING THE MIND: HOW MINDFULNESS CAN BENEFIT ENGINEERS

In this article, Reji Varghese explores research conducted at Stanford University by Beth Rieken, Sheri Sheppard, and Shauna Shapiro between 2015 and 2017 examining whether mindfulness meditation could help engineering students become better at innovation and creative problem-solving. The findings were later published in a 2019 Harvard Business Review article titled 'Mindfulness for Engineers'.

Source: Magic Wand Media

For decades, engineering excellence meant tighter tolerances, better productivity, lower rejection rates, and solving problems efficiently within known constraints.

Those things still matter. But manufacturing has changed. Engineers today work with automation, robotics, sensors, software, lightweight materials, electrification, and increasingly, AI-assisted systems. Problems rarely stay confined in one department anymore.

A question that is beginning to emerge across engineering education and industry is: Are engineers being trained only to execute processes, or are they also being trained to observe carefully, question assumptions, and innovate?

Research by Beth Rieken and her colleagues at Stanford University offers an interesting perspective. Their work explored the relationship between mindfulness and innovation in engineering students.

The word mindfulness creates confusion because many people associate it with wellness programs or meditation apps. But the Stanford research approached it more practically. In this context, mindfulness refers to the quality of attention a person brings to a task. Focus matters, but so does curiosity, openness, and the ability to notice without rushing toward conclusions.

On the shop floor, this is not abstract at all.

An experienced machinist listening to a spindle sound and quietly saying, "Something is not right," is demonstrating mindfulness. So is the fixture designer who asks why a part is being clamped a certain way simply because "we've always done it like this." Many major engineering problems announce themselves quietly before they become visible on a report.

Convergent and Divergent Thinking

One part of Rieken's research involved engineering students being given divergent thinking tasks. Divergent thinking is simply the ability to generate multiple possible solutions instead of moving immediately toward one correct answer.

That matters because engineering education traditionally rewards convergent thinking. Students are trained to solve structured problems using established formulas and methods. Analytical rigor is essential but over time it can also condition people to search for predefined answers rather than fresh possibilities.

In one experiment, participants were asked to think of alternative uses for a brick and also consider design solutions for a flood-retaining wall. Students with higher baseline mindfulness consistently generated more original ideas and considered a wider range of factors.

A second study involving nearly 1,400 engineering students across the United States found that mindfulness strongly predicted what researchers called 'innovation self-efficacy' — confidence in one's ability to innovate.

What stood out most was not concentration alone. The strongest predictor was a mindset of openness and curiosity, what Zen traditions sometimes call a 'beginner's mind'.

Steve Jobs, Apple, and Mindfulness

Steve Jobs often spoke about something similar.

Long before mindfulness became fashionable in Silicon Valley, Jobs was practising Zen meditation and studying Eastern philosophy. In Walter Isaacson's 2011 biography of Steve Jobs, Jobs is quoted as saying, "If you just sit and observe, you will see how restless your mind is. If you try to calm it, it only makes it worse, but over time it does calm, and when it does, there's room to hear more subtle things – that's when your intuition starts to blossom and you start to see things more clearly and be in the present more. Your mind just slows down, and you see a tremendous expanse in the moment. You see so much more than you could see before. It's a discipline; you have to practice it."

That way of thinking shaped Apple's design philosophy too. Jobs believed simplicity was much harder than complexity. Many engineers will recognize the truth in that immediately. It is easy to keep adding sensors, features, menus, and layers of software. It takes real clarity to remove what is unnecessary. Manufacturing companies today face a similar challenge.

Are Engineers Being Trained to Execute and also Innovate?

Many organizations unknowingly train engineers to avoid uncertainty. Processes become rigid. Hierarchies discourage questioning. Young engineers quickly learn that the safest path is usually to follow established methods quietly and avoid mistakes.

That creates consistency. It can also slowly suffocate initiative.

India's Manufacturing sector is entering a phase where innovation becomes increasingly important. Competing on cost alone is no longer enough. Whether in Aerospace, Automotive, EVs, Defence, Medical Devices, or Precision Engineering, Indian manufacturers are moving toward higher-value work. That transition requires a different kind of engineering mindset.

Source: Magic Wand Media

India's Manufacturing sector is entering a phase where innovation becomes increasingly important. Competing on cost alone is no longer enough. Indian manufacturers are moving toward higher-value work. That transition requires a different kind of engineering mindset.

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An engineer who simply repeats an older process or design may complete the task successfully. But the engineer who pauses and asks whether the process itself can be rethought may create something genuinely valuable.

Often the difference is not intelligence. It is awareness, perception, and curiosity.

Industry leaders across India frequently observe that many young engineers are technically capable and hardworking, yet struggle when problems become open-ended. They are comfortable solving textbook questions but less comfortable dealing with ambiguity on the shop floor, where the answer is not sitting at the back of the book.

Part of that comes from how engineering is taught. There is enormous emphasis on examinations, formulas, and predefined answers. Far less emphasis is placed on reflection, out-of-the-box thinking, or learning to sit with a problem long enough to really understand it.

As a result, engineers often become highly efficient at execution while remaining hesitant about independent innovation.

Companies can encourage reflection by giving engineers time to study processes deeply instead of constantly reacting to production pressure. Cross-functional interaction between design, quality, manufacturing, and automation teams also exposes people to new ways of thinking.

As Indian manufacturing moves toward greater sophistication, competitive advantage may come not just from better machines or software, but from sharper human perception.

Best Insights Emerge When Engineers are Mindful

A machinist notices unusual chip formation on one side of a component. A maintenance engineer senses a behavioural change in a machine before diagnostics detect it. A quality engineer spots a rejection pattern others dismissed as random variation. Those moments rarely happen when people are mentally overloaded and rushing from one crisis to another.

As Indian manufacturing moves toward greater sophistication, competitive advantage may come not just from better machines or software, but from sharper human perception.

Engineering colleges and companies can encourage this through surprisingly simple initiatives: voluntary meditation sessions, quiet reflection spaces, workshops on mindfulness and stress management, and healthier work environments that support deep thinking instead of constant distraction.

What may sound philosophical in theory is becoming increasingly valuable in design offices and on the shop floor. Because most engineering breakthroughs begin the same way – someone notices what everyone else missed.

Reji Varghese is an industry veteran with nearly four decades of experience in high-precision fixture building. He also contributes as a guest writer to several leading national newspapers and magazines.

The Tungsten Crunch

When the price of a single industrial intermediate surges 900 percent in a single year, it is no longer a market anomaly — it is a structural alarm. Ammonium Paratungstate, the critical midpoint in the tungsten supply chain, has done exactly that on Rotterdam benchmarks, sending shockwaves through the cutting tool and manufacturing industries.

Tungsten carbide — the critical material for cutting tools such as drills, end mills, and indexable inserts — is becoming one of the most strategically precarious inputs in manufacturing.

China accounts for approximately 80 percent of global tungsten mining and processing capacity. Export restrictions and domestic policy adjustments have contributed to upward price pressure, but the problem runs deeper. New mine development has been chronically underfunded worldwide, and the pipeline of tungsten concentrate is not keeping pace with demand. That demand is accelerating simultaneously across Defence, Aerospace, Electric Vehicles, and Semiconductors — all competing for the same shrinking pool of material. Defence procurement during wartime triggers pre-emptive stockpiling that tightens the market further. Scrap carbide now commands record premiums, a clear signal that primary supply alone cannot meet demand.

The APT Bottleneck

Over 75 percent of global tungsten production passes through Ammonium Paratungstate before becoming powder, carbide, or alloys — making APT the hidden lever of the entire tungsten economy.

Its purity, refined to 99.9 percent, directly determines carbide grain structure and tool life. When APT supply tightens, manufacturers face not only cost increases but quality variability as they turn to less familiar suppliers. Rising energy and logistics costs compound the pressure at every stage. There is no single relief valve; every link in the chain is strained simultaneously.

> **The immediate priority should be leveraging trade relationships with tungsten-producing nations to secure stable, long-term supply agreements. Industry bodies need to coordinate collective procurement, giving smaller manufacturers the negotiating scale they cannot achieve alone.**

The Industry Must Act

The forces driving tungsten carbide costs higher — supply concentration, underinvestment in new mines, and structural demand growth — are not cyclical. They are here to stay. Three priorities belong on every procurement leader's agenda: build long-term supplier agreements that diversify sourcing across multiple geographies; integrate carbide recycling as a strategic supply buffer, not an afterthought; and engage with emerging tungsten sources globally, even at a near-term cost premium. The value of diversification will only grow.

Strategy for India

For Indian manufacturers, this moment is both a challenge and an opening. India's Cutting Tool, Automotive, and Engineering sectors are significant consumers of tungsten carbide, and the industry should act decisively. The immediate priority should be leveraging trade relationships with tungsten-producing nations to secure stable, long-term supply agreements. Industry bodies need to coordinate collective procurement, giving local manufacturers the negotiating scale they cannot achieve alone. Tosher Hormusjee, Executive Committee Member & Past President, Indian Cutting Tool Manufacturers Association (ICTMA), says that he has been pushing for action for the past ten years but response has been slow.

Domestically, carbide recycling remains underutilized. India generates substantial scrap volumes across its manufacturing base, yet formal reprocessing infrastructure is underdeveloped. Building that capacity now — while premiums are high — creates a locally insulated supply buffer. Longer term, Indian manufacturers should engage with Make in India and the Production Linked Incentive scheme to develop upstream APT processing capability. Even modest domestic APT capacity would reduce dependence on imported intermediates and strengthen India's position in the global tungsten value chain.

The current tungsten crunch is not a cycle — it is a reconfiguration of the global supply landscape. The manufacturers that emerge strongest will be those who recognize this now, before the next price surge makes the choices for them.

NIKHIL NAYAK
Managing Director
NN Combined Engineering Agencies Pvt Ltd

REDEFINING THE GRINDING LANDSCAPE

Driven by the strict mandates of zero-tolerance manufacturing, the acoustic demands of electric drivetrains, and an acute global shortage of skilled labor, the grinding sector is rewriting the economics of the production ecosystem.

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Machine Learning (ML) algorithms operate in real-time, analyzing micro-sensory data to adjust manufacturing tolerances at a nanometer scale. This is the new reality of modern grinding. Grinding has evolved into the definitive frontier of smart manufacturing. We engaged with the industry's leading engineering minds to uncover how these advancements are transforming today's shop floors. To understand how sub-micron precision is achieved, manufacturers must look beneath the digital interfaces and focus directly on fundamental metallurgy.

Metallurgical Foundation Meets the Digital Brain

Nimesh Kumar Singh, Technical Director, SANBERG Global Machines Pvt Ltd, highlights that seasoned castings are an irreplaceable manufacturing asset. "A freshly poured casting carries residual internal stresses from solidification that will slowly redistribute over time, causing micro-distortions in critical datum surfaces long after the machine is commissioned," he explains. "Natural aging, where castings are stored outdoors for extended periods, allows these stresses to dissipate gradually, achieving a level of microstructural equilibrium that ensures sub-micron precision over decades."

"Engine valve lapping is a precision finishing process used to achieve an extremely accurate contact surface between the engine valve face and the valve seat. Compared to conventional manual grinding, a dedicated valve lapping machine offers much higher consistency, surface accuracy, and sealing quality."

Sachin Doshi
Managing Director
Abhijat Equipments Pvt Ltd

This graphite flake matrix found in properly aged gray cast iron functions as a natural vibration absorber, completely dampening the micro-chatter that degrades component surface finishes. However, SANBERG does not simply rely on historical casting techniques; the company pairs this structural maturity with advanced artificial intelligence. In its Hyperion and Vulcan machine lines, SANBERG integrates Machine Learning models designed to optimize wheel dressing cycles.

While traditional fixed-cycle dressing operates on conservative, arbitrary time intervals, wasting expensive abrasive grit and machine uptime, the ML models analyze live production data. By identifying subtle correlations between sensor patterns and wheel wear, the system predicts tool degradation well before errors manifest. On shop floors utilizing these automated systems, unnecessary dressing cycles have been reduced by up to 40 percent, directly cutting abrasive costs and establishing a highly predictable surface roughness.

Grinding for Extreme Silence in EVs

The rise of the Electric Vehicle (EV) has fundamentally transformed automotive tolerance expectations. In a traditional internal combustion engine (ICE) vehicle, the structural noise and acoustic profile of the engine block easily mask minor transmission vibrations. EVs, however, are inherently quiet. Consequently, drivetrain components, reduction gears, and motor shafts must be manufactured with a focus on high efficiency and extreme silence, as any microscopic profile error will result in an audible, high-pitched gear whine.

According to Sandeep Taneja, Director, JTEKT Micromatic Machinery India Pvt Ltd, grinding machinery has evolved far beyond standard mechanical boundaries to secure these sub-micron requirements. JTEKT's platforms feature real-time thermal compensation and advanced data integration, deploying embedded mini-computers running specialized application modules (AAA modules). These systems supply live telemetry directly to maintenance teams, enabling condition-based predictive maintenance that drives down the Total Cost of Ownership (TCO) while maintaining quality during high-volume production runs.

"The pinch peel grinding process, enabled by a high powered spindle and rigid work support, allows the blank to be finished in a single pass with high stock removal. This approach dramatically reduces grinding time while maintaining strict dimensional accuracy and superior surface finish quality."

Santosh Plakkat
Product Manager
ANCA CNC Machines

This industrial challenge is further explored by Kapil Dhand, Managing Director, Micromatic Grinding Technologies Pvt Ltd. To support advanced EV driveline materials, MGT has re-engineered its CNC cylindrical grinding platforms, optimizing overall machine stiffness and upgrading servo control systems to deliver sub-micron consistency.

The company has already deployed specialized non-round grinding platforms for cam lobes, crankshafts, and Capto profiles to leading tier-1 automotive suppliers, including Kalyani Techno-

To support advanced EV driveline materials, MGT has re-engineered its CNC cylindrical grinding platforms, optimizing overall machine stiffness and upgrading servo control systems to deliver sub-micron consistency.

“We have enhanced our CNC-200 series with advanced CNC controllers, precision ball screw drives, auto dressing systems, auto compensation features, and Constant Surface Speed (CSS) technology to meet the demands of zero-tolerance manufacturing.”

Bhupinder Singh
Managing Director
Bhagwansons Centerless Grinders

Bhagwansons couples grinding platforms with high-speed vibratory bowl feeders and automatic bar feeding attachments. This facilitates continuous component feeding and reliable production, allowing manufacturing facilities to operate safely around the clock.

forge and Sona Comstar, directly supporting components destined for major EV OEMs. Through ongoing technological collaborations with JTEKT Japan and specialized hydrostatic research initiatives with premier Indian Institutes of Technology (IITs), MGT is helping position India as a global powerhouse for high-end grinding technology.

Neutralizing the Silent Killer of Precision

In high-volume manufacturing environments, thermal expansion represents the primary threat to long-cycle process stability. Motorized grinding spindles operate under variable speeds, bidirectional rotations, and diverse wheel pack configurations, generating localized heat that causes micron-level spindle growth. In this context Santosh Plakkat, Product Manager, ANCA CNC Machines, outlines the development of its Motor Temperature Control (MTC) firmware, designed explicitly to eliminate this issue. ANCA’s MTC firmware utilizes an advanced algorithm that allows operators to define a strict target spindle temperature. The control system monitors and regulates the thermal state of the motorized spindle in real-time, drastically reducing initial machine warm-up times and preventing dimensional variations during high-load manufacturing sequences.

To support this nanometer-resolution control, ANCA’s MX7 and FX Ultra series rely on a bi-symmetrical gantry and a polymer concrete base to isolate external frequencies and ensure absolute structural stiffness.

Furthermore, ANCA’s CPX Linear blank preparation grinder utilizes a high-powered ‘pinch-peel’ grinding method to consolidate the production floor. By utilizing a high-powered spindle alongside rigid work supports, raw blanks can be finished in a single pass. This approach allows manufacturers to completely bypass legacy pre-machining steps like milling, delivering finished geometries with surface roughness values better than 0.2 Ra while significantly reducing processing times.

The Fluid Dynamics of Spindle Engineering

When evaluating centerless and vertical machining environments, achieving high material removal rates (MRR) without sacrificing geometric accuracy requires a careful balance of vibration damping and thermal management. Kinjal Shah, Director-Technical, Hi-Life Machine Tools Ltd, explains the mechanical advantages of incorporating hydrodynamic white metal

“By integrating robotic automation, auto-loading/unloading systems, and smart process controls with existing machines, customers can improve productivity, reduce manual intervention, and enhance precision and consistency. These upgrades are scalable, allowing manufacturers to automate specific operations first and expand gradually based on production needs.”

Kinjal Shah
Director—Technical
Hi-Life Machine Tools Ltd

bearings into wheel head spindles rather than standard anti-friction alternatives.

“Hydrodynamic white metal spindle bearings outperform standard anti-friction bearings for ultra-precision grinding because the oil-film along with white metal lining creates a high-damping and self-averaging thermally stable support system,” Shah highlights. “Instead of transmitting discrete rolling-element vibration into the grinding zone, it dampens the vibration leading to lower chatter, lower runout, superior geometric stability, and exceptional surface finishes.”

For its HLC Series of high-speed centerless grinders, Hi-Life implements a specialized ‘cartridge type’ spindle. This assembly utilizes pre-aligned, grease-packed bearings that deliver high-rigidity and stable thermal behavior at elevated speeds. Because it operates without continuous oil circulation, oil-induced thermal expansion is eliminated. Paired with robust oil seals, the cartridge design prevents contamination from coolant and abrasive dust, ensuring maintenance-free operation during continuous 24/7 production cycles.

“Our strength lies in a customer-first mindset and an unwavering commitment to delivering safe and reliable products. To safeguard the operators, machines, and grinding wheels, all machines are equipped with retraction modules that enable the machine to retract immediately during a power failure.”

Sandeep Taneja
Director
JTEKT Micromatic Machinery India Pvt Ltd

The importance of this mechanical stability is reinforced by Sachin Doshi, Managing Director, Abhijat Equipments Pvt Ltd, in reference to the company’s Arya-100 centerless grinder. By utilizing an automated hydraulic dressing system, the machine ensures a highly uniform, constant feed rate across the grinding and regulating wheels. This smooth motion eliminates the micro-jerks associated with manual dressing, preventing the development of wheel profile errors that lead to component lobing or multi-lobed out-of-roundness.

Beyond centerless operations, Abhijat Equipments has automated legacy engine finishing through its specialized multi-valve lapping machinery. In modern high-compression, turbo-charged, and BS6-compliant engines, achieving a perfect gas-tight seal between the valve face and the valve seat is vital for combustion integrity.

By utilizing fine abrasive compounds under controlled axial movements and precise oscillation patterns, Abhijat's automated lapping process eliminates the surface waviness and human errors inherent to conventional manual grinding. This automated approach ensures exact concentricity and generates a continuous, uniform sealing ring, resulting in a series of direct performance advantages.

Automation and Modernization

The shift toward Industry 4.0 has transformed material handling from a secondary consideration into a core component of process control. As Manufacturing sectors face a growing shortage of skilled operators, automated systems are essential for maintaining consistency and throughput.

Bhupinder Singh, Managing Director, Bhagwansons Centerless Grinders, discusses how their CNC-200 series addresses these demands. By integrating advanced CNC controllers, precision ball screw drives, automated dressing units, and Constant Surface Speed (CSS) technology, the machinery delivers automated, micron-level

“When Indian manufacturers shift from manual grinding to full-servo controlled grinding platforms, the benefits extend far beyond surface finish improvement. One major advantage is process repeatability, which reduces rejection rates and dependency on operator skill. Servo systems also reduce setup time through programmable recipes and automatic wheel compensation.”

Makrand Kulkarni
Vice-President—Sales
Phillips Machine Tools India Pvt Ltd

For its HLC Series of high-speed centerless grinders, Hi-Life implements a specialized ‘cartridge type’ spindle. This assembly utilizes pre-aligned, grease-packed bearings that deliver high-rigidity and stable thermal behavior at elevated speeds.

repeatability. For critical components like needle rollers and bearing races, this setup ensures high profile accuracy with minimal operator intervention.

To enable true ‘lights-out’ manufacturing, Bhagwansons couples these grinding platforms with high-speed vibratory bowl feeders and automatic bar feeding attachments. This tightly synchronized material handling automation loop facilitates continuous component feeding and reliable production, allowing manufacturing facilities to operate safely around the clock.

This focus on modernization is also a priority for Hi-Life Machine Tools. As detailed by Shah,

“MGT is actively integrating sustainable engineering practices into its grinding technologies. One key development is the implementation of coherent coolant nozzle technology, which enables highly efficient coolant delivery directly into the grinding zone, improving heat dissipation while significantly reducing coolant consumption and filtration system sizing requirements.**”**

Kapil Dhand
Managing Director
Micromatic Grinding Technologies Pvt Ltd

the company provides modular robotic automation upgrades and automated loading/unloading systems designed to modernize legacy machine shops without requiring heavy capital investment or causing extended downtime. This scalable approach allows manufacturers to automate specific operations first and expand gradually based on production needs, easing the transition into a smart manufacturing ecosystem.

The Green Grinding Imperative

Grinding has historically been an energy-intensive process that consumes high volumes of cutting fluids. Today, machine tool manufacturers are actively developing sustainable solutions to help companies meet strict Environmental, Social, and Governance (ESG) targets without compromising material removal rates.

Dhand highlights MGT’s implementation of coherent coolant nozzle technology. Traditional flooded coolant systems often disperse fluid inefficiently, requiring larger filtration systems and higher energy usage. MGT’s coherent nozzles deliver a precisely focused stream of fluid directly into the grinding zone, maximizing heat dissipation while reducing total coolant consumption and filtration sizing requirements.

Simultaneously, maintaining coolant cleanliness is critical for protecting internal machine components and ensuring surface finish quality. As Bhupinder Singh emphasizes, their integrated magnetic paper band filters and specialized coolant separators continuously extract ferrous micro-particles and grinding sludge from the fluid circuit. This clean, stable fluid circulation reduces wheel loading and minimizes thermal distortion, helping hardened steel components reliably achieve fine surface roughness values while extending the service life of wheels, bearings, and hydraulic components.

JTEKT Micromatic Machinery India has also focused on eco-efficiency by designing lubrication circuits with zero oil wastage, returning all spindle lubricants back to the primary reservoir. Its platforms utilize high-efficiency servo motors and Variable Frequency Drives (VFDs) on hydraulic pumps to lower total energy consumption. Additionally, smart power-saving circuits automatically turn off screens and internal motors during idleness, allowing operators to visualize and audit real-time energy metrics directly on the machine interface.

“Many times, standard designs don’t work, so we make small but important changes in machine structure, work holding, or process sequence. We engage with the customers during trials and make improvements based on their feedback. We focus on making a machine that performs reliably on the shop floor.**”**

Shreepalsinh Jadeja
CEO
Kiya Products Pvt Ltd

Tailoring Global Technology for Local Shop Floors

Deploying high-end international technology onto local shop floors requires an understanding of unique environmental challenges, including volatile power quality and an ongoing technical skill gap. To this end, Makrand Kulkarni, Vice-President—Sales, Phillips Machine Tools India Pvt Ltd, explains how the company customizes global grinding brands like KENT, Palmary, and Haas Multigrind for the Indian market. “We tailor these technologies for Indian customers by focusing on cost-efficiency, energy optimization, and reliable performance under local shop-floor conditions.”

When helping manufacturers transition away from manual workflows, Phillips emphasizes the hidden productivity gains that come with full-servo controller platforms, such as programmable component recipes and automatic wheel compensation. These integrated tools maximize machine uptime, extend grinding wheel longevity, and significantly reduce setup times, providing a faster return on investment (ROI).

To address the industrial skill gap, the company utilizes advanced machine simulators and structured application training. Operators are trained beyond basic button-pushing; they learn the fundamentals of process optimization including wheel selection, coolant viscosity monitoring, and G-code refinement, transforming machine operators into capable process specialists.

To mitigate local infrastructure challenges like unpredictable power fluctuations, JTEKT Micromatic Machinery India fits its machinery with specialized retraction modules. In the event of a sudden power outage, the module automatically backs the grinding wheel away from the workpiece instantly, protecting the operator, the machine spindle, and the component from catastrophic structural damage. Furthermore, its localized engineering support team is fully capable of executing complete CNC retrofits on machines that have been running on the shop floor for over two decades, maximizing operational lifecycle.

Pragmatic CNC Adoption for the MSME Sector

While multi-axis CNC machines and automated robotic cells represent the pinnacle of high-end manufacturing, a substantial portion of the industrial landscape—particularly within Indian Micro, Small, and Medium Enterprises (MSMEs)—remains highly sensitive to initial capital costs. For these shops, the market has long been split between cost-prohibitive European imports and cheap, unorganized mechanical machines.

To bridge this gap, companies like Abhijat Equipments have introduced optimized, multi-slide bar-type CNC platforms, such as the HYB-32. By pricing these systems strategically between traditional cam-operated automatics and high-end CNC lathes, they provide a practical entry point for local workshops looking to upgrade their precision capabilities without over-extending financially.

“Railway axle journals and windmill main shaft bearings demand simultaneous compliance with multiple diameter tolerances in a single setup as any repositioning introduces datum-shift error. Our CNC angular head grinders execute multi-diameter plunge cycles governed by Heidenhain linear encoders and length gauges that deliver fast, reliable, and accurate position measurement.**”**

Nimesh Kumar Singh
Technical Director
SANBERG Global Machines Pvt Ltd

This pragmatic engineering philosophy is deeply shared by Shreepalsinh Jadeja, CEO, Kiya Products Pvt Ltd. “At Kiya, we believe precision is not a feature—it is the foundation of everything we build,” states Jadeja. “In the Indian SME segment, the shift from hydraulic to CNC is happening steadily. Many customers are not looking for full automation—they want consistency, less dependency on operator skill, and reduced rejection.”

Kiya Products focuses heavily on simplifying the user experience, utilizing straightforward CNC architectures, standard grinding cycles, and direct technical support during initial shop-floor trials. This has driven a sharp rise in the adoption of Special Purpose Grinders (SPMs). By assessing a component’s geometry and volume requirements from the outset, Kiya designs tailored, single-setup machines that eliminate unnecessary secondary steps without being over-engineered, helping small businesses scale their output effectively.

Driving the Global Manufacturing Footprint

The insights shared by these industry leaders demonstrate that by combining structural rigidity, smart CNC controllers, real-time thermal management, and AI-driven process optimization, modern grinding has become a cornerstone of high-end manufacturing. As the industrial ecosystem continues to mature across international markets, the ability to deliver sub-micron precision under tough, real-world shop-floor conditions ensures that modern grinding technologies will remain a driving force behind global engineering innovation.

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ADVANCED FINISHING SOLUTIONS FOR MODERN AUTOMOTIVE STEERING SYSTEMS

The growing adoption of Electric Power Steering and Steer-by-Wire systems is driving the need for highly precise finishing technologies in automotive steering components. Through its patented NANOSCREW process, Grind Master is advancing microfinishing capabilities to deliver smoother surfaces, lower friction, and improved steering performance.

Source: Grind Master Machines Pvt Ltd

Sameer Kelkar, CEO & R&D Head, Grind Master Machines Pvt Ltd, presenting a paper at the European Automotive Steering and Braking Systems Summit in Stuttgart, Germany.

SAMEER KELKAR
CEO & R&D Head
Grind Master Machines Pvt Ltd

AKSHAY BHAT
Lead Engineer, R&D
Grind Master Machines Pvt Ltd

Driven by electrification, autonomous functions, and rapidly evolving customer expectations, the Automotive industry is undergoing a transformative shift. Among the many subsystems affected by this evolution, steering systems have emerged as a critical contributor to overall vehicle refinement. Noise, vibration, and harshness (NVH) characteristics — once secondary considerations — are now decisive factors in defining perceived quality. This has placed unprecedented emphasis on advanced finishing technologies for steering system components.

Modern Electric Power Steering (EPS) systems demand extremely smooth and precise motion. Unlike hydraulic systems, where fluid damping masked many imperfections, EPS directly transmits mechanical characteristics to the cabin. Even microscopic variations in surface finish, waviness, or geometry can translate into audible noise or tactile feedback at the steering wheel. Consequently, the role of finishing has evolved from a supporting process to a core enabler of premium vehicle performance. It has therefore become 'mission critical'.

Surface finishing plays a central role in determining the durability, efficiency, and NVH performance of components such as steering racks, ballscrews, bearings, and drive shafts. A finely controlled surface ensures proper lubrication retention, minimizes friction, and promotes consistent motion. In steering systems, this translates directly into smoother steering feel, reduced noise, and improved long-term reliability.

Finishing Requirements in Traditional Steering Racks

Traditional hydraulic steering racks typically require finishing in two key regions: the shaft portion and the area behind the rack teeth. Achieving optimal surface quality in these regions involves a combination of cylindrical finishing, superfinishing, and linear finishing techniques.

Source: Grind Master Machines Pvt Ltd

Figure 1: Steering system components

Cylindrical finishing (Figure 2), for instance, involves rotating the component between centers while applying a controlled pressure of a rotating finishing wheel — typically a convolute wheel. Cylindrical finishing is specifically required on the shaft portion and generates a circumferential lay pattern aligned with rotary contact conditions. This finishing method can remove the scale from hardening and generate a decent finish of around Ra 0.2 to 0.3 microns.

Linear finishing (Figure 3) is applied behind rack teeth to generate a linear lay pattern aligned with the rack's sliding motion. This directional texture reduces friction during axial movement, ensures smoother contact with guides and seals, improves lubrication behavior, and minimizes wear, ultimately enhancing durability, efficiency, and consistent performance of the steering rack system.

Superfinishing (Figure 4) is a method that uses the combination of rotation of the steering rack and oscillation of a superfinishing abrasive (typically a microfinishing film) for generating a cross-hatch patterned plateau finish. This finish is considered superior to the finish generated by cylindrical finishing — both in terms of Ra value (as fine as Ra 0.02 microns) and much better control on Rz and Tp. Superfinishing can be applied on both the shaft portion and the area behind the rack teeth, making this the preferred method for many steering system manufacturers.

EPS and SBW Systems Drive Higher Precision Requirements

EPS (Electronic Power Steering) and SBW (Steer-By-Wire) systems are considered the future of steering systems. The international Automotive industry, including Europe and China, is fast adopting EPS, with aggressive plans towards SBW. Both the above systems involve ballscrew-based steering mechanisms, which impose significantly tighter requirements (Figure 5 and 6). These systems rely on precise rolling contact between balls and threads, making them highly sensitive to surface irregularities. Key parameters such as lead accuracy, backlash, waviness, and roundness must be tightly controlled. Among these, surface finish plays a particularly critical role as it directly influenc-

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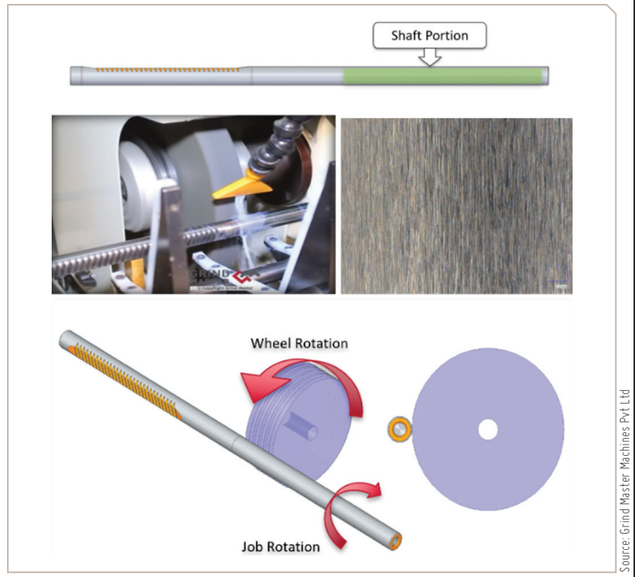


Source: Grind Master Machines Pvt Ltd

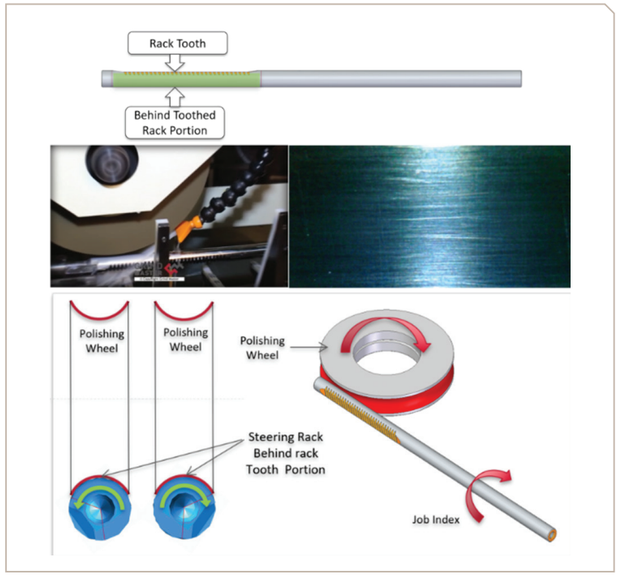
Figure 2: Cylindrical finishing process for steering racks

es friction behavior and noise generation.

Challenges in Ballscrew Manufacturing

Ballscrews are manufactured using several primary methods, including thread rolling, thread whirling, and thread grinding (Figure 7). Each method offers distinct advantages but also presents unique challenges. Thread rolling is fast and economical, but often produces coarse surfaces and geometric distortions. Thread whirling improves flexibility and finish but tends to introduce periodic waviness. Thread grinding delivers high precision, yet it can result in thermal damage such as grinding burns and micro-cracks, while also being cost-intensive (Figure 8).

To overcome these challenges, secondary finishing processes are essential. Traditional approaches include finishing with abrasive wheels or stone-based superfinishing.

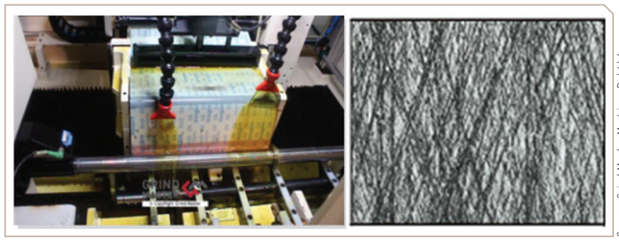


Source: Grind Master Machines Pvt Ltd

Figure 3: Linear finishing process for steering racks

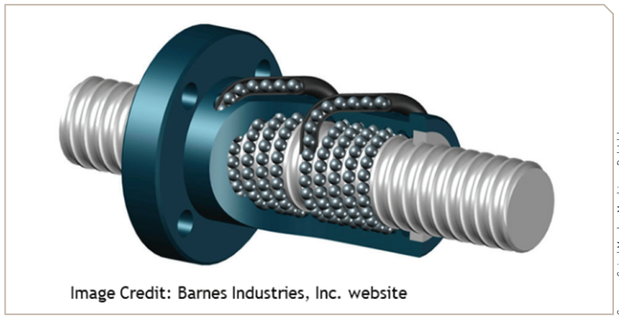
Abrasive wheel-based finishing has several limitations, including the inability to achieve finishes below Ra 0.2 microns, inconsistency in finishing, and limited capability to improve geometry. Abrasive wheel-based finishing machines also tend to use many more processing steps than Superfinishing methods, thus requiring more space, power, and cycle time.

Superfinishing with stones can achieve fine surface finishes but often suffers from process variability. Loading effects on abrasive surfaces can reduce cutting efficiency, leading to inconsistent results and increased maintenance requirements. Superfinishing with stones is also unable to remove the scale that forms on rolled ballscrews after heat treatment. A significant breakthrough in this domain is the development of film-based microfinishing technologies. Grind Master's patented NANOSCREW process represents a major leap forward, combining specialized tooling with customized abrasive films to ensure complete and uniform contact with complex ballscrew geometries. Unlike conventional methods, this approach guarantees that fresh abrasive material interacts with the component in every cycle, resulting in highly consistent outcomes.



Source: Grind Master Machines Pvt Ltd

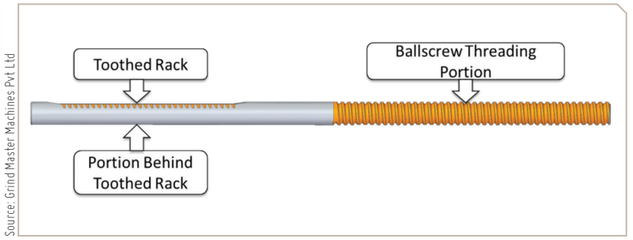
Figure 4: Superfinishing for steering racks



Source: Grind Master Machines Pvt Ltd

Figure 5: Image of a ballscrew

Grind Master's patented NANOSCREW process represents a major leap forward, combining specialized tooling with customized abrasive films to ensure complete and uniform contact with complex ballscrew geometries.

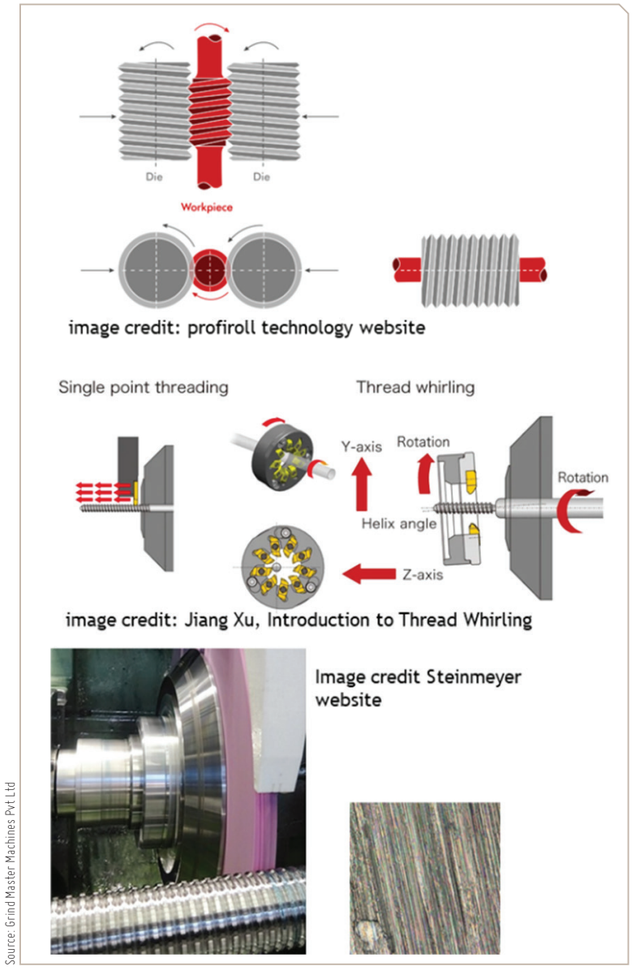


Source: Grind Master Machines Pvt Ltd

Figure 6: Finish requirements in EPS steering racks

Advancements in Film-Based Microfinishing Technologies

Microfinishing (Figure 9) using film-backed abrasives was introduced as an alternative to traditional stones in the 1970s. Over the decades, advancements in machine design and tooling have extended these benefits to a wide range of automotive components, including crankshafts, camshafts, and transmission parts.



Source: Grind Master Machines Pvt Ltd

Figure 7: Schematics of the three processes — thread rolling, thread whirling, and thread grinding

Grind Master has developed and patented the 'NANOSCREW' method to apply microfinishing films to ballscrews. Advancements in the process in the past few years have allowed the process to conform to helical geometries, achieving surface finishes below Ra 0.05 microns. This represents a substantial improvement over conventional processes and is particularly valuable for high-performance EPS systems.

The microfinishing method uses force-balancing finish units that wrap around the part, eliminating bending and improving contact uniformity. The result is reduced cycle time, enhanced geometry control, and improved surface consistency. By combining hard and soft contact elements, these systems achieve both geometry improvement and surface smoothing in a single operation (Figure 10).

Improving Surface Quality, Geometry, and NVH Performance

The impact of advanced microfinishing on component performance is profound. Surface roughness reductions from Ra 0.4 microns to Ra 0.04 microns are routinely achieved, while waviness improvements of over 90 percent have been documented. These improvements lead to smoother motion, reduced friction, and significantly lower noise levels. In practical terms, this translates into quieter cabins and more

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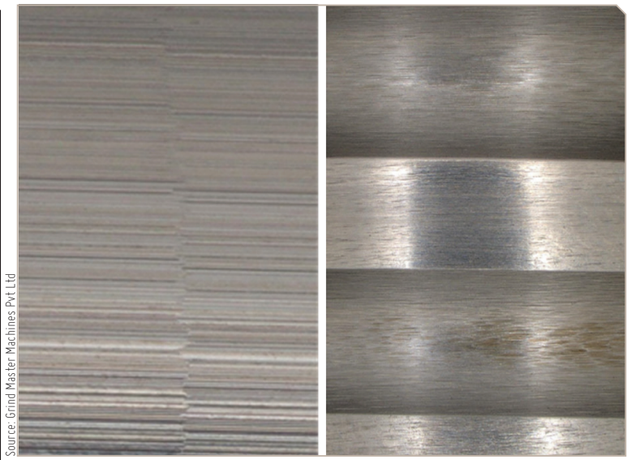
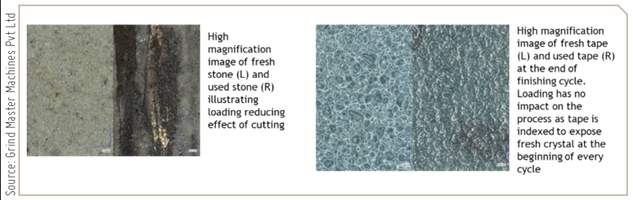


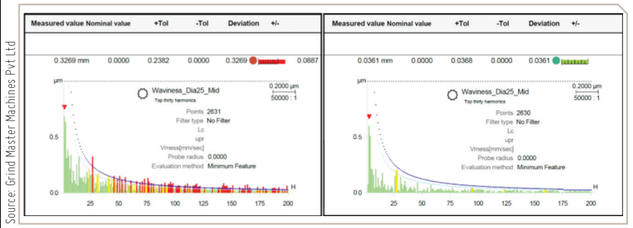
Source: Grind Master Machines Pvt Ltd

Figure 8: Surface characteristics from whirling (L). Waviness induced due to process limitations and grinding (R) processes — burn marks, clogging, and heat-induced damaged layer.



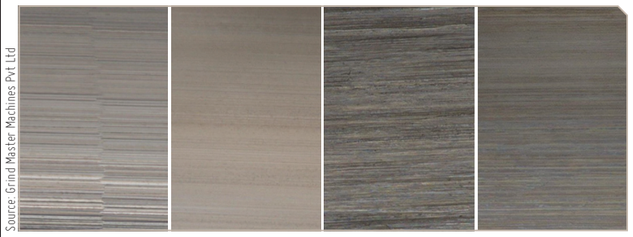
Source: Grind Master Machines Pvt Ltd

Figure 9: Microfinishing films offer far better consistency due to indexing — fresh abrasive is in contact with the part



Source: Grind Master Machines Pvt Ltd

Figure 10: Waviness measured, out of tolerance before microfinishing (L) and within tolerance after microfinishing (R)



Source: Grind Master Machines Pvt Ltd

Figure 11: Before and after microfinishing surface comparison (magnified views) After whirling (a), microfinishing after whirling (b), after grinding (c), microfinishing after grinding (d)

Film-based processes deliver a controlled helical texture that aligns with the functional requirements of ballscrew operation. The result is not only better surface quality but also improved repeatability and process reliability.

refined steering feel in modern vehicles (Figure 11).

Flexibility is another important advantage of modern microfinishing systems. A single machine can handle multiple part variants, accommodating differences in diameter, pitch, and length with minimal setup time. This is particularly valuable in high-mix production environments, where quick changeovers are essential for maintaining productivity.

Comparative Advantages of Film-Based Microfinishing

Comparative analyses highlight the superiority of microfinishing with film over traditional methods. While wheel-based polishing may introduce scratches and inconsistent textures, and stone superfinishing may suffer from tool wear and variability, film-based processes deliver a controlled helical texture that aligns with the functional requirements of ballscrew operation. The result is not only better surface quality but also improved repeatability and process reliability.

While steering racks and ballscrews are the primary focus, similar finishing technologies are applied to other steering components such as drive shafts, sector shafts, and control valve shafts. Dedicated process development facilities, equipped with advanced metrology tools, enable the customization of finishing solutions to meet specific application requirements.

Ultimately, the advancement of microfinishing technologies has redefined the standards for steering system manufacturing. By enabling ultra-smooth surfaces, precise geometries, and highly consistent results, these processes play a crucial role in achieving the NVH performance demanded by modern vehicles. As the industry continues to move toward electrification and autonomy, the importance of such technologies will only continue to grow.

	Ballscrew Polishing Finishing Wheel Method	Ballscrew Superfinishing Stone Method	Ballscrew Microfinishing NANOSCREW Method
Methodology Used By	American Machine Builders	German Machine Builder	Grind Master
Type of Machine	Robotic/CNC/PLC Machine	Interpolated CNC Machine	CNC/PLC Machine
Input Limitations	Rolled Ballscrew with Scale is ok	Scale cannot be removed. Must be Rolled and Grinded Or Rolled and Scale Removed	Rolled ballscrew with scale is ok
Limitations on Input Conditions	Grinded/Whirled/ Rolled ok Rolled with Scale ok	Grinded/Whirled OK Rolled must be processed for scale removal	Grinded/Whirled/Rolled ok Rolled with Scale ok
Output finish capability for Basic EPS	Ra 0.25 microns with Level 2 Finish (includes Scale Removal)	Ra 0.25 microns with (Scale Removal/ Grinding is an additional operation)	Ra 0.15 microns with Level 1 (includes Scale Removal)
Output Finish capability for Advanced EPS or Machine tool Ballscrew	Below Ra 0.2 microns is not possible	Below Ra 0.1 microns is possible with Level 2 finish	Below Ra 0.1 microns is possible with Level 2 finish
Geometry Improvements	Possible Deterioration in Form/Waviness due to cutting action of Rubber	Possible Improvements in Waviness and Form	Consistent Improvement in Waviness and Form
Process Consistency	Low – Loading of Finishing Wheels, Wear Compensation challenges	Low – Loading of Superfinishing stones, Wear Compensation, Stone chip off challenges	High – Fresh Abrasive in contact with fresh part Contact tooling has known durability and easy to replace
Texture of Finish	Random Texture radial-dominated pattern Small scratches	Cross hatched pattern	Helical pattern

Making for the World

Grind Master has been a pioneer in Superfinishing and Microfinishing in India, with a profound impact on the Automotive industry in achieving fine finishing specifications. With over 50 percent exports in advanced technology products, it is today recognized globally as an expert in the field, with a strong capability in process research and breakthrough developments. Working with the most advanced steering system manufacturers globally has enabled Grind Master to stay at the forefront of developments. The company is proud to bring its truly 'Made in India – Made for the World' microfinishing and superfinishing solutions to the Indian steering industry.

Grind Master has been a pioneer in Superfinishing and Microfinishing in India, with a profound impact on the Automotive industry in achieving fine finishing specifications. With over 50 percent exports in advanced technology products, it is today recognized globally as an expert in the field.

DRIVING CAPACITY ENHANCEMENT

Through cellular manufacturing and shopfloor redesign, Kiswok transformed its machining operations within the same 3,500 sq mt facility. An earlier setup of 41 CNC machines operated by 196 personnel, producing 56,000 components per month, was restructured into an optimized cellular layout. This enabled the company to scale up to 52 CNC machines, reduce manpower to 166, and increase output to 70,000 components per month.

Source: Kiswok Industries

RAJNISH CHANDRA
Plant Head
Kiswok Industries

In an increasingly competitive manufacturing landscape, productivity improvement is no longer driven solely by adding machines or manpower. Sustainable growth today depends on intelligent shopfloor design, lean principles, and disciplined execution. This case study from Kiswok Industries, one of India's leading foundries for machined ferrous castings, illustrates how a focused cellular manufacturing transformation enabled a 25 percent productivity improvement without plant expansion, while simultaneously improving cost, quality, and delivery performance.

Business Context and Objective

Kiswok Industries serves major OEMs in the heavy commercial vehicle segment. Rising customer demand and new RFQs (Request for Quotation) exposed limitations in the existing product machining line at Unit-1. The layout was operation-wise, spread across multiple zones, with long roller conveyors and significant work-in-process inventory.

The project objective was clearly defined: increase product capacity from 56,000 to 70,000 components per month, optimize manpower, reduce WIP, and accommodate additional CNC machines within the same footprint without impacting customer deliveries.

Source: Kiswok Industries

Challenges in the Existing Layout

The baseline assessment revealed multiple operational constraints. Material movement followed a zig-zag path across operations OP-10, OP-20, OP-30, and OP-40, resulting in excessive travel distance, long waiting times, and high WIP. Significant manpower was deployed for material feeding and handling. Parts frequently contacted each other on conveyors, causing dents, noise, and quality concerns. Common production lines also led to part mix-ups, requiring manual sorting during packaging.

A detailed Value Stream Mapping (VSM) study showed a Value-Added Ratio of only 1.75, indicating substantial non-value-added activities and improvement potential.

Lean Strategy and Team Engagement

A cross-functional team comprising Production, Maintenance, Quality, Civil, Safety, Planning, and Purchase was formed under strong plant leadership. The team adopted lean principles with a sharp focus on flow, waste elimination, ergonomics, and safety.

Key guiding principles included uninterrupted customer supply, phase-wise execution, no additional manual material handling manpower, and strict adherence to change-management and safety systems. Operator involvement and GEMBA-based reviews were integral to building ownership and acceptance.

Implementation Approach

The transformation was executed over ten months through a structured roadmap. Baseline VSM and bottleneck analysis were followed by cellular layout design, line balancing, and conveyor rationalization. Execution was planned during non-production hours and weekends to avoid delivery disruptions.

Hydraulic fixtures were introduced to reduce operator fatigue, and utility lines were redesigned to support the new layout.

Lean electrical initiatives—including power-saving modes, elimination of stabilizers, and installation of phase-failure relays—were implemented in parallel, reinforcing sustainability objectives.

Key Improvements Introduced

The new cellular layout aligned machines sequentially by operation, enabling single-piece flow from OP-10 to OP-40. Roller conveyor length was reduced by more than 60 percent, and unnecessary material movements were eliminated. Machines were positioned ergonomically, allowing multi-machine operation by a single operator.

Jogging tracks improved accessibility around cells, while coolant pipelines routed behind each cell minimized handling. WIP between operations was reduced from ten pieces to one, significantly improving flow and visibility.

The impact of the transformation was both immediate and measurable. Kiswok Industries achieved 25% higher capacity, a 50% productivity gain per person, along with lower work-in-progress levels, improved process flow, and more efficient space utilization.

Results and Performance Gains

The impact of the transformation was both immediate and measurable. Monthly production increased to 70,000 components, achieving the targeted 25 percent capacity enhancement. Total manpower reduced from 196 to 166, a 15 percent optimization, while the number of machines increased from 41 to 52 within the same facility.

The Value-Added Ratio improved from 1.75 to 4.0, reflecting a substantial reduction in waste. Manpower cost per component dropped from INR 54.44 to INR 41.50, and delivery performance improved consistently due to reduced congestion and better line balance.

Financial Impact and Sustainability

The layout optimization freed approximately 392 sq mt of floor space, enabling new machine installation without building expansion. Energy savings of nearly 2.3 lakh kWh per annum were achieved, translating into a meaningful reduction in carbon footprint. The overall project delivered a return on investment in under twelve months, demonstrating strong financial viability.

Change Management and Cultural Shift

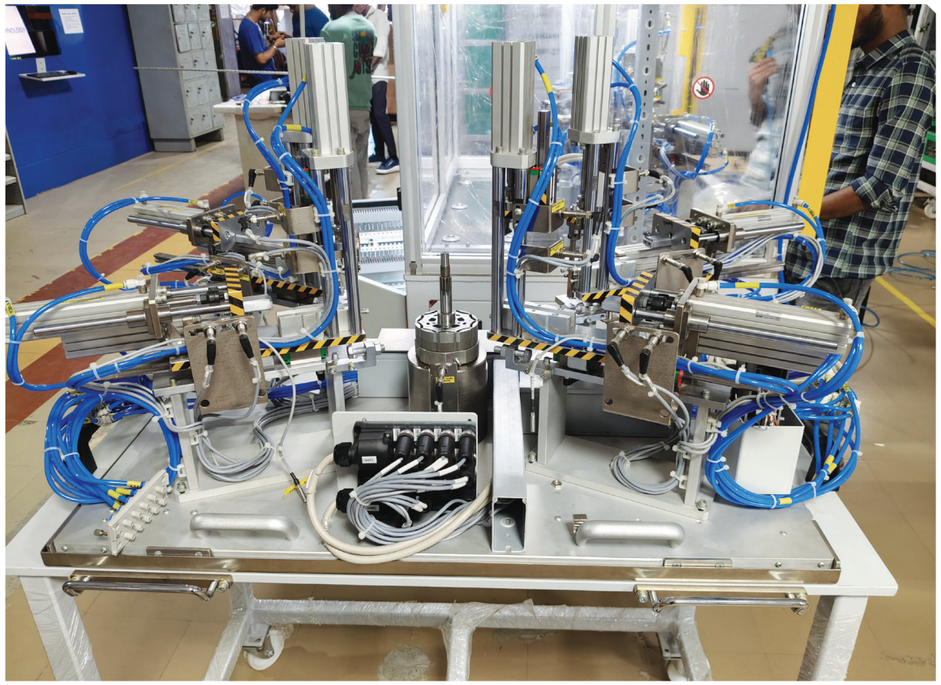
Resistance to change from operators and supervisors was addressed through transparent communication, training sessions, and involvement during layout finalization. Visible leadership support and early wins helped embed a culture of continuous improvement and cross-functional collaboration.

Gains by Bettering Every Day

This transformation demonstrates that significant productivity gains are achievable through layout optimization and lean thinking, even within existing constraints. By focusing on flow, engaging people, and executing systematically, Kiswok Industries strengthened operational excellence while building a scalable model for future deployment—truly reinforcing the philosophy of being "Better Every Day, in Every Way."

INTELLIGENT ROTOR MAGNET INSERTION AUTOMATION

One of the most critical and skill-dependent processes in EV motor assembly is rotor magnet insertion, where precision directly impacts motor performance and reliability. This case study from Mekhos Technology Services demonstrates how intelligent, selective automation transformed a manual, error-prone operation into a robust and scalable solution, delivering measurable gains in productivity and quality.



Source: Mekhos Technology Services Pvt Ltd

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Mekhos Technology Services Pvt Ltd is a bootstrapped Indian automation company founded in 2015, specializing in assembly and testing solutions through turnkey, bespoke machine development. Mekhos focuses on delivering reliable, value-driven automation for high-mix, high-variant manufacturing environments, particularly in the Automotive, Electronics, and Medical sectors. The organization's engineering philosophy emphasizes problem definition, root-cause analysis, and pragmatic design choices that balance robustness, flexibility, and cost—an approach well aligned with India's price-sensitive manufacturing landscape. The rotor magnet insertion solution discussed in this paper is a representative example of Mekhos' capability to translate productivity challenges into scalable automation outcomes.

India's electric two-wheeler market is expanding at an unprecedented pace, compelling manufacturers to scale up production while improving quality, consistency, and cost efficiency. At the National Productivity Summit 2025 held in Ahmedabad, the company presented a case study focused on one such critical manufacturing challenge: rotor magnet insertion in EV motor assembly. This article adapts that conference presentation into an industry narrative, outlining the problem definition, solution development, and implementation journey of a semi-automatic magnet insertion system.

Source: Mekhos Technology Services Pvt Ltd

Issues in Rotor Magnet Insertion

Rotor magnet insertion directly influences motor performance, efficiency, and reliability. In the pre-implementation stage, this operation was entirely manual. Operators were required to identify the correct magnet variant, verify polarity, and insert magnets into the rotor assembly. Depending on the design, up to forty magnets were inserted per rotor. With multiple rotor variants in production, the process was highly skill-dependent and vulnerable to human error.

The manual process resulted in lower output per manpower. Work-in-progress levels were high and operator upskilling time was significant. More critically, the absence of structured poka-yoke mechanisms increased the risk of incorrect polarity insertion and magnet damage, leading to rework and potential scrap. These issues became increasingly visible as annual production volumes continued to rise.

The project was initiated with clear and measurable objectives. These included reducing cycle time, improving production throughput, lowering dependency on operator skill, reducing training time, and minimizing rejection through robust poka-yoke implementation. An equally important requirement was the ability to handle multiple rotor variants within a single machine, while remaining viable for a price-sensitive market.

Selective Automation as the Solution

To ensure that the solution addressed root causes rather than symptoms, a detailed Why-Why analysis was conducted. The analysis highlighted excessive manual verification, lack of standardized changeover methods, and absence of error-proofing as the primary contributors to inefficiency. This reinforced the need for an approach that combined automation with process discipline and lean principles.

During the solution generation phase, robotic automation was evaluated, particularly for its flexibility in handling future rotor design changes. However, a detailed pro-con analysis revealed that robotic solutions resulted in higher capital cost, increased cycle time, and reduced robustness. Simultaneous insertion of multiple magnets was not achievable in a cost-effective manner. Based

This project demonstrates that intelligent mechanical automation, supported by poka-yoke and structured problem-solving, can deliver substantial productivity gains without excessive complexity.

on life cycle assessment and manufacturability considerations, a simpler mechanical solution was selected.

The final concept was a semi-automatic rotor magnet insertion machine with manual loading and unloading and fully automatic insertion. The operator loads the rotor and a group of magnets into dedicated magazines. Magnet insertion is carried out using pneumatic cylinders, while a servo-driven rotary system precisely positions the rotor for each insertion location. Electrical and pneumatic quick connections enable rapid variant changeover using SMED-based fixtures.

Quality assurance was embedded into the machine through multiple layers of poka-yoke at both prevention and detection levels. Polarity sensors ensure correct magnet orientation prior to insertion. Component presence sensors confirm proper loading. Proximity sensors monitor home and work positions of pneumatic cylinders. Orientation detection sensors ensure fixtures are correctly referenced, while docking locator pins eliminate fixture misalignment during changeover.

Following implementation and stabilization, the results were significant. Cycle time was reduced by 48%, production per shift at the station increased by 90%, and overall cell output improved by 30%.

Substantial Productivity Gains

Following implementation and stabilization, the results were significant. Cycle time was reduced by 48 percent compared to the manual process. Production per shift at the station increased by 90 percent, while overall cell output improved by 30 percent. The risk of magnet damage was reduced due to consistent insertion force and controlled orientation. Operator upskilling time also reduced, as the machine logic guided correct operation.

One of the key learnings from this project was the importance of selective automation. Fully automating complex, non-repetitive activities such as rotor component loading would have increased system complexity without proportional benefit. By automating only repeatable, value-adding steps and designing for future variant changes within defined limits, the solution achieved robustness, flexibility, and viability.

From a productivity standpoint, the project aligns strongly with the broader themes discussed at the National Productivity Summit 2025. The focus was not merely on increasing speed, but on improving effectiveness across manpower, quality, and flexibility. By embedding quality at the source and reducing manual dependency, the solution improved output per operator while lowering risk and variability.

This project demonstrates that intelligent mechanical automation, supported by poka-yoke and structured problem-solving, can deliver substantial productivity gains without excessive complexity. As India's EV manufacturing ecosystem continues to mature, such pragmatic and scalable automation approaches will play a vital role in driving sustainable industrial growth.

TOWARD INTELLIGENT AND SUSTAINABLE MANUFACTURING

This year, TMTS made a comeback to Taichung—the heart of the machine tool industry cluster—at the newly opened Taichung International Convention Center (TICEC), marking a significant milestone for Taiwan's manufacturing sector on the global stage. As the country reinforced its leadership in advanced manufacturing, Modern Manufacturing India chronicled defining moments where technology, collaboration, and global perspectives converged.

Source: TMBA

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Organized by the Taiwan Machine Tool & Accessory Builders' Association (TMBA), the ninth edition of TMTS, held from March 25–28, 2026, at TICEC, reached new heights, featuring over 400 exhibitors and more than 1,800 booths and hosting over 70,000 professional visitors from over 80 countries, across 28,483 sq mt. This impressive scale not only demonstrated the strength of Taiwan's comprehensive and efficient supply chain but also reflected the high degree of trust the international market places in 'Made in Taiwan'.

TMTS 2026 featured a comprehensive range of manufacturing technologies and solutions across the machine tool ecosystem, including metal cutting and forming machines, smart manufacturing systems, industrial robots, CAD/CAM software, cutting tools, measuring systems, quality assurance solutions, and associated equipment and technologies.

Maximizing the 'Front Shop, Back Factory' Advantage

This year's exhibition marks a historic milestone as it returned to the 'Home of Machine Tools'—Taichung—and served as the first major international trade show held at the newly inaugurated TICEC.

"Taichung, as a global hub for machine tools, offers a complete supply chain ecosystem. Bringing the exhibition back to this city allows international buyers to gain a deep understanding of Taiwan's manufacturing strength in a short amount of time, further facilitating business opportunities," said Patrick P Chen, Chairman, TMBA, at the Opening Ceremony of the exhibition.

He emphasized that hosting TMTS 2026 in Taichung allows international buyers to inspect the latest technologies at the show and visit production lines within a 30-minute drive, significantly boosting order conversion rates.

Despite the severe challenges posed by rapid shifts in the global geopolitical and economic climate, he urged Taiwanese manufacturers to embrace 'unity, transformation, and a new start'.

The opening ceremony was an august gathering of high-level officials and industry leaders, including Shen Jong-chin, Senior Advisor to the President; Johnny Chiang, Vice President of the Legislative Yuan; Ho Chin-tsang, Deputy Minister of Economic Affairs; Cheng Chao-hsin, Vice Mayor of Taichung City; Raymond Greene, Director, American Institute in Taiwan (AIT); Claudia Fontana Tobiassen, Director, Trade Office of Swiss Industries; and Eva Ley, General Manager, German Trade Office Taipei. They were joined by representatives from international machine tool associations and over 300 experts from industry, government, and academia.

Toward a Customer-Centric Solutions Platform

Centered on the theme 'AI-Powered Sustainable Manufacturing', TMTS 2026 highlighted the global shift toward the 'Dual Transformation'—digitalization and sustainability.

Source: TMBA

A major highlight of this year's show was the Ecosystem Pavilion. Industry giants such as the Tongtai Group and Yeong Chin Machinery (YCM) led several suppliers to showcase integrated upstream and downstream 'dual transformation' solutions (digital and green). Other notable participants presenting smart and green technologies included the Super Precision Engineering & Manufacturing Alliance (SPEMA), Fair Friend Group (FFG), HIWIN Group, and Goodway Group.

The Pavilion reflected the transformation of Taiwan's Machine Tool industry, which is rapidly transitioning from traditional equipment manufacturing to a customer-centric solutions platform. By integrating AI applications, Digital Twins, and energy management systems, the industry has advanced from standalone machine intelligence to full-scale integration across manufacturing processes and supply chains.

In addition to monitoring the status of smart machinery worldwide online, the event also introduced machine energy management demonstrations. Supported by the Precision Machinery Research & Development Center (PMC) and ITRI, domestic manufacturers, including CHMER, CHEVALIER, YCM, HEIDENHAIN, Keyarrow, and MYLAS, have become global umati partners.

Driven by the mission 'Where Solutions Come Together', TMTS 2026 redefined the value of industrial exhibitions, showcasing Taiwan's competitive edge as a trusted and strategic partner in the global resilient supply chain.

Source: TMBA

Advancing AI-Led Industrial Transformation

TMTS 2026 featured six specially curated immersive experiences to demonstrate the industry's transformative strength. The latest milestones in Digital Transformation (DX) and Green Transformation (GX) were showcased. Highlights include demonstrations of AI applications and Digital Twins, as well as guided tours for AI-powered and energy-saving labeled products. Additionally, international forums focused

Driven by the mission 'Where Solutions Come Together', TMTS 2026 redefined the value of industrial exhibitions, showcasing Taiwan's competitive edge as a trusted and strategic partner in the global resilient supply chain.

on semiconductors, aerospace, and AI robotics to foster cross-domain synergies and strengthen global industry connections. Enhancing the visitor experience, a digital treasure hunt and the TMTS App provided smart navigation, paperless workflows, and real-time matchmaking. To further expand the show's international visibility, 'TMTS On-Air' delivered live broadcasts and exclusive interviews throughout the event.

Source: TMBA

Centered on the theme 'AI-Powered Sustainable Manufacturing', TMTS 2026 highlighted the global shift toward the 'Dual Transformation'—digitalization and sustainability.

Strengthening Integrated Manufacturing Ecosystems

Overall, TMTS 2026 went beyond showcasing individual technological breakthroughs to emphasize the integration of the broader industrial ecosystem. From equipment and systems to end-use applications, the exhibition highlighted cross-sector collaboration spanning Semiconductors, Aerospace, Medical Technology, and Electric Vehicles, underscoring Taiwan's strength in delivering integrated manufacturing solutions to global markets.

On the international front, TMBA continued its collaboration with the German Machine Tool Builders' Association (VDW) to showcase the 'umati' zone. The dedicated area demonstrated cross-brand data connectivity and energy management capabilities, highlighting Taiwan's alignment with global smart manufacturing standards.


Source: TMBA

Exhibitors Showcase AI-Driven Manufacturing, Automation, and Integrated Solutions

TMTS 2026 provided a strong platform for exhibitors to present next-generation manufacturing technologies focused on AI integration, intelligent automation, Digital Twin applications, precision engineering, and sustainable production.

Among the key developments announced during the exhibition, QUASER Group revealed its strategic alliance and the acquisition of UK-based Winbro. Recently, the company announced the establishment of a laser application and testing center in Taiwan. Targeting the Aerospace, Semiconductor, Hydrogen Energy, Green Energy, and UAV sectors, the center aims to provide localized and real-time technical support while reducing cross-border testing delays and improving R&D and production efficiency. At TMTS 2026, QUASER also showcased the PRO.FLEX5 5-Axis Multi-Tasking Machining Centre and introduced the QHSD3 EDM Machine.

Amid the global challenges of labor shortages and rising production costs, Sunmill CNC Machine Tools, a leading name in precision machinery, and OSCARMAX, a pioneer in electrical discharge machine (EDM) technology, officially announced a strategic alliance. Together, they are debuting the 'OscarFMS' (Flexible Manufacturing System)—a comprehensive one-stop solution designed to maximize added value by integrating the pinnacle of Taiwan's precision engineering.

The integrated system combines EDM machines, robotic automation, and scheduling software into a modular manufacturing platform, with OSCARMAX's EX Series AI-powered die sinker EDM at its core, featuring advanced AI control and 'zero-training' automation.

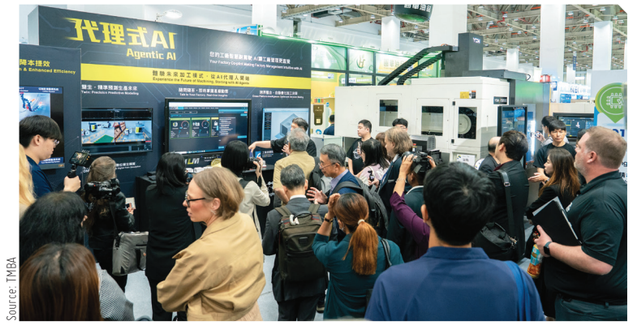
HIWIN Headquarters Group presented integrated smart manufacturing solutions under the theme 'AI Empowerment × Sustainable Smart Manufacturing', bringing together HIWIN, HIWIN MIKROSYSTEM, and MATRIX in a joint showcase. The Group featured vertically integrated capabilities, spanning precision motion systems, nanopositioning technologies, robotics, automation, advanced gear manufacturing equipment, and complete production-line solutions, demonstrating how integrated technologies support increasingly complex requirements in global high-end manufacturing.

Source: TMBA

HIWIN MIKROSYSTEM showcased nano-level precision control and high-dynamic-response systems for advanced packaging and inspection processes, while HIWIN demonstrated how robotics, automation, and motion control technologies can be integrated into scalable, system-level manufacturing solutions.

Force One Machinery Co, Ltd presented its latest advancements under the theme 'Continuously Advancing Intelligent CNC Automation'. The highlight machine was a high-precision twin-spindle Y-axis CNC lathe, engineered with a rigid structural design and advanced multi-tasking capabilities to significantly enhance machining efficiency and dimensional stability. In response to today's high-mix, low-volume manufacturing demands, the company also introduced its newly patented SCARA robotic auto-loading system and a compact servo automatic door system, delivering a fully integrated intelligent machining cell solution.

Meanwhile, Ching Hung Machinery & Electric Industrial Co., Ltd (CHMER), a global leader in EDM, under the theme 'Ecosystem × Integrate the Future', unveiled its NV Series high-precision linear motor driven Wire Cut EDM. It is designed to meet the demands of high accuracy, stability, and reliability in advanced industries such as Electronics, Medical Devices, Automotive, and ICT. CHMER highlighted its NV432L, featuring cutting-edge AI and energy-saving technologies.



Source: TMBA

In alignment with TMTS's 'Front Shop, Back Factory' exhibition model, CHMER hosted an in-house exhibition at its Taichung headquarters alongside its booth display. More than 10 innovative machines were showcased on-site, featuring automation- and IoT-integrated manufacturing solutions that enabled visitors to experience full-line smart manufacturing applications.

TMTS 2026 Celebrates Resounding Success

The event successfully proved to be a significant milestone in the evolution of Taiwan's Machine Tool industry, highlighting not only advanced manufacturing technologies but also the growing integration of intelligent, sustainable, and ecosystem-driven solutions.

As global industries navigate supply chain realignments and the transition toward net-zero manufacturing, the exhibition demonstrated Taiwan's strength in connecting core components, automation systems, digital technologies, and integrated manufacturing solutions. Through strong industry collaboration and continued innovation in smart manufacturing, TMTS 2026 reinforced Taiwan's position as a trusted and competitive partner in the future of global manufacturing.

From equipment and systems to end-use applications, the exhibition highlighted cross-sector collaboration spanning Semiconductors, Aerospace, Medical Technology, and Electric Vehicles, underscoring Taiwan's strength in delivering integrated manufacturing solutions to global markets.

THE RIGHT FILTER FOR EVERY GRINDING APPLICATION

KNOLL Maschinenbau, a leading provider of conveyor systems, filtration systems, and pumps for metal processing, has introduced its two filter solutions: HydroPur and MicroPur® that can address the issue of cooling lubricants and grinding oils getting contaminated with minute chips and particles during grinding and polishing.

The KNOLL HydroPur is a hydrostatic filter capable of supplying metal-cutting machine tools with purified cooling lubricant (emulsion or oil). Due to its shallow discharge angle and high filter fineness, this filter type is particularly suitable for use in grinding processes. KNOLL offers different variants of the HydroPur, which differ in maximum filtration capacity, potential vacuum assist as well as numerous options. Thanks to the modular design using standard components, a customer-specific filter can be configured without the need for an expensive custom design.

The smallest model, a HydroPur H 250, is a complete system consisting of a hydrostatic filter head, a clean tank, filter fleece, supply pumps, and an optionally available unit for surface skimming.

The HydroPur 400 is a cost-effective, entry-level filter featuring purely hydrostatic filtration. An optional supplementary magnetic roller is also available. The HydroPur H 700 demonstrates simple vacuum-assisted filtration. This is achieved via a side-channel compressor, which generates vacuum in the filter chamber and thus enhances filtration.

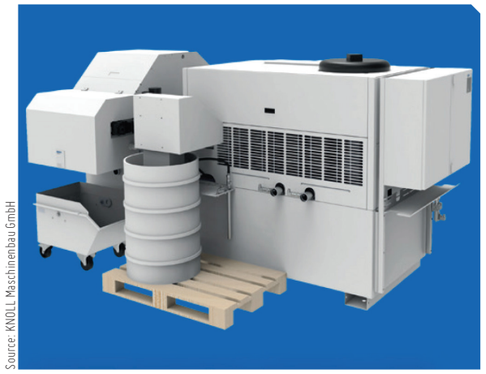
The HydroPur H 700 also features a winding unit for the used filter fleece.

While the two HydroPur variants described are already successful in the market, the V variant, equipped with a large vacuum turbine and filter pump, will receive sales approval shortly.

Thanks to the powerful vacuum pump, HydroPur V filters achieve significantly improved filtration performance. In the case of the HydroPur V 1500, this is 1,500 l/min. The H variant with the same filter head handles 1,000 l/min. Incidentally, the additional "E" in the product name stands for an additional continuous filter belt, which ensures reduced operating and disposal costs.

Source: KNOLL Maschinenbau GmbH

The modular design of the KNOLL HydroPur allows for "configuration rather than construction." This results in fast delivery and a very attractive price-performance ratio.



Source: KNOLL Maschinenbau GmbH

KF 400-E with a MicroPur®240 superfine filter and sludge concentrator.

The Click.it Pro hardware solution, with its five freely programmable buttons, display, and microcontroller, deserves special note.

When Filter of Super Fineness is Required

Designed for the finest filtration, the MicroPur® superfine filter – also featuring a modular design – is KNOLL's flagship product. It is ideally suited for use in the grinding of carbide and HSS tools. But it also delivers optimal results in the machining of castings. The MicroPur® achieves a filter fineness of less than 3 µm and manages without filter consumables thanks to its special design, which makes a significant contribution to its high degree of efficiency and sustainability.

KNOLL's smallest standard model, the MicroPur®120, features two backflushable filter elements for a filtration capacity of approximately 120 l/min. The KNOLL MicroPur® product range also includes standalone units in sizes of 240 and 480, as well as individually-configured, centralized filtration systems for entire production areas.

The Click for Increased Efficiency

The innovative Click.it probe system developed by KNOLL specifically helps to reduce waste and increase efficiency in various production processes. Whether one needs to requisition materials, call the foreman or monitor machines, Click.it ensures that information arrives right where it is needed, without detours. The system, which is available in various expansion levels, is based on a combination of buttons, sensors, software, and interfaces that collect data and transmit it to a central server. The server processes the data and transmits it to various output devices. In parallel with this, it is possible to evaluate the data, which allows for transparent process control.

KNOLL in India

KNOLL Maschinenbau GmbH's conveyor systems, filtration systems, and pumps for metal processing are available in India through NN Combined Engineering Agencies Pvt Ltd (NNCEA), which provides complete manufacturing solutions—including logistics and supply-chain support—for a wide range of industries.

The KNOLL HydroPur is a hydrostatic filter capable of supplying metal-cutting machine tools with purified cooling lubricant (emulsion or oil). Due to its shallow discharge angle and high filter fineness, this filter type is particularly suitable for use in grinding processes.

WHERE SPRING BLOOMS AND STEEL BENDS

Outside the expansive architectural facade of the Korea International Exhibition Center (KINTEX) in Goyang, South Korea's iconic cherry blossoms reached a breathtaking, incandescent zenith this April. The brilliant spectacle of nature served as a poetic prelude to the industrial renaissance occurring within the venue.

Held from April 13-17, 2026, the 21st Seoul International Manufacturing Technology Show (SIMTOS 2026) showcased the intersection of natural beauty and advanced engineering. While spring heralded a seasonal rejuvenation outdoors, the exhibition floor inside signaled a sweeping transformation across the global Manufacturing sector, which is actively discarding its conventional methods to adopt a fully autonomous, data-driven paradigm.

Organized by the Korea Machine Tool Manufacturers' Association, (KOMMA), SIMTOS 2026 was officially recognized by the Korean Government as a 'Global Top Exhibition'. The event provided a technology testbed and a robust business platform for an industry navigating complex supply chain pressures and rapid technological evolution.

During the opening ceremony, Kim Won-jong, Chairman, KOMMA & President, DN Solutions Global, projected a proactive scenario. He welcomed the global manufacturing community and emphasized the magnitude and strategic significance of the exhibition amid ever-changing global supply chain challenges. He highlighted how manufacturing competitiveness has emerged as a defining factor in national and industrial resilience. "In times like these, advanced manufacturing technologies that drive productivity and sustainability are more critical than ever," he emphasized.

Source: Magic Wand Media

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A Premier Global Business Nexus

Held under the visionary theme, 'AI Autonomous Manufacturing Meets Talent', SIMTOS 2026 established a new benchmark for industrial expositions. The exhibition spanned a colossal arena of approximately 100,000 sq mt, accommodating 1,315 participating companies from 35 nations across 6,059 highly specialized booths. Around 100,000 industrial delegates populated the halls over its five-day tenure. An impressive surge in pre-registered attendees highlighted a structural shift toward pre-planned, purposeful corporate procurement rather than passive viewing.

Highlighting its global status, international participants constituted 53.1 percent of the total exhibitor footprint. National pavilions were maintained by Germany, Italy, Switzerland, Japan, Taiwan, and China.

The event attracted qualified procurement officers and buyers from 60 countries, sparking active cross-border consultations, agent discoveries, technological alliances, and immediate export transactions.

Source: KOMMA

The Spatial Blueprint

The logistical arrangement of SIMTOS 2026 meticulously mirrored the anatomy of contemporary intelligent factories, creating a distinct division between physical processing power and digital orchestration.

KINTEX 1: The Integration of High-Precision Hardware

Exhibition Center 1 focused on the deep integration of physical machining and automated hardware. It was divided into specialized zones such as the Metal Cutting & Die Mold Tech Pavilion, Material Parts & Control Tech Pavilion, and Tooling & Measuring Tech Pavilion. Robotic automation systems were seamlessly paired with heavy cutting equipment, providing a direct preview of 'dark factories' capable of operating entirely without human intervention. Major industry players like SMEC, KCNC, Hyundai WIA, and Hwacheon Machinery showcased robust tooling systems designed to elevate structural efficiency.

> "The sheer number of Indian visitors at SIMTOS 2026 was an unmistakable signal of India's manufacturing ambitions under the 'Make in India' initiative. Their focus centered on high-precision, high-productivity machining solutions, automation and unmanned-operation packages, and iDOO-based digital monitoring systems."
>
> **Joongkweon Lee**
> **Managing Director**
> **DN Solutions India**

KINTEX 2: The Core of Manufacturing AX

Exhibition Center 2 served as the digital central nervous system of the exhibition, centered around the AI Factory Pavilion and the Manufacturing Automation &

SIMTOS 2026 showcased the rapid shift toward autonomous manufacturing, with AI-powered factory ecosystems, digital twins, robotics, and data-driven production emerging as key industry priorities.

Source: Magic Wand Media

Source: Magic Wand Media

Source: Magic Wand Media

Strong participation from Indian buyers and distributors highlighted growing demand for advanced manufacturing technologies, reinforced by DN Solutions' upcoming Bengaluru production facility.

> **"**During SIMTOS 2026, HK Laser & Systems drew significant attention from both existing customers and prospective clients, who highlighted not only the cutting performance of our laser systems but also the company's growing capabilities in automation-driven manufacturing solutions.**"**
>
> **Soomin Kay**
> **Director, Corporate Strategy**
> **HK Laser & Systems**

Robot Digital Transformation Exhibition (M.A.D.E. in SIMTOS). The focus shifted from individual machines to interconnected software intelligence. Leading software and digital engineering firms demonstrated how real-time factory data and physical AI can be combined to optimize production lines, eliminate downtime, and orchestrate automated factory ecosystems.

Industry Leaders and Technological Breakthroughs

Unified Turnkey Ecosystems

A primary highlight of the exhibition was the strategic presentation by DN Solutions, led by Kim Won-jong, Chairman, KOMMA & President, DN Solutions Global. The company demonstrated a major portfolio expansion through the integration of HELLER's high-precision 4- and 5-axis Horizontal Machining Center (HMC) technologies. As outlined by Joongkweon Lee, Managing Director, DN Solutions India, "This alliance complements DN Solutions' existing portfolio and allows us to address a broader range of high-precision machining needs. Second, HELLER's long-standing relationships with leading global OEMs, combined with its expertise in turnkey systems, automation, and lifecycle services, position DN Solutions not just as a machine tool supplier, but as a true solution partner."

At SIMTOS 2026, DN Solutions unveiled iDOO RMS+, an in-house platform managing hundreds of machines, now commercially deployed in the US and Korea. It delivers real-time equipment monitoring, uptime/downtime productivity analytics, process data visualization, and bi-directional MES/ERP integration.

"An embedded LLM-based chatbot—pre-trained on manuals, maintenance guides, alarm codes and troubleshooting SOPs—lets operators resolve alarms through natural-language queries. iDOO RMS+ will further expand to robots, automation cells, IT systems and physical AI, enabling remote operation, minimal downtime, and genuine lights-out manufacturing," Lee informed.

Advanced Fiber Laser Automation

Addressing critical industrial pain points like labor shortages and downstream workflow bottlenecks, HK Laser & Systems attracted significant crowds. The company presented an integrated smart factory approach aligned with the industry's shift toward automation. Live demonstrations featured its high-power fiber laser cutting systems, specifically the FO and FS series, operating at high accelerations directly on the exhibition floor. The gantry-type FO Series drew strong praise from the Shipbuilding, Heavy Industry, and Thick-Plate Processing sectors.

"Compared to conventional plasma systems, HK's FO Series gantry-type fiber laser machine demonstrated faster cutting speeds, improved cut-edge quality with reduced Heat Affected Zones (HAZ) and secondary processing, and lower consumable costs. The FO Series also drew attention for its conveyor-based automatic discharge system designed to improve workflow efficiency and support continuous production environments," shared Soomin Kay, Director, Corporate Strategy.

Precision Engineering and Metrology Champions

Hwacheon Machinery Co., Ltd: Marking 80 years of engineering heritage, Hwacheon demonstrated its '4S Provider' philosophy—System, Software, Solution, and Service. Featured machinery included the heavy-duty VT-1350 Ram-type Vertical Turning Center, built for thermal stability, and the i2 Turn-Mill Center, designed for complex multi-process setups. The company introduced an innovative touch via its Harmony Series, integrating interactive voice assistant technology directly into the CNC machining environment.

Marposs: Marposs introduced the MIDA ARTIS Wall, an interactive display showcasing an integrated machine tool control ecosystem. This tool-monitoring infrastructure captures real-time changes in power, vibration, and force to ensure maximum cutting quality. Marposs also displayed its Laser ML3G non-contact tool measurement system and advanced helium-based leak testing solutions.

Pragati Automation Pvt Ltd: Pragati highlighted the ATC4024V automatic tool changer along with high-performance Power Tool Turrets (BMT 55) and robust hydraulic units built for rigid, high-accuracy operations.

Sphoorti Machine Tools Pvt Ltd: The company showcased its precision-engineered BMT, VDI driven, and static tool holders for multi-axis turn-mill centers, reflecting an agile approach to modern engineering needs.

Source: Magic Wand Media

The Indo-Korean Strategic Manufacturing Corridor

A significant trend highlighting the business impact of SIMTOS 2026 was the influx of Indian industrial delegates. Inspired by the nationwide 'Make in India' initiatives across the Automotive, Aerospace, Defence, and Die & Mold sectors, these visitors focused heavily on high-precision machining centers, robotic cells, and digital monitoring systems. Exhibitors responded directly to this market demand.

In alignment, DN Solutions confirmed that its new production facility in Bengaluru is on track to open this August (Q3 2026). This local footprint will supply globally consistent precision machinery with significantly reduced logistics lead times, establishing India as a primary pillar of the group's global growth strategy.

AI Meets the Human Element: Talent and Leadership

While the primary technological theme focused on automated, unmanned operations, SIMTOS 2026 maintained that human ingenuity is the true catalyst for industrial progress. The exhibition featured several target programs designed to support human talent within the changing ecosystem:

Career Connect (Job Fair): Developed under the event's core theme, this matchmaking platform connected young job seekers with industrial technology corporations, generating tangible recruitment results through on-site interviews.

Women Engineers' Network Forum: A dedicated professional symposium that offered detailed insights into the expanding contributions, professional trajectories, and leadership opportunities for female engineers within the heavy manufacturing sector.

Global AX Manufacturing Innovation Conference: Brought together global thought leaders to discuss real-world industrial applications of AI and data orchestration across modern manufacturing networks.

A Vision Realized

The exposition proved that advanced manufacturing enterprises are no longer just theorizing about an AI-driven future—they are actively deploying it on the shop floor today. By successfully linking machinery, data networks, and professional talent, the event established an exciting path forward for the global industrial community.

Anticipation is already building for the next biennial iteration, with SIMTOS 2028 officially announced to return to KINTEX from April 3-7, 2028.

While automation dominated the exhibition, dedicated programs for workforce development, women engineers, and young professionals underscored the continued importance of human expertise in industrial transformation.

INDIA'S LARGEST TOOLING SHOWCASE REINFORCES GLOBAL STATURE

The 14th Die & Mould India Exhibition (DMI 2026), organized by the Tool & Gauge Manufacturers Association of India (TAGMA), concluded successfully at the Bombay Exhibition Centre, Mumbai.

Source: TAGMA

Held from April 21–24, 2026, the four-day event served as a definitive platform for the Tooling industry, bringing together over 350 exhibitors and more than 35,000 visitors to showcase the latest advancements in manufacturing technology.

The exhibition highlighted the rapid momentum within India's manufacturing ecosystem, featuring over 35 product launches and participation from more than 15 industry sectors, including Automotive, Aerospace & Defence, Electronics, and Medical Devices. The event's global reach was further amplified by a vibrant Japan and Korea Pavilion and delegations from over 25 international companies, reinforcing DMI's stature as a premier hub for innovation and business collaboration.

Forging Impact

"This edition stands as our largest so far," said Devaraya M Sheregar, President, TAGMA India. "We are seeing positive momentum, with stronger order books and a clear shift towards advanced technologies, automation, and modern machining. Our toolmakers are increasingly serving both domestic and international markets, reflecting the growing competitiveness of our industry."

The inauguration ceremony was marked by the presence of industry leaders, including Chief Guest Manoj Kolhatkar, Managing Director & CEO, Tata AutoComp Systems Ltd, and Guests of Honor FR Singhvi, Joint Managing Director, Sansera Engineering Ltd, and President, Aerospace India Association; Vinamra Mishra, Joint Secretary, Ministry of MSME; and Hector U Villanueva, Chairman, FADMA.

Concluding with a note of appreciation, D Shanmugasundaram, Vice President, TAGMA India, said, "We sincerely thank all international delegates, exhibitors, partners, sponsors, and the TAGMA team for their support in making this event a success. Such global participation and continued collaboration will play a key role in strengthening the industry and shaping its future."

The exhibition provided a comprehensive look at the complete value chain, ranging from CNC machining, additive manufacturing, and 3D printing to CAD/CAM/CAE software, precision cutting tools, and quality control systems. By uniting technology providers, raw material suppliers, and end-user industries, DMI 2026 once again cemented its role as a vital catalyst for India's journey toward becoming a global manufacturing powerhouse.

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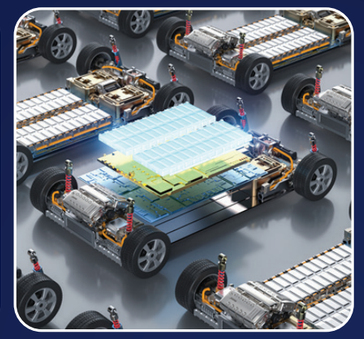

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