

infrastructure, 5G networks, industrial automation, and defence electronics prioritise durability and efficiency over bleeding-edge miniaturisation. At the same time, global momentum toward chiplet-based architectures, heterogeneous integration, and wide bandgap materials is reshaping how chips are designed and manufactured. These trends require flexibility and close coordination between design and fabrication, rather than a single-minded focus on node shrink.

According to Darshil Shah,

“Future fabrication plans need to reflect how chip usage is evolving across key sectors. Many applications now value reliability, power efficiency, and system-level performance more than simply moving to smaller nodes. This creates demand for manufacturing that supports mature processes alongside wide bandgap materials and advanced packaging, including heterogeneous integration. At the same time, global momentum toward chiplet-based architectures and customised silicon requires greater flexibility and closer coordination between design and fabrication. These shifts can be addressed through phased investments that begin with proven, high-demand applications and expand through pilot lines and shared facilities as architectures mature. Grounding capacity decisions in real deployment patterns helps ensure relevance as technology requirements continue to change.”

Such a phased approach allows India to stabilise operations, develop manufacturing discipline, and gradually expand into more complex technologies without overextending resources.

The manufacturing reality check

Despite strong policy backing, India's semiconductor journey faces undeniable challenges. Semiconductor manufacturing depends on extreme precision and consistency. Small variations in process control, equipment calibration, or material quality can have outsized impacts on yield. Building this depth of manufacturing excellence takes time, repetition, and a culture that values

process discipline.

India is also working to strengthen access to specialised materials, equipment servicing, and supply chain support. Global semiconductor



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ecosystems are tightly interconnected, and new entrants must navigate long qualification cycles and high capital costs. For this reason, industry leaders caution against unrealistic timelines.

Establishing advanced semiconductor fabrication in India is a complex, long-term endeavor. The industry requires extreme precision and years of process stabilization to achieve reliable yields—areas where India is still building its manufacturing depth. While limited access to specialized tools and long investment cycles present hurdles, a phased growth strategy focusing on incremental learning is more viable than rapid scaling. By leveraging its design expertise and a massive domestic electronics market, India can steadily cultivate a world-class manufacturing ecosystem.

India's large domestic electronics market offers a crucial advantage. Early demand from automotive, consumer electronics, telecom, and industrial sectors can help fabs achieve steady utilisation while processes mature.

Academia's expanding role in the semiconductor mission

Across the country, select institutions are restructuring their academic programmes to align with industry needs and national objectives. Among them, K J Somaiya School of Engineering (KJSSE), Mumbai, has adopted a comprehensive approach that integrates curriculum design, hands-on training, research, and industry collaboration into a single framework.

Dr Jagannath Nirmal, Professor & Head, Department of Electronics Engineering, K J Somaiya School of Engineering, explains this institutional shift:

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This emphasis on relevance reflects a broader trend in semiconductor education. As fabrication and packaging units move closer to commercial operation, the demand will rise for engineers who can contribute immediately, without long training cycles. Industry-aligned curricula and practical exposure help reduce this gap.

From learning design to building chips

Beyond classroom instruction, hands-on exposure remains critical. Semiconductor design and manufacturing are experiential disciplines, where familiarity with industry-standard tools and workflows determines real-world effectiveness. To address this, KJSSE has aligned itself with a national programme focused on indigenous chip development.

As Dr Nirmal notes,

“Further strengthening this initiative, KJSSE has established the Centre for Chip to Startup (C2S) under the Government of India's Chip to Startup (C2S) Programme run under the umbrella of the Ministry of Electronics and Information (MeitY) with the objective of promoting indigenous semiconductor development and addressing national semiconductor needs. The centre serves as a platform for skill development, innovation, and entrepreneurship, enabling students and faculty to work on end-to-end semiconductor design problems from system specification to chip-level implementation. The key highlight of the C2S initiative at KJSSE is hands-on training using industry-standard EDA tools, including Cadence and

Synopsys, which are extensively used in the global semiconductor industry for design, simulation, verification, and physical implementation. Through structured laboratory sessions, projects, and workshops, students gain practical exposure to complete VLSI design flows, significantly enhancing their industry readiness.”

Such initiatives play a crucial role in building confidence and competence among students. Exposure to complete VLSI design flows helps bridge the gap between academic theory and industrial practice, making graduates more effective contributors to India's growing semiconductor workforce.

Research and industry integration

Research-driven innovation forms another essential layer of the ecosystem. As India expands its semiconductor footprint, advances in materials, device structures, testing methodologies, and reliability engineering will become increasingly important. Academic institutions, when supported by the right tools and industry engagement, can play a meaningful role in addressing these challenges.

According to Dr Jagannath Nirmal, “KJSSE also emphasises research-driven learning in semiconductor technologies. With access to advanced tools and strong faculty mentorship, several students have successfully published research articles in reputed international journals and conferences. These research outcomes reflect the growing academic strength and innovation culture within the institution.”

Equally important is the translation of industry problems into academic research. Semiconductor companies face persistent challenges related to verification complexity, yield optimisation, testing efficiency, and long-term reliability. When these challenges are shared with academic partners, they become opportunities for applied research and skill development.

Partnerships, policy, and the long view

Beyond basic infrastructure, the acceleration of a semiconductor

ecosystem depends on deep collaboration between global experts and local operators. By integrating design firms, equipment suppliers, and manufacturers early on, the steep learning curves of fabrication can be significantly compressed. This synergy ensures that technical “know-how” is effectively localized, stabilizing production flows and allowing for faster equipment tuning and yield improvements. Furthermore, such partnerships ensure that backend processes like assembly and testing mature alongside fabrication, creating a balanced and resilient manufacturing chain.

Long-term success also requires a stable policy environment and the development of integrated industrial clusters. Effective governance must provide predictable incentives and seamless access to utilities and land, creating a reliable foundation for decades of investment. By embedding academic institutions directly within these manufacturing hubs, research can be aligned with real-world production needs. This proximity, combined with specialized training in micro-fabrication and materials science, ensures a continuous pipeline of skilled talent ready to scale operations and maintain global competitiveness.

A measured leap forward

India's semiconductor journey is neither a sprint nor a gamble. It is a long-term national project that demands patience, coordination, and sustained execution. What sets the current phase apart is the alignment between policy intent, industry participation, academic readiness, and market demand.

As fabs take shape, talent pipelines strengthen, and partnerships deepen, India is laying the groundwork for a semiconductor ecosystem that can endure global cycles and technological shifts. The leap may be measured, but its impact could be transformative.