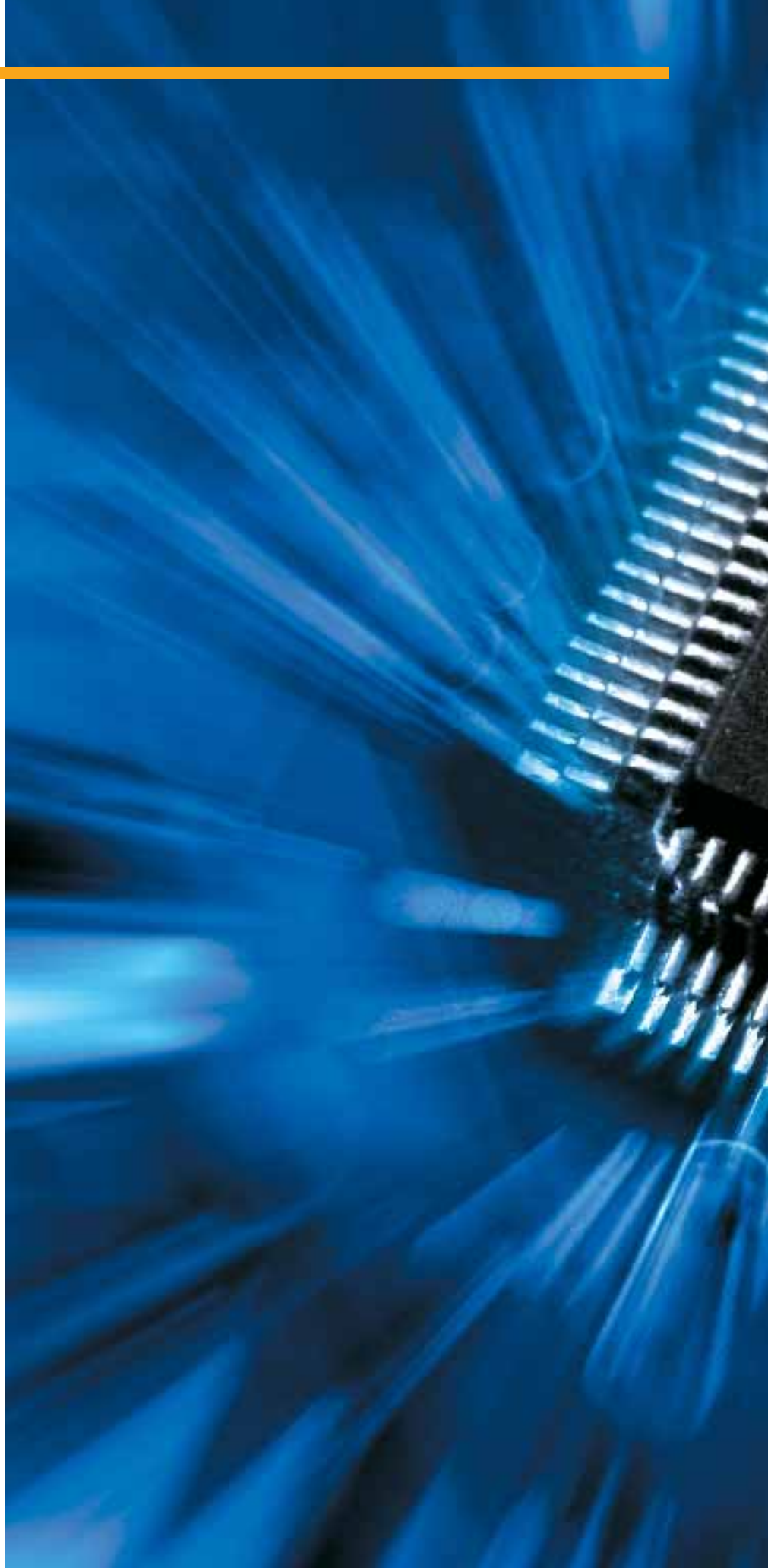


When Nokia, the world's leading mobile phone handset maker, set up a plant in 2006 near Chennai, the capital of the south Indian state of Tamil Nadu, it not only raised many an eye-brow in the electronics industry, but spawned a new era of manufacturing trend in the country.

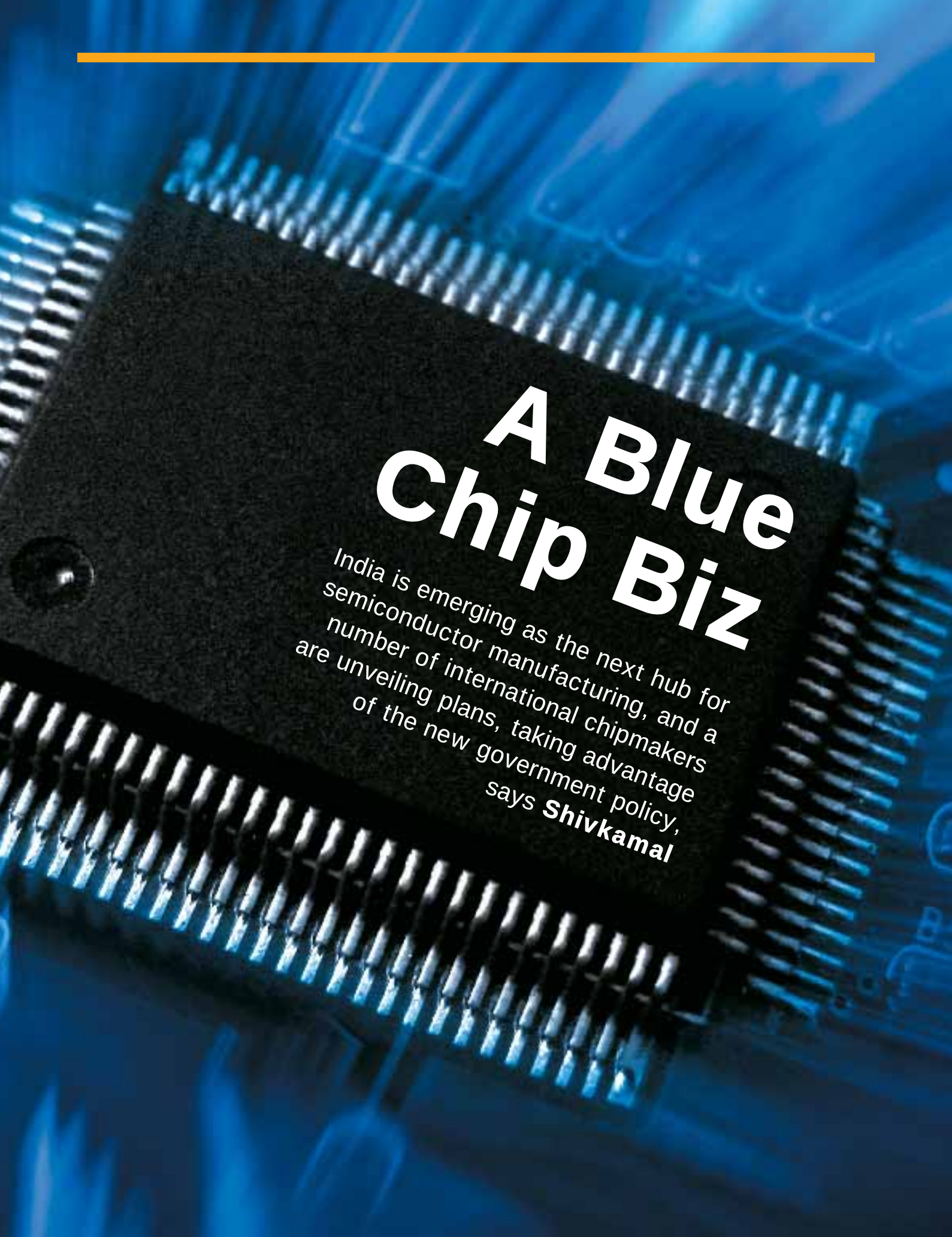
Almost a year down the line, Nokia acknowledged that production of electronic goods in Chennai was cheaper than in Shenzhen, China, the traditional manufacturing hub, preferred by well-known original equipment manufacturers (OEMs).

India has catapulted to the world league in semiconductor manufacturing. The reasons – a maturing ecosystem for the electronics industry and the policy decisions taken by a proactive government to attract investments in the electronics industry, particularly semiconductor manufacturing. A semiconductor is an essential component in any electronic equipment, be it a television set, a cellular phone, a PC or an audio player.

India is now seen as the next hub of semiconductor manufacturing. Already, a number of companies set up by Indians with technical support from global giants have unveiled their plans for the country.

According to the India Semiconductor Association (ISA), the premier body of semiconductor companies and chip design firms in India, the country has already emerged as a preferred destination for chip designing and embedded software purely because of the talent pool. India can now go a step ahead and take up manufacturing of semiconductors for both the world and domestic markets.

"Highly dynamic markets demanding new product variants/models from companies have forced OEMs/product



A Blue Chip Biz

India is emerging as the next hub for semiconductor manufacturing, and a number of international chipmakers are unveiling plans, taking advantage of the new government policy, says **Shivkamal**

companies to reduce the product development cycle time by outsourcing to companies, especially to India," points out ISA President Poornima Shenoy. "Declining margins and research and development budgets have forced companies to look for cost-effective centres without compromising on the quality of work."

What makes India an attractive destination for semiconductor manufacturing? There are two reasons. The first is that companies, particularly MNCs, can cater to the rapidly growing domestic electronics market at cheaper costs by sourcing semiconductors from India. Secondly, India can emerge as an alternative to China and Taiwan in manufacturing semiconductors.

The case for serving the domestic electronics industry is stronger. According to an ISA - Frost & Sullivan report, India is developing as one of the largest markets for electronic equipment. India's electronic equipment consumption was estimated at around $28.2 billion in 2005.

It is expected to reach $126.7 billion by 2010 and $363 billion by 2015 growing at a compounded annual growth rate of 29.8 per cent.

India's electronic equipment consumption in 2003 was 1.8 per cent of the global electronic equipment output in 2005. It is expected to grow to 2.9 per cent in 2007, 5.5 per cent in 2010 and 11 per cent in 2015. The consumption by 2015 will be equal to 11 per cent of the global electronic equipment output.

Another encouraging sign is that the semiconductor content in the estimated electronic consumption in 2015 is expected to be $36.3 billion accounting for 6.5 per cent of the global semiconductor revenues.

India offers high potential for electronic equipment manufacturing companies. The estimated production of $155 billion in 2015 is expected to create an opportunity of $15.52 billion for semiconductor companies and also for Electronic Manufacturing Services (EMS) companies.

The cost and opportunity benefits for companies in the semiconductor and embedded design sectors are also high.

Indian Semiconductor Ecosystem (Electronics Industry - Semiconductor Industry Interface)

Electronics Industry
Original Equipment Manufacturers
Nokia, Alcatel, Wipro, Videocon

Electronic Manufacturing Services companies
Flextronics, Solectron, NeST

Design Houses
Mistral, NeST, Flextronics

Industrial Design Firms
Bang Design, Lemon Design, FT Design

Software Intellectual Property firms
Sasken, Emuzed, Encore Software, L&T Software

System Integrators
Wipro, Tata Elxsi

Hardware services & board manufacturing
ProcSys, iWave, Peninsula

Semiconductor Industry
Chip Vendors, Texas Instruments, ST Microelectronics, Intel, Cypress Semiconductors, Freescale, Moschip

Electronic Design Automation (EDA) tool companies
Cadence, Synopsys, Mentor Graphics, Synplicity

VLSI Design Services companies
Wipro, Sasken, MindTree Consulting, HCL

Silicon IP companies
MindTree Consulting, Sasken, GDA

Embedded Software companies
Sasken, Verismo Networks, MindTree Consulting

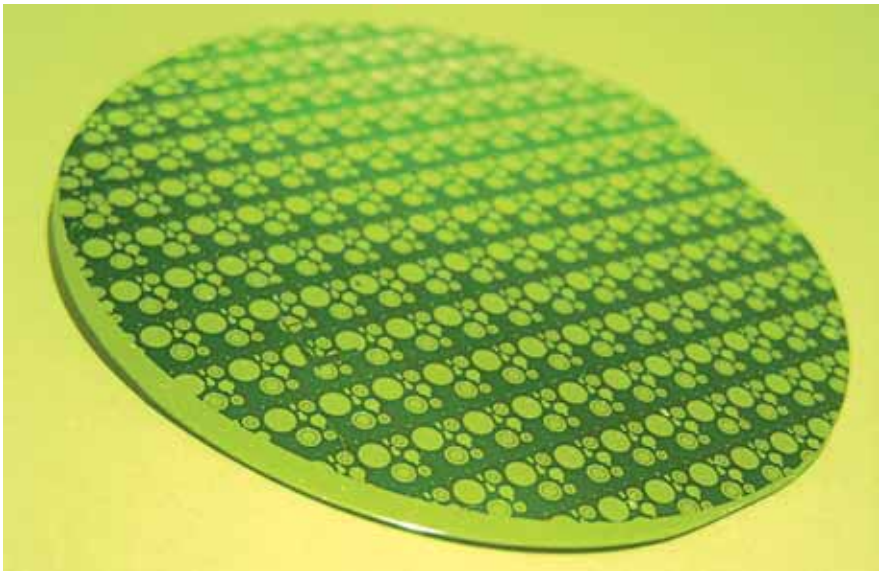
Design verification companies
MindTree Consulting, Sasken

Quality Testing
Stag Software

Product Testing
Tessolve

Fab equipment companies
Applied Materials

Fab companies (proposed)
SemIndia, Moser Baer, Videocon, Hindustan Semiconductor Manufacturing Company



INNOVATIVE DESIGNS: A silicon wafer with MIS (Metal Insulator Semiconductor)

> The fact that intellectual property protection is strong in India is another contributing factor leading to increased outsourcing of design services to Bangalore.

A direct revenue generation of $43.07 billion by 2015 is expected to generate employment for 781,780 engineers. The indirect and induced revenue generation of $33.59 billion is expected to generate employment of 2.96 million.

Such a forecast will also have a significant impact on India's Gross Domestic Product (GDP). The direct revenue generation of $202.57 billion in 2015 is expected to contribute 12.32 per cent to the GDP and generate employment of 3.58 million. The indirect and induced revenue generation of $261.69 billion in 2015 is expected to contribute 15.90 per cent to the GDP and generate employment of 5.77 million.

The Indian electronics industry, which consumes semiconductors, is developing in a big way. There are OEMs like Nokia, Alcatel and Videocon, who have already set up plants in India. Companies specialising in hardware services and board manufacturing, system integrators, software IP firms and industrial design firms have already established their presence.

How will semiconductor manufacturers benefit from setting up plants in India? The major advantage is that they can source chip design locally from Indian companies. A chip or microprocessor is the most complex part of an electronic device and designing chips is at the top end of the software value chain. Chips are an integral part of semiconductors. VLSI (Very Large Scale Integration) and System on Chips (SoC) are at the pinnacle of chip design. Incidentally, India specialises in both categories.

For instance, as many as 18 out of the top 25 chip companies have set up chip design centres in India, making the country an emerging worldwide leader in chip design.

Indian chip designers provide design services or work at the subsidiaries of global chip companies, especially US and European firms.

Industry leaders believe India is becoming a 'design store' with a strong presence in Intellectual Property (IP) development, integration and embedded software services. The VLSI Society of India estimates the Integrated Chip design population in India to be around 11,000, while those working on the embedded software add up to 60,000.

Four cities are driving the growth of VLSI design in India. Bangalore is at the top followed by Hyderabad, Delhi/Noida and Chennai. Bangalore is now home to 70 of the 130 firms (including multinationals) engaged in chip design in India. That makes it not just way ahead of the rest of the Indian competition but one of the top global clusters in chip design, comparable to Silicon Valley, Cambridge (in the UK) and Taiwan.

Of the 70 firms designing chips in Bangalore, nearly 30 are captive offshore design centres of MNCs such as Intel, Texas Instruments and NXP Semiconductors (formerly Philips). Irrespective of where in the world an innovative chip design firm may be located, more and more of them are acquiring a Bangalore branch.

What is perhaps most significant is a new tribe of innovative start-ups headed by entrepreneurs of Indian origin (the firms may be registered anywhere in the world) whose development work mostly goes on in Bangalore and which own the intellectual property they create. It is this tribe that is setting out to close the innovation gap after the services supremacy is fully established.

When compared to other chip design clusters of the world, Bangalore has the fastest growing community of VLSI engineers – 15,000, next only to Silicon Valley in the US, which has 55 chip design services firms employing around 20,000 VLSI engineers. The industry in the US is nearly two decades old whereas Bangalore entered this premier club less than a decade ago.

The Cambridge cluster has 12 firms and employs around 2,000 VLSI engineers. Its work is focused on technology innovation. Taiwan, whose strength lies in manufacturing, has three firms offering chip design services. Last year, two delegations representing the Taiwanese

ÂIT WILL OPEN THE FLOODGATES FOR FOREIGN INVESTMENTSÊ

India Semiconductor Association (ISA) president Poornima Shenoy, a vocal proponent of semiconductor manufacturing, tells ***India Now*** *that the nation possesses the right ecosystem for semiconductor manufacturing. Excerpts from an interview:*

Will India grab a chunk of the semiconductor manufacturing business?

The Indian semiconductor design industry, comprising VLSI design, board design and embedded software companies, has design companies across Bangalore, the National Capital Region (NCR), Hyderabad, Chennai, Pune, Ahmedabad and Goa.

All the global top-10 'fabless' design companies have India operations. With its growing middle class population of nearly 400 million people, which will only increase over time, India's electronic equipment consumption is expected to reach $363 billion by 2015. The major end use segments are communications, information technology and consumer electronics. Together, the important product subcategories that would drive the semiconductor market in India are mobile handsets, wireless equipment, especially BTS equipment which is gaining momentum, set top boxes, and smart card terminals.

What advantages will companies gain by setting up semiconductor manufacturing facilities in India?

The Indian semiconductor industry received a boost this year with the announcement by the government of the Semiconductor policy. It is the first step in building a scalable and robust semiconductor industry in the country. The policy has a special incentive package to attract investments for setting up semiconductor fabrication and other micro and nanotechnology manufacturing industries.

This is further to the in-principle approval given by the union cabinet in January. A key benefit is the grant of special economic zone (SEZ) status. This way the government has provided both pre-operative and post-operative benefits to the industry, which is important even for the development of the eco-system.

How will India benefit from semiconductor manufacturing?

It will open the floodgates for foreign direct investment in the country and encourage exports. For a country which imports almost 60 per cent of its electronic goods today, the chip manufacturing facility could ensure that a substantial portion of this demand is satisfied through local manufacturers.

Poornima Shenoy

In addition, it would also provide domestic manufacturers an opportunity to participate in the $1,300 billion worldwide market for electronic goods. The growth of the semiconductor industry would provide a further impetus to the chip designing industry in the country through increased domestic demand. This in turn would have a significant multiplier effect on the growth of the software industry in the country.

The chip manufacturing facility would provide the infrastructure and environment for research activities to ensure development of cutting edge technologies in the country. This in turn would play a vital role in generation of a talent pool in the country which would provide a competitive edge to our people. Therefore, the chip manufacturing facility would provide a platform for higher and specialised learning in this fast growing industry which has acquired a high priority status in the leading economies of the world.

What will be the other benefits?

The experience of other countries reflects that the operation of a single chip manufacturing facility creates requirements for almost 15 ancillary industries such as assembly, testing and packaging, which are highly labour intensive. Chip manufacturing facilities, therefore, have the potential to generate significant indirect employment in the economy, which would be almost ten times the level of employment generated in the semiconductor industry.

Will India be able to compete with other semiconductor manufacturing hubs like Taiwan and China?

The key factor for success lies in market demand which is growing exponentially in India. The emergence of foundries has been the key driver behind the rise of Asian countries as leaders in the semiconductor industry.

The findings of a survey by Leachman and Leachman identify the main reasons that are rated closely by companies for Fab site selection: Tax advantages offered by the country; Availability of engineering and technical talent; Proximity to existing company facilities; Environmental regulations in the country; Political institutions; Presence of other Fabs in the country; Firm's prior investment experience.

Why are companies coming to India?

Highly dynamic markets demanding new product variants/models from companies have forced original equipment manufacturers OEMs/product companies to reduce the product development cycle time by outsourcing to companies.

BANGALORE BECKONS: About 30 of the 70 designing firms in the city are offshore units of MNCs

Semiconductor Development Hotspots

Bangalore:
Intel, Texas Instruments, ADI, TCS, Wipro, Infineon, Cypress, Sasken, Synopsys, MindTree, Freescale, Broadcom and Qualcomm.

Hyderabad:
Motorola, ADI (Chiplogic), Synopsys, Mentor Graphics, Conexant, Portal Player and Hellosoft.

Delhi/Noida:
STM, Freescale, Cadence, Transwitch and Conexant.

Chennai:
Midas, HCL Tech and Banyan Networks.

semiconductor manufacturing companies were in Bangalore looking for tie-ups with chip design servicing firms.

Shenoy of the ISA attributes the rise in chip design work to the growing semiconductor ecosystem and availability of talent. "The fact that intellectual property (IP) protection is very strong in India is another major contributing factor. Design work will continue to flow into Bangalore," she predicts. Last year alone the apex body of the semiconductor industry saw its membership double.

India is seen as a destination for quality and IP work, not just an option for lowered cost. "Design companies are keen on India since design automation companies are here," she adds. "As both the design engineers and people who develop tools are here, that's seen as a big plus. Practically every chip company has set up a design centre in India."

Shenoy notes that the VLSI design industry in India is anticipating another large round of investments in 2007. According to the ISA-Frost & Sullivan report, the total number of design start-ups in the Indian VLSI design market was estimated at 320 in 2005.

"The increase can be attributed to the establishment of captive offshore design centres in India and the increase in outsourced work to the non-captive companies," adds Shenoy. Also, the availability of a huge base of engineering workforce coupled with their proficiency in English has made India an attractive destination for design and development.

> India is rated the best on availability and scalability of talent. However, the country is fourth on the quality of talent and fifth on quality of technical education.

Captive companies (subsidiaries of multinational companies, making strategic investments in India) are looking at the growing domestic market by 2015 and the consistency of consumption growth in the end-user markets.

The semiconductor sector encompasses VLSI design, hardware/board design and embedded software development, offered by both captive and non-captive companies across India.

Captive companies have scaled up to carrying out end-to-end design and development activities. Another promising statistic is that design start-ups in India are set to rise from 600 in 2005 to 3,248 in 2015.

The driving forces behind this growth is the rapidly growing domestic market, a strong education infrastructure, comparatively lower cost design talent, short product lead times, reduced entry barriers, rising government support, and last, but not the least, improving infrastructure.

Electronic Design Automation (EDA) companies (both product and service) are the starting block for the VLSI and hardware / board design market. They are important links in the semiconductor value chain. EDA companies have taken the lead in developing engineering human resource for the industry in India.

FABLESS MODEL: Many firms design, develop and test the chips in India

The ISA-Ernst and Young Benchmarking Study: India in the Global Semiconductor Design Ecosystem, which was released recently, rates India the best among different destinations, including Silicon Valley, Taiwan, the UK, Israel, Canada and the Czech Republic on availability and scalability of talent.

Released at the ISA Vision Summit in Hyderabad, the report emphasises the need for government, industry and academia to put in a concerted and coordinated effort to make the nation a preferred destination for semiconductor design.

Sunil Shenoy of Ernst & Young, points out that the peer countries considered for benchmarking included other preferred destinations for semiconductor design. "India is rated the best on availability and scalability of talent. However, the country is fourth on the quality of talent and fifth on quality of technical education," he notes.

The report recommends increasing the supply of high quality new talent by encouraging more students to opt for relevant engineering streams and to view the semiconductor design sector as an attractive career opportunity.

India is rated relatively low among the set of countries on maturity of semiconductor design sector owing to the 'services' approach. Taiwan and Israel, where a fair amount of product design takes place to support manufacturing, are rated higher than India. "However, it is heartening to note that the past couple of years have seen several turnkey jobs being done by MNCs through captive or third party outfits in India," the report notes.

While India's rating in the Intellectual Property Rights (IPR) protection is in the moderate range, the perception about India is better than that for some other countries in the peer set. The report stresses on increasing the robustness of the IPR regime and effective implementation of IP laws.

The report also notes that while India has the best talent cost advantage, Silicon Valley is perceived to have the least. High talent cost is limiting its growth. However, the maturity of the Indian semiconductor design sector is 'moderate,' reflecting its 'primarily services' ap-

GROWTH OPPORTUNITIES: The government has announced a host of incentives to the sector

> Buoyed by the success of the chip design sector the government recently unveiled a policy to attract investments of $6 billion to $10 billion by luring two to three fab units.

proach. Indian IT firms like Wipro, Tata Consultancy Services and MindTree Consulting, which are into chip design services, are aggressively expanding their activities. Wipro alone has a team of more than 1,400 VLSI engineers working on different areas of semiconductors, making it the largest chip design services firm in the world.

Firms in Bangalore are involved primarily in front-end design work and providing testing and verification-level services. But a few of them are involved in end-to-end design activities, ranging from specification to tape outs (shipping the complete product). The firms are based on a fabless model where they design, develop and test the chips which are then fabricated or manufactured by others.

Buoyed by the success of the chip design sector, the Indian government, which sees tremendous growth opportunity for the semiconductor sector, recently unveiled a policy to attract investments. With this, the government expects to attract an investment of $6-10 billion by luring two or three fabrication units, with an investment worth $2-3 billion each, by 2010. Minister for IT and Communications Dayanidhi Maran notes that an appraisal committee will receive expressions of interest from interested parties and submit its recommendations to the government.

The government has announced a host of incentives that include bearing 20 per cent of the capital expenditure during the first 10 years if a unit is located in a Special Economic Zone (SEZ) and 25 per cent in case of other units. The countervailing duty (CVD) on capital goods too would be exempted in case of units situated outside an SEZ.

The policy further entails that for semiconductor manufacturing (wafer fabs) plants, the investment will be about $620 million, while for manufacturing other products the investment will be $250 million. In cases where projects have a 1:1 debt to equity ratio, the government will restrict its equity participation to around 26 per cent. The remaining part will be in the form of interest-free loans, tax subsidies and concessions.

The policy covers LCDs, plasmas, storage devices, solar cells, photo-voltaics and nanotechnology products, as well as assembly and testing of these products.

But much before the Semiconductor policy was announced, firms had made a beeline to invest in manufacturing in India. The first was the SemIndia project, promoted by an NRI consortium and headed by Vinod Agarwal, which announced a $3 billion 'Fab City' project, including a $100 million ATMP (Assembly, Test, Mark, Pack) facility.

The project is located near the new Hyderabad airport, and SemIndia is looking at closing the financial package. It has the added advantage of land allocation, and has also progressed on SEZ clearance.

The second major announcement was made by Hindustan Semiconductor Manufacturing Company, a company floated by Devendra Verma, managing partner of California-based investment company, Edgewood. Infineon Technologies is the technology partner for its semiconductor manufacturing plant.

The fab will focus on four products — chipsets for mobile phones, direct to home TV set top boxes, automotive and smart cards. The first line would represent an investment of $1 billion.

Indian consumer electronics maker Videocon Ltd intends to invest $250 million in a semiconductor facility in eastern or southern India. The company said it has found a technology partner and is scouting sites in West Bengal and Andhra Pradesh.

Moser Baer, a manufacturer of optical storage media devices, announced a solar fab in collaboration with Applied Materials at a cost of $250 million at Greater Noida near Delhi. Certainly, India has begun on a win-win note.