India
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Think Innovation Think India

"Mind to Market"

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Report

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Business Research

India R&D 2006- REPORT

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Inaugural Session

The introductory session of the 'India R&D 2006' conference was dedicated to discussions on the topic 'Mind to Market', addressing the synergy between the world of science and the world of business. Dr. Amit Mitra, Secretary General, FICCI, opened the session by inviting Mr. Saroj K. Poddar, President, FICCI to present his welcome address. Dr. Ajay Dua, Secretary, Department of Industrial Policy and Promotion, Government of India; Mr. Kapil Sibal, Minister for Science and Technology and Earth Sciences; Dr. A.P.J Abdul Kalam, the Hon'ble President of India and Dr. T. Ramasami, Secretary, Department of Science and Technology, Government of India, were the eminent dignitaries who spoke on the occasion.

In his welcome address, Mr. Saroj Poddar remarked that research and development is a key driver of economic development and competitiveness at par with global players. Mr. Poddar sounded upbeat about the encouraging annual growth rate of 31 percent registered by the total R&D investment in India. He asserted that the country's research laboratories are quite active while conceding that there is an urgent need to commercialise them.. He also stressed on the need for closer interaction between the academia and the industry.

Mr. Poddar also opined that a transparent framework for Intellectual Property Rights (IPRs) and fair and equitable sharing of benefits is extremely important for a synergistic relationship between the academia and the industry. He also drew attention to the deficiencies in the country's education system of the country, which does not teach young minds to think out of the box.

The next speaker, Dr. Ajay Dua, emphasised that a nation needs to ensure the following if it wants to be at the forefront of human development:

- Free development of new ideas
- Facilities for the incubation of innovations
- Mechanisms for the fair and equitable commercialisation of innovations
- IPRs oriented towards wealth generation

The third speaker in the session, Mr. Kapil Sibal, remarked that the emerging need of the global economy is to constantly innovate and reinvent. He also stressed on the need for a coalition between basic science and applied science.

Mr. Sibal remarked that the ICT revolution has to be turned into a reality for all. He also expressed firm conviction that an ICT and bio-tech revolution sweeping across fields as diverse as telecommunications, biological sciences and nanomaterials would definitely prove to be an exciting journey for the innovative mind as well as the market.

Mr. Sibal also spoke about today's consumers who seek best possible products at the lowest possible price; this is a big challenge for the global industrial community. India has been successful in meeting this challenge in certain cases, which is exemplified by the influx of pharma companies to India for contract research. Similarly, a host of players from the automobile industry are manufacturing their products in India. He also expressed belief that this trend would see India becoming a breeding ground for the development of new drugs in the future.

Mr. Sibal also stressed on the need to encourage industries to participate in initiatives such as low-cost housing projects, providing access to clean drinking water and sanitation, literacy drives and healthcare services at affordable prices. He concluded the session by stating that the individual's mind must be acclimatised to the market and vice versa, and that the mind and the market would have to work in harmony.

The next speaker in the session was Dr. A.P.J Abdul Kalam. He focussed on a framework termed the 'World Knowledge Platform' that would integrate the core competencies of the partner countries with a view to

developing knowledge products. In the initial phases, the main objective of the platform would be to connect R&D institutions, universities and industries by using fibre broadband from the partner countries on certain select 'R&D Missions'.

Stressing on the power of fibre optics, Dr. Kalam pointed out that it can make the world a borderless place. He spoke about the use of fibre optics in academic institutions to teach courses online and its application in the industrial world to design complicated systems such as an aircraft.

The Hon'ble President also shared his experience in designing, developing, producing and marketing a missile system, which was an Indo-Russian joint venture. It involved the core competencies of both the nations and paved the way for the creation of a billion-dollar business. He used this example to home in on the need for synergy between the core competencies of different nations in order to produce world-class products at reduced costs. The resultant products would be internationally competitive and would hence be able to service a large market.

Dr. Kalam also pointed out a few areas that needed to be brought on to the 'World Knowledge Platform' with utmost urgency:

- Energy-exploration, storage and production and conversion
- Water-treatment, sustainable use, efficiency in use, desalination technology; healthcare-diagnosis, drug delivery system and life-long care
- Agriculture and products Production, preservation, processing and storage and distribution
- Hardware, software and networking products and user interfaces
- Automobile industry Hardware and embedded software integration and assistance in transport system through GPS
- Traditional medicine Herbal and natural products and collaboration with modern bio-product manufacturers

The Hon'ble President presented a model of Energy Independence which would enable the country to fight the challenges posed by the depletion of fossil fuels. He pointed out that India aims to achieve energy security by 2020 and Energy Independence by 2030. He also stated that the energy mix required to achieve Energy Independence could be achieved using the following four sources of power hydel and thermal power (till coal reserves are available), solar power using high-efficiency CNT-based SPV cells and wind energy, thorium-based nuclear reactors and bio-fuel for the transportation sector. Dr. Kalam also ventured to talk at length about the Carbon Nano Tube (CNT) technology, stating that various nations need to proactively collaborate in order to overcome the R&D challenges in this field.

Touching upon the nuclear energy sector, Dr. Kalam stated that India's nuclear power generation capacity is expected to increase from 3,900 MW to 7,400 MW by 2010 and further to 24,000 MW by 2020. He also focused on the use of thorium instead of uranium for nuclear power generation.

The Hon'ble President also suggested a few steps to be undertaken during the 5th World Energy Conference, New Delhi, in order to increase power generation through wind energy. These steps include conducting studies to explore potential sources of power such as off-shore wind farms, working towards the standardisation of wind turbine power plants and identifying alternate sources of energy for the transportation sector.

Speaking about the agricultural sector, Dr. Kalam placed emphasis on the high-yielding variety of seeds, tissue culture and clonal propagation, global warming, radio isotope and farming and atomisation. He focused on India's need to embrace mechanization for providing the right quantity of water and nutrition to the crops.

Dr. Kalam spoke about the convergence of technologies during the session. He stressed on the need to amalgamate nanotechnology and ICT. This, said he, would lead to material convergence; from the marriage of material convergence and biotechnology will be born a new science called 'Intelligent Bioscience', which would lead to a disease-free and more intelligent human habitat with greater longevity and higher human capabilities.

The session ended with Dr. Kalam bringing forth the concept of 'Creative Leadership'. Creative leaders would help mobilise the resources of the country to produce products and systems and meet market demands, he said.

The session was concluded by Dr. T. Ramasami. He remarked that India has truly started off on the journey from mind to market under the aegis of the President, Dr. Abdul Kalam. He also lauded the Science and Technology ministry, led by Mr. Kabil Sibal, in providing the necessary legal framework which will help the industry collaborate with research institutions and help foster an innovative mindset in India. Dr. Ramasami finally thanked all the speakers for their valuable comments on the topic.

Key Recommendations

- Considering the huge amount of R&D investment in India which was USD 2.9 billion in 2001 to USD 8.5 billion in 2005, new laws should be framed similar to those on the lines of the Bayh Dole Act of the US to utilize the R&D efforts in public funding institutions.
- Develop the framework “World Knowledge Platform” in the areas of energy, water, healthcare, traditional medicines, automobiles, agriculture and food and knowledge products, which will integrate the core competencies of the partner countries to develop knowledge products. The Platform will enable joint-design, development, cost effective production and marketing of the knowledge products in various domains based on core competency of the partner national in international markets. The mission of this Platform would be to connect and network the R&D institutions, universities and industries using fibre broad-band from partner national on select R&D missions.

Plenary Session 1

India The R&D Destination

The first session of the 'India R&D 2006' conference was dedicated to discussing India as an R&D destination. Mr. Kapil Sibal, Minister for Science and Technology and Earth Sciences, chaired the session. Dr. Chris Henshall, Pro-Vice Chancellor of External Relations, University of York, UK; Dr. Tony Hey, Corporate Vice-President, Technical Computing, Microsoft Corporation; Mr. Benard de Montferrand, Ambassador-at-large at the Ministry of Industry, Former Ambassador to India and Japan, France; and Mr. Ashish Gupta, COO and the Country Head of Evalueserve, were the eminent dignitaries who spoke on the occasion.

In his opening address, the chairman Mr. Kapil Sibal, remarked that India is set to emerge as a leading R&D destination for the world, and he touched upon various cases from the recent past to support his optimism. He emphasised the fact that even R&D dedicated to finding India-specific solutions can produce adjuvant global solutions.

Mr. Sibal cited two reasons for India's significance an R&D destination. First, any R&D solution designed in India has access to a large market. Second, India possesses a huge resource base comprising high-quality human capital. In the final analysis, a combination of low-cost economy and high-quality human resources makes India an ideal R&D destination.

Mr. Sibal expressed concerns over certain issues that have a global impact, including diseases such as TB and HIV-AIDS plaguing the poor of the world; global warming; climate change; and carbon dioxide emissions. He also urged governments to overcome the existing inattention that the agricultural sector suffers from. Neglecting this sector would lead to a food crisis, given the fact that global population is growing alarmingly. He opined that new technologies need to be developed to pre-empt this situation. Such technologies would benefit not only India but the entire world. He further remarked that India should emerge as an R&D destination for economies across the world.

The next speaker Dr. Chris Henshall stated a few basic requisites that a country needs to ensure in order to be a successful R&D destination. These include:

- A world-class system to promote science and innovation
- High-quality publicly funded scientific infrastructure which would work in coordination with the industry
- R&D-intensive businesses, facilities and services to support the creation of hi-tech businesses
- Human resources with a flair for innovation

Dr. Henshall cited some steps adopted by the UK Government in this direction.

- Promoting innovation and enterprise as a key feature of the country's economic policy
- Aiming to increase R&D intensity from 1.9 percent to 2.5 percent of the GDP by 2014
- Awarding incentives to the private sector, including tax credits through different kinds of collaborative programmes with public and private organisations in the field of research
- Focussing on spurring the interaction between the business community and universities
- Funding knowledge transfer networks that help in bringing business professionals and academics on the same platform to facilitate the sharing of ideas and opportunities

Dr. Henshall put forth the example of his own university to explain how government policies work at the ground level interaction with the business community is a part of the core curriculum at the University of York. The university is developing research facilities that can be employed in joint business initiatives. The university is also part of many knowledge transfer networks and partnerships and collaborative research endeavours. It also boasts of a wide range of shared facilities, such as the biotechnology facility, Nero Imaging, etc. In addition, the university features various outward-facing research groups and has forged a wide range of collaborative R&D partnerships with industry leaders. The university also conducts a range of enterprise programmes and provides research facilities to its staff, students and local businesses.

Dr. Henshall also spoke about Science City York, a partnership between the city of York and the University of York. It is backed by its regional development agency and works in close coordination with local businesses. Science City York focusses on the development of three key clusters bioscience, creative industries and IT and digital.

Science City York operates in the following areas:

- Providing business support to hi-tech companies
- Facilitating the development of support systems needed for professional services, finance and property
- Encouraging the development of skilled workforce locally in order to address the HR needs of businesses active in the region

Dr. Henshall remarked that the success of Science City York has encouraged the formation of five new Science Cities based on the same model.

Further, Dr. Henshall discussed a similar model the White Rose University Consortium which works at the regional level. This consortium is the result of a strategic partnership between Yorkshire's leading universities Leeds, Sheffield and the York.

Dr. Henshall concluded his speech with the following points:

- To emerge as a successful R&D destination, a country needs internationally accomplished scientists and cutting-edge infrastructure.
- The scientific community must appreciate the importance of collaborating with the business community.
- Successful R&D destinations also require innovative businesses that are willing to and are of capable of interacting effectively with the scientific community.
- The government should finance basic science and provide the right incentives to universities and businesses.

The next speaker in the session was Dr. Tony Hey. Dr. Hey spoke about some of the key drivers which would play a crucial role in propel innovation in the future. He drew the audience's attention to the large number of Indian graduates working in Microsoft. He also spoke about the Microsoft Research Laboratory which was recently set up in Bangalore.

In his speech, Dr. Hey attached significant importance to computation. Computation has pervasively transformed the sciences, including life sciences and material and social sciences. He asserted that technical computing will be the 'heart' of all innovations in the future. He also discussed the emergence of e-sciences and data-centric sciences. Disciplines such as bioinformatics, genomics and drug design require multiple teams with varied skill sets to co-function in synergy. E-sciences, he said, will support all such 'collaborative-networked' sciences. However, this calls for high performance computing and information management.

Dr. Hey remarked that Microsoft plans to work with Indian scientists in areas such as advanced computing for science and engineering, in order to find solutions based on data sensor networks for new-age problems accompanying the evolution of science and engineering; smart agriculture; GM crops; and climate change and hydrology.

In conclusion, Dr. Hey reiterated Microsoft's inclination to collaborate with the scientific and business communities in India in order to deliver applications that will cater to the world in general and India in particular He also remarked that the end objective of technical computing is to speed up the process of innovation and enable businesses to transition from 'mind to market'.

The next speaker Mr. Benard de Montferrand came to India as a diplomat to help the French competitiveness cluster in their efforts to develop international relationships. He announced that India is perceived as a front-running R&D destination by France.

Mr. Montferrand focussed on the new French policy on R&D which emphasises innovation. France introduced a new innovation policy a year and a half back that not only focussed on expanding the budget for R&D but also encouraged private expenditure on R&D. He also spoke about four new institutions that have been set up for financing R&D expenditure. Nearly 15 competitiveness clusters were finalised after the establishment of these institutions.

Mr. Monteferrand placed considerable emphasis on the role of cooperation. Cooperation, he asserted, will have to be accorded primacy at different levels, including clusters, companies, laboratories, etc. To attain to such a degree of cooperation, the industry needs to organise regular workshops that will bring together the Indian and French clusters, labs, companies, academia, etc.

The last speaker in the session was Mr. Ashish Gupta. His speech addressed the challenges that inhibited India's growth in the past and outlined the positive changes that the country is now witnessing.

Mr. Gupta pointed out that R&D activities in India are suffering from the lack of commercialisation owing to the following three reasons:

- Indian culture has never encouraged the practice of making money by selling knowledge.
- Socialistic economic policies stifled innovation and firms were not awarded any incentives to innovate.
- The British rule had left the Indians bereft of innovative thinking.

However, things have changed slowly after 1991. R&D expenditure has increased manifold. Not only the Central government but also the private sector has started funding R&D activities. Mr. Gupta shared an interesting observation with the audience in India, product development or the commercialisation of technology requires lesser capital investments than in the US because of the purchasing power parity that characterises the Indian economy. Mr. Gupta pointed out that there is now a proliferation of institutes in India for the promotion of innovation and R&D. He also mentioned that the schemes operated by the government as well as the academia have met with some degree of success. In keeping with the general atmosphere of growth, the country is also witnessing the establishment of various clusters.

Mr. Gupta stressed on the need to focus our attention on R&D in the rural areas of India, since these areas constitute 70 percent of our economy. Some programmes have already been initiated in the rural areas, but much more remains to be done.

Mr. Gupta concluded his speech by saying that public mindset needs to change if the journey from mind to market has to be completed without major hiccups. He came up with the following recommendations to ensure this:

- On the policy side, India should follow the footsteps of countries such as the US, UK, Japan and China; those involved with research need to awarded more incentives.
- Acts similar to the Bayh Dole Act in the US could be implemented in India as well.
- The academic curriculum in India should be revamped and better accreditation mechanisms should be put in place.
- Efforts should be made to educate the public and exorcise the negative feeling associated with the commercial use of innovation.

Key Recommendations

- Government should create databases based on sensor networks which should have a record of data such as surface temperatures, atmospheric data etc. Scientists should work in conjunction with technologists to create innovations in the areas of agriculture, crops, climate change and hydrology.
- There should be research facilities for business groups to encourage knowledge transfer networks and partnerships. There should be offices similar to those on the lines of 'active enterprise and innovation office' with managers who can understand the business and its needs, and with researchers who have the required skill sets. These offices would also act as the interface seed corn funds and venture capitalists.
- For the development of emerging industries, academia, industry and government should be brought together based on the 'Science city' in the city York. This would help a business venture to expand and grow by providing the required ecosystem. This would lead to the creation of more jobs and wealth inflows in the 'Science city'.
- There are 450,000 engineers from India every year, out of which only 20 percent are hired for jobs. Considering this, an appropriate curriculum should be introduced and a better 'Accreditation mechanism' should be established. This would help in promoting more private colleges and research institutions.
- As the conventional mindset is a roadblock in the transition of ideas from mind to market. The mindset should be changed by creating role models of successful entrepreneurs through TV shows etc.

Special Session

Opportunities for International Collaboration on R&D

Dr. T. Ramasami, Secretary, Department of Science and Technology, Government of India, chaired the special session of the 'India R&D 2006' conference. Mr. Y. P. Kumar, Head, International Divisions, Department of Science and Technology (DST); Prof. David Begg, Principal, Tanaka Business School, Imperial College, London, UK; Dr. Orna Berry, Venture Partner, Gemini Israel Funds, Israel; Prof. Thomas Christaller, MD, Fraunhofer Institute for Intelligent Analysis and Information System, Germany; Dr. Milkos Boda, President, National Office for Research and Technology, Hungary; and Eng. Ahmed Obeid Hassan, Director General, Industrial Research and Consultancy Center (IRCC), Sudan, were some of the other dignitaries who graced the occasion. The session was dedicated to discussions on the topic 'Opportunities for International Collaboration on R&D'.

While speaking on India's positioning vis-à-vis cooperation with other nations in the field of science and technology, Mr. Y. P. Kumar touched upon the funding structure for research in India. He noted that research is mainly funded by the government, universities, R&D institutions, autonomous organisations, private industries and NGOs. He also talked about the various research-oriented scientific departments under the Ministry of Education.

Mr. Kumar laid special emphasis on the Science & Technology International Cooperation (STIC) programme being run by the DST. The main objective of this programme is to boost India's presence in international cooperation on the emerging focus areas in science and technology. The speaker listed the following advantages of a programme like this:

- To develop first-hand global acquaintances
- To gain access to international research facilities
- To benefit from the experiences of the international research community
- To share the results and the cost of research with the partner countries
- To participate in mega science projects
- To create world-class facilities, centres of excellence, joint ventures, etc., to promote R&D
- To demonstrate India's capabilities in the area of science and technology

Mr. Kumar pointed out that DST runs various regional and multilateral programmes in addition to the international cooperation programme. Currently, DST runs two centres for the promotion of advanced research and two more are under formulation.

Mr. Kumar concluded his speech by informing the audience about the focus areas for the programme in the future. He also spoke about his division's plans to enhance cooperation with select countries and forge public private partnerships for the benefit of science and technology in the country.

The next speaker Prof. David Begg spoke about the factors driving international collaboration in the area of science and technology in the UK. He expressed conviction that India will emerge as a leading knowledge economy in the future and remarked that the UK wishes to partner India in her journey.

During his speech, Prof. Begg referred to the efforts made by the Imperial College, London, to encourage public private partnership. The college is also trying to integrate its business school and its scientific community, in a bid to effect a seamless transition from mind to market.

Prof. Begg asserted that public private partnerships are crucial for the prosperous existence of universities and research institutes. Imperial College has launched the Rajiv Gandhi Centre for Innovation for the purpose of developing a network between UK- and India-based companies; and the universities; research organisations; and governments of the two countries. The centre, Prof. Begg claimed, will not only act as a portal to the Imperial Science Campus for India but will also encourage multinationals based in London to pursue their interests in Indian firms operating in the area of science and technology.

Dr. Orna Berry, the next speaker, spoke about Israel's failure to market its innovations. She spoke at length about the Office of the Chief Scientist. The Office, according to Dr. Berry, focuses on channelling R&D for economic growth. This initiative has accelerated technology and knowledge transfer in Israel. The Office also conducts various international activities. The formation of the BIRD Foundation was one of the major milestones in the history of Israel's participation in international collaboration. This foundation helps build partnerships between Israeli and American firms.

The next speaker Prof. Thomas Christaller spoke at length about the Fraunhofer Institute and its collaboration with the ADA Software Group, an SME in India. The institute had planned to develop service robots, a project involving multi-disciplinary research. The institute developed a robot construction kit named VolksBot, which could be used in universities for research and physical prototyping in service robot applications. The ADA software was involved in the distribution and manufacturing of VolksBot in India.

Dr. Miklos Boda was the next speaker in the session. He spoke about the innovation strategy adopted by Hungary. Hungary plans to expand its R&D budget and also aims to boost private contribution to R&D. The Hungarian government is trying to link the country's strong academic research base with the industry. Hungary has also implemented an act on the lines of the Bayh-Dole Act in the US, which would help cement linkages between the academia and industry. Certain key areas, such as life sciences, ICT, food industry, bio energy and nanotechnology, occupy a central position in the government's R&D initiatives. The Hungarian government has also established three new common 'laboratories' to enhance international cooperation. The first laboratory in the field of nanotechnology was developed in collaboration with Russia; the second one, developed in collaboration with France, is dedicated to research in the field of biotechnology; and the third facility caters to the Ambient Intelligent project in collaboration with Germany.

The next speaker, Eng. Hassan, spoke about Indo-Sudanese relations in the light of the following points:

- India is an important trade partner of Sudan.
- The two countries have established a functional joint business council.
- India has extended two EXIM Bank lines of credit to Sudan.
- India's ONGC-OVL is active in the oil and gas industry in Sudan.
- The two countries have signed 11 agreements on economic, cultural and technological cooperation.

Following this, Eng. Hassan spoke about Sudan's comprehensive national strategy on science and technology. He sounded optimistic about the steps taken by Sudan's Ministry of Science and Technology to encourage applied research and technology transfer in the fields of food security, agriculture and agro processing, animal resources, biomedicine and pharmaceuticals, environmental studies and engineering. It also supports the construction of incubators and science parks. He also informed the audience about 'Sudan Technology City', a hub for IT activities. As a part of this project, the government plans to set up a science park managed by specialised professionals. Sudan Technology City aims at increasing the wealth of the community and promoting innovation and competitiveness. According to Eng. Hassan, the government intends to stimulate and manage the flow of knowledge and technology among universities, R&D institutions, industry and the market. Further, he spoke about the various incentives that the government has awarded to the industry.

Key Recommendations

- Education in India should be deregulated so that both the quality and the quantity of researchers trained can increase with the industry requirements.
- Increase the number of incubation centres to provide a platform required for innovation and commercialisation of the R&D to a larger number of innovators/researchers.
- Joint research centres should be built in collaboration with international research institutes, to leverage the specific technical expertise of different nations. Bi-national funds should be created to assist the local industries to collaborate in international markets.
- To effectively utilise the R&D work done in public funded institutes, innovation supportive legislation such as Bayh-Dole act should be enacted.

Plenary Session II

R&D Infrastructure in India

The second plenary session of the 'India R&D 2006' conference was dedicated to discussions on the topic 'R&D Infrastructure in India'. Mr. Habil F. Khorakiwala, Chairman, Wockhardt Limited, and President Elect, FICCI, chaired the session. Prof. Samir K. Brahmachari, Director, Institute of Genomics and Integrative Biology; Dr. K. K. Gokhale, Managing Director, Konkan Railway Corporation Ltd; Dr. Gopichand Katragadda, Head, GE Global Research, Bangalore; Dr. Natarajan Venkateswaran, Vice-President (R&D), Materials and Engineering Research, Reliance Industries Limited, were some of the other dignitaries present during the occasion.

While providing a brief overview of the Indian pharmaceutical sector, Mr. Khorakiwala noted that research activity in this sector has witnessed significant growth as compared to the past decade. A number of companies are involved in various stages of drug discovery and development at present, and 12 to 13 new chemical entities are undergoing clinical research. He cited the example of Wockhardt to support his optimism: started in the biotechnology sector eight to nine years ago, Wockhardt has today developed the capability to construct genes and even carry them all the way to the production level. India's research budget, he estimated, would almost double from the existing USD 8-9 billion to approximately USD 18-20 billion in the next five years.

Following this, the speaker went on to compare the R&D budgets of USA, China and Japan and stated that India still has a long way to go to match the quantum of research activity achieved by these countries. However, he also opined that India is on solid ground owing to the excellent quality of human resources available in the country in almost every scientific field. At the same breath, he pointed out that India would needs close to 300,000 people over the next five years in order to keep up with the pace of global research and innovations.

Mr. Khorakiwala drew attention to the fact that many global organizations, such as GE, Philips, Motorola and Novartis, have set up research bases in India. He pointed out that GE and Philips have their second largest research bases in India, following those in the US and Europe. Mr. Khorakiwala argued that the level of competitiveness, openness to change and innovation is quite high in India, notwithstanding as shown by the improvement in the competitive index. He informed the audience that the Krishnamurthy's Manufacturing Competitive Council, of which he was a member, had identified innovation as the main driving force for India in the future. He opined that to support such a high level of innovation, India would have to foster strong academia-industry linkages as in the West.

Following the Chairman's address, Prof. Samir K. Brahmachari spoke about new developments in the field of biology in China and asserted the need to compare them with those in India. He argued that though India has all the resources human and material to compete with any other nation, it suffers from a dearth of ideas when it comes to innovation. He dared Indian innovators to think beyond what is visible, expect the unexpected and break away from the beaten path. He asserted that there are four key elements required to create an environment that promotes innovation creativity, knowledge, innovation transfer and incentives. (Prof. Brahmachari further noted that the Indian industry has already instituted a successful system of incentives.)

The speaker also stressed upon the virtue of thinking beyond our times by citing the example of the Human Genome Project, the goal of which was to decode the entire human genome sequence. He pointed out that the researchers working on this project did not have advanced instruments or technology, but they had strong self-belief. Unfortunately, India failed to realise the opportunity which some other countries seized in 1990. It was as late as in 1996-1997 that any real efforts were made in this direction with the establishment of what is now known as the Institute of Genomics and Integrated Biology (IGIB), by Prof. Brahmachari himself. He said that when China joined the sequencing effort in 1998, India decided not to contribute to the sequencing technology, instead choosing to concentrate on projects to unravel the function of the genome. India was believed to have immense

opportunities in this field, thanks to its large population, large families and genetic diversity. In keeping with this, India gambled with an unconventional route and invested just USD 2 million in sequencing compared to USD 60 million by. Prof. Brahmachari informed the audience that India started analysing the genome and amalgamated this with a disease-based approach; these efforts were rewarded in the form of breakthroughs in computing techniques and bioinformatics. IGIB forged collaborations with a host of reputed hospitals and doctors and created the largest genetic resource pool covering a significant number of complex disorders, while other countries were still engaged in sequencing. According to Prof. Brahmachari, the difference lay in the Indian approach of assimilating hospitals in the R&D network rather than engaging in sequencing. This unique approach made the headlines when the first bio-informatics software was built and commercialized in 2003, with funds from the Chatterjee group. In 2004, the largest PPP was set up with the support of the Department of Science and Technology (DST). India also pioneered the recombinant growth factor drug, REGEN-D.

Prof. Brahmachari remarked that it is the young researchers of the country rather than the senior scientists who fuelled these breakthroughs. He said that the new campus of IGIB is expected to absorb approximately 450 researchers compared to the present 200, and leveraging this massive workforce to deliver greater yields at a low cost will be a big challenge.

Moving on, Prof. Brahmachari touched upon the creation of the G N Ramachandran Knowledge Centre, the largest bioinformatics facility in the country. He apprised the audience on a major project on drug target development undertaken by this organisation. He also spoke about the organisation's tie-up with TCS Biosuit and the software co-development and commercialization initiatives undertaken jointly with Jaleja Technologies. He stressed upon this new innovation model in which a project is carried out in alliance with the industry rather than looking out for markets after developing a new idea.

Prof. Brahmachari also briefed the attendees about the Centre for Genomic Application, which was inaugurated on 11 May, 2001, in Delhi and was awarded grants of approximately USD 6 million each by the DST, CSIR and the Chatterjee Group. The objective of this facility, said Prof. Brahmachari, is to free scientists from centralised operations; this would go a long way in reducing costs, optimising government expenditure, nurturing the biotechnology and pharmaceutical industries, and catalysing the genomic revolution in India. The facility broke even last year and the surplus is being utilised for further research and supporting entrepreneurs. Situated in Okhla, Delhi, the institute has become a tourist destination! It is currently working towards the establishment of an incubation club involving fresh talent and ideas. The institute will also offer incubation space to various industries in the future.

The next speaker Dr. K. K. Gokhale spoke about the challenges faced by the Konkan Railway Board while laying tracks spanning 220 kms of mountainous terrain. This railway line was conceptualized differently from other lines in the country a new type of anti-collision mechanism was developed for the first time in India in collaboration with M/s. Karnex Micro Systems. This achievement was especially significant since it was set off by one of the most ghastly railway disasters ever in Bengal. Dr. Gokhale stated that these anti-collision devices do not interfere with the existing signaling or other systems; they take over only when a potential threat is perceived by the system. This anti-collision mechanism, he claimed, can be installed anywhere in the world irrespective of the pre-existing systems. Hence, Konkan Railway Corporation has secured a worldwide patent for it.

Dr. Gokhale informed the audience that in October 2001, extended field trials were conducted on the Jalandhar-Amritsar section, where 250 units were fitted over a length of 100 kilometers. As a result, the number of accidents in that section reduced dramatically and the system was given due recognition in the White Paper on safety. He also stated that the Konkan Railway Corporation was awarded a contract of INR 949.1 million by the North Frontier Railways.

According to Dr. Gokhale, the key to the success of this innovation was the combination of the professional knowledge of the Konkan Railway Board a public sector company and the technical expertise of Karnex. He asserted that this project exemplifies the importance of the 'mind to market' concept. However, the speaker rued the fact that the anti-collision system is struggling to gain mass acceptance because of bureaucratic constraints and the non-continuity of officers in establishments such as the Railway Board.

Following this, Dr. Gokhale proceeded to speak about another innovation the sky bus metro, which runs on an environment-friendly and cost-effective technology. He informed the audience that a test track has already been built in Goa, and the Konkan Railways is currently setting up a certification process for it.

The third speaker of the session, Dr. Gopichand Katragadda, started by defining innovation as the output derived from individuals and organisations engaged in creating new values. He said that these entities are interdependent and neither can produce innovation in isolation.

Dr. Katragadda argued that innovation should be driven by the requirements of business and the demands of the consumers. Innovation, reminded the speaker, is a function of three steps create, nurture and change. In the creation phase, an innovator is free from expectations and worries and can therefore think clearly; however, it is imperative for the thinkers to reach out and gauge the mood of the market. He further added that there is an urgent need to break down the barrier between the thinkers and those who lead the process of execution. He opined that is the best ideas are the most vulnerable; therefore, it is crucial for the stakeholders to have patience and remain focused, so that they can maintain synergy with those who control the fate of research. In the final analysis, what matters most is the ability to change and design strategies that can adapt to the ever-changing needs of the consumers. Constant revaluation is the call of the hour even for products developed for the Western market so that we can adapt these to the Indian conditions when required.

Dr. Katragadda pointed out that India possesses a vast pool of intellectual capital, which is a major attraction for industry majors such as GE; thanks to the influx of global players into the Indian market, even Indian professionals settled abroad are willing to come back to the country if given the opportunity. He added that setting up an R&D unit in India is not very difficult today, since the large number of existing R&D setups can facilitate the sharing of knowledge and equipment, making the environment truly conducive to innovation. He criticised Indian educational institutions for relying too much on bookish learning rather than on applied learning and for churning out a large number of graduates without caring much about the overall quality of education.

Dr. Katragadda also reminded the audience of the restrictive effects of bureaucracy and urged innovators to take on the mantle of market leaders and not languish as followers. He reiterated the importance of understanding the needs of the industry before initiating process of innovation and stressed upon the need for adequate funding and protection of intellectual property.

The next speaker Dr. Natarajan Venkateswaran began by briefing the attendees about innovation at Reliance Industries. He spoke about the four Indian research centres of Reliance, touching about the organisation's plans to set up a corporate research and technology centre. He also drew attention to Reliance's collaborative efforts with premier research institutions and industries in the country.

Dr. Natarajan commented that research today has turned multidisciplinary as opposed to the nature of research three to four decades ago and that the level of sophistication and investments required has also increased exponentially. He was of the view that out-of-the-box thinking and a complete roadmap of concepts culminating in commercialization is an urgent need today.

Referring to R&D infrastructure, he stressed on the importance of optimally utilizing the existing infrastructure before launching a process of proliferation. Citing the example of the IITs, Dr. Natarajan said that they are already equipped with the required infrastructure and they only need to ensure efficient utilization of these resources. He called for the creation of more premier research institutes, which would cater to research in

focused areas. He also advocated the setting up of networked digital libraries to enable scientists to access any publication at the click of a button, without wasting too much time in locating it. Dr. Natarajan pointed out that India lags behind in R&D as compared to countries such as the USA and Japan, where funding is mostly the prerogative of the industry. As opposed to this, in India, the government is the chief contributor. The commercialisation of R&D, he observed, receives a shot-in-the-arm from industry funding, as is evident from the example of Japan.

Dr. Natarajan blamed the tendency of our education system to stifle creative thinking in students for the woeful shortage of new ideas from the country's hefty human-resource base. He argued that an ideal curriculum must foster innovativeness and creativity and encourage young students to put on the thinking cap.

Key Recommendations

- The collaboration between industry, academic institutes and government needs to be strengthened. New research centres should be created from such collaborations to fulfil the increasing demand of researchers.
- Networked digital libraries and other such knowledge sharing networks should be established to facilitate the dissemination of knowledge and innovation.
- The focus on education and training should shift more towards applied learning and in upcoming areas such as nanotechnology and biotechnology.
- R&D funding from private sector should increase substantially as it results in higher rates of commercialisation of the research being conducted. Presently, the government is providing almost 75 percent of the funding in order to increase the overall R&D expenditure.

Plenary Session III

Public Private Partnership The Way to Commercialise Innovation

The plenary session-3 of the 'India R&D 2006' conference aimed at discussing the commercialisation of innovations through public-private partnerships. The session was chaired by Dr. K. Kasturirangan, Member of Parliament, Ex-Secretary, Department of Space. Dr. P. Anandan, Managing Director, Microsoft Research India; Dr. D. Yogeswara Rao, Head, Technology Networking and Business Development Division, CSIR; Dr. Kathryn Walsh, Director, Electronics-enabled Products Knowledge Transfer Network (KTN), Loughborough University, UK; and Dr. Norman Kaderlan, President, Technology Innovation Group, USA, were the eminent dignitaries who presented their views during the session.

Dr. K. Kasturirangan initiated the discussion with a few general observations. First, he spoke about innovation as a key resource for sustaining economic growth in a competitive world. He emphasised that innovation requires rapid commercialisation, which could be achieved by collaboration between universities, government departments, research labs and the industry. He opined that creation of innovation clusters, enhancement of IP acquisition and expansion of R&D budget are the basic requisites for encouraging innovation.

Dr. Kasturirangan sounded extremely positive about the growth of private equity and investment in India. He pointed out that developments in micro technologies, nano technologies, applications, disaster management support, water support systems, high-end technology for manufacturing new materials, etc., could benefit significantly from Public Private Partnership (PPP).

Dr. Kasturirangan concluded his speech with a reality check on the strength of the foundation for PPPs in India. The various elements required for PPP include public financing, basic research conducted in universities and labs, policies to attract the best global talent in science and technology, and collaboration between universities, governments, research labs and the private sector.

Dr. P. Anandan, the first speaker in the session, referred to the experience that he had garnered while working with the Microsoft Research Lab in the area of research partnership. He emphasised the fact that PPP is critical in creating an atmosphere conducive to research and development. He cited a few research partnerships developed by Microsoft Research Lab during the past one and a half years.

- The first project was called 'Virtual India'. This project sought to bring Indian imagery and cartographic data online. Dr. Anandan remarked that this project could not have been successful without support from the Survey of India and the Government of India.
- The second project is based on sensor development and is being conducted in close coordination with IIT Bombay.
- The third project addresses the problem of poor educational content and quality of teaching in rural areas. The model followed in the project taps effective teaching content and practices from good schools in urban areas and uses them to educate the rural population.

Dr. Anandan stressed on the fact that none of these projects could have been possible without Microsoft Research Lab's partnership with various other organizations.

Dr. Anandan concluded the session by stating that public institutions, the government and private organisations have to play a critical role in complementing research endeavours by the scientific community. He suggested that a consortium jointly funded by public and private organisations be set up for ushering in 'grand societal challenges'.

Dr. D. Yogeswara Rao, the next speaker in the session, shared his experiences related to the development of PPP in the country and the success of CSIR in this direction.

Dr. Rao stated that under the programme 'New Millennium Indian Technology Leadership Initiative', all projects are developed in the PPP mode. Each project involves at least one industrial partner. Nationally evolved as well as industrially originated projects are developed under this programme. The speaker claimed that six years after the commencement of the programme, 42 well-structured projects have been developed across various sectors. Today, the programme has 287 partners, including research groups as well as private industries. Currently, it is the largest PPP in the country in the R&D domain.

Subsequently, Dr. Rao assessed the status of the programme six years (INCONSISTENT?)after its launch. He pointed the following achievements of the programme over this fiveyear period:

- Filed three INDs in the health sector: psorasis based on single-plant herbal formulation, TB molecule, and lysostaphin
- Developed three herbal formulations
- Developed software such as Biosuite, a bio informatics software; Genocluster; Darshee, a visualization software for bio informatics area; and Varsha GCM, a software for monsoon prediction.
- Developed 128-node super computers
- Developed technologies for producing cellulose, hemicellulose, lignin from bagasse and lactic acid from sugarcane juice and for bio processing of skins and hides
- Obtained 50 international patents and holds over 70 peer-reviewed publications

Almost all the above projects, observed Dr. Rao, required collaborative efforts from various research institutions, private organisations and government bodies.

Dr. Rao concluded the session by stating that the 'New Millennium Indian Technology Leadership Initiative' programme had successfully brought several Indian stakeholders on one platform. Further, he pointed out that the success of this programme has induced other funding agencies to adopt the PPP model to launch similar projects.

Dr. Kathryn Walsh, the next speaker in the session, spoke about a group of organisations called the Knowledge Transfer Networks (KTN) in the UK. This network drives the flow of human resources, knowledge and experience between the industry and academia. It links companies, universities and supply chains between businesses in different sectors. The network also helps the government in the allocation of funds for supporting the R&D initiatives of various companies.

Dr. Walsh concluded the session by expressing conviction that national boundaries will not act as barriers if the different government departments, industry and academia work in synergy. She informed the audience that Indians formed the third largest national group within KTN.

The last speaker in the session was Dr. Norman Kaderlan. He spoke about the innovation support system developed by his group. Dr. Kaderlan pointed out that innovation support is currently in a fragmented state and is also ridden by the lack of coordination and inefficiency. Local research, argued the speaker, needs to be given adequate time for maturation before it can be exposed to commercialisation. This comprehensive innovation support model reduces the risks associated with the commercialisation of technology to a certain extent.

Following this, Dr. Kaderlan discussed the various aspects of the innovative support system, beginning with the stakeholders involved:

- Universities and R&D labs
- Industries, which include major multinational corporations or SMEs
- Governments, which include national, regional or municipal governments
- Industry associations, which may be professional societies or knowledge transfer networks

Dr. Kaderlan further stated that the creation of innovation-friendly culture is contingent upon the availability of the following:

- Trained human resources
- Access to technology
- Access to capital
- Access to entrepreneurial business knowledge
- Robust business infrastructure
- Financial, marketing and distribution mechanism
- Supportive public policy
- Supportive culture

Dr. Kaderlan also focussed on the need to implement robust mechanisms for the commercialisation of innovation. He pointed out that a regular flow of funds is of critical importance during the early stages of any research initiative. He also emphasised the importance of constantly evolving educational programmes at all levels. Proactive innovation, said the speaker, is the need of the hour.

Key Recommendations

- Public private partnership model should be adopted in the upcoming research areas, such as medical technologies, nanotechnologies and its applications, disaster management support, water support systems, and hi-end technology for manufacturing new materials.
- Public and private institutes should establish a joint consortium to undertake research in strategic domains or areas of national importance. This consortium should serve as a common platform for the sharing of resources amongst all the involved individuals and organisation including NGOs and research labs.
- Knowledge Transfer Networks, dedicated to various research fields, should be established. Such knowledge sharing networks should facilitate the knowledge sharing amongst all the involved organisations and provide a clear structure to ongoing and future research activity.
- In addition to the afore-mentioned initiatives, the Initiatives which could help in creating a favourable environment for innovation should be taken, such as setting up of a technical advisory council for entrepreneurs, commercialisation of technologies targeting mass markets such as rural India, and providing early development stage funding to the new ventures.

Plenary Session IV

Innovation to Incubation

The fourth session of the 'India R&D 2006' conference was dedicated to discussions on the topic 'Innovation to Incubation'. Dr. T. Ramasami, Secretary, Department of Science and Technology (DST), Government of India, chaired the session. Dr. Jim Dukowitz, Principal, Technology Innovation Group, USA; Prof. S. Mohan, Professor, Department of Instrumentation, Indian Institute of Science, and Chief Executive, Society for Innovation and Development; Dr. Gary J. Jones, Manager, International Partnership Development, Sandia National Lab, USA; Mr. Peter Harman, Deputy Chief Executive, UK Business Incubation, UK; and Ms. Jane Davies, Vice-Chairman, United Kingdom Science Park Association (UKSPA), were some of the other eminent dignitaries who spoke on the occasion.

The first speaker Dr. Jim Dukowitz spoke about the concept of 'proactive innovation', which he described as a method to foster the formation of technology-based, high-growth businesses in emerging economies. He argued that the creation of such businesses is essential for emerging economies. However, problems such as a fragmented ecosystem impeding the commercialisation of innovations; cultural antipathy towards wealth creation from knowledge; scarcity of skilled manpower; lack of indigenous technologies; ignorance about intellectual property creation and transfer; and lack of markets for certain new technologies make it difficult for these economies to sustain such drives. Referring to public welfare programmes such as vaccination drives, which are a regular feature in most emerging economies, Dr. Dukowitz observed that these initiatives are disconnected from the concept of wealth creation; little attention is paid towards innovation, entrepreneurship, and new business creation as means to deliver these services, which results in extremely low returns on investment.

Dr. Dukowitz went on to describe the concept of 'proactive innovation' as involving the following six steps:

- First, the needs of the market and the society as a whole should be proactively identified and rated based on their priority in consultation with the government and private sector.
- Next, entrepreneurs and experts from the government, universities and industry should proactively work towards developing innovative solutions in each 'need' category.
- Specific technologies should then be sourced these technologies should be identified, screened, assessed, and then transferred to the appropriate host country.
- Further, skills related to the technologies that are sourced should be transferred to the host country through training programmes. Simultaneously, new expertise evolving around the newly sourced intellectual property should be created within an enterprise in the host country.
- The next step is to develop a viable financial plan, secure gap funding to validate markets, create prototypes, secure intellectual property and pay the licensing fee. The technology should then be transferred to a business incubator or a business accelerator, where it can be exposed to the process of commercialisation.
- Lastly, the newly set-up businesses should be encouraged to collaborate with local universities, research institutions and companies for developing products and services based on that technology.

Dr. Dukowitz cited the example of the technology partnership between Jordan and the US and argued that the contribution of a foreign technology partner shrinks with time as the host country develops its own technological capability. The collaboration between the two then reduces to just marketing and licensing agreements. He stated that the innovation support system, which helps in bringing about such a transformation, needs to be bolstered with the following important resources: stakeholders; a strategy formulation team which helps select experts in creating business concepts and devising technology solutions; technology sourcing teams working to identify indigenous and foreign technologies and aid appropriate companies or entrepreneurs in the host country in adopting these technologies ; and adequate capital inflow to enable these companies to access the markets.

Dr. Dukowitz opined that proactive innovation helps in utilising the existing resources to address key market and societal issues. It helps an emerging economy to stand on its feet by tapping domestic entrepreneurial reserves, creating domestic intellectual property and tech-savvy domestic companies with support from the global R&D community.

The next speaker Prof. S. Mohan spoke about innovation in academic institutions. He lamented the limited interaction between the country's universities and the industry, which frequently leads to incompatibility in goals. He observed that while the R&D activities hosted by universities are driven purely by scientific motives, the industry tailors R&D activities to focus on products and consumers. This scenario, he asserted, must change for the mutual benefit of both parties.

Prof. Mohan attributed this divide to multiple factors. He noted that the academia is ignorant about the needs of the industry; therefore, it does not customise its research to the industry's requirements. Academicians tend to work in isolation, whereas the industry needs a more multi-disciplinary approach. To address this issue, Prof. Mohan suggested the formation of agencies to help scientists form peer groups and effectively interact with the industry.

He cited the following examples of successful collaborations between the Indian Institute of Science with major multinationals on specific R&D projects:

- A collaborative research lab was set up at IISc by General Motors for conducting research on lightweight materials for the automotive industry.
- IISc worked with six foreign universities on Boeing's 787 Dreamliner project.
- Cookson Electronics visited the IISc campus to conduct research on lead-free solder.

These research collaborations helped the IISc faculty understand the industry's requirements and initiate projects focusing on multi-disciplinary research. Moving on, the speaker stressed upon the importance of clusters with reference to the emphasis laid by IISc on five clusters, namely, transport; micro and nano-technologies; pharmaceuticals, drugs and vaccines; energy; and environment. He specifically spoke about CAR, the Core Group on Automotive R&D, which has been established at the IISc to provide a common platform the automotive industry, academic institutions and companies from abroad. He informed the audience that organisations such as the Society for Automobile Manufacturers (SIAM) and NASSCOM as well as the Ministry of Heavy Materials have held successful meetings with a few European companies in a bid to identify potential projects, such as transportation for the upcoming Commonwealth Games in India.

Prof. Mohan concluded by emphasising the importance of creating a network of liaison offices to enable technology creation and commercialisation. He also advocated networking between industries and academic institutions from Europe, the USA and India.

The next speaker Dr. Gary J. Jones spoke about the policies adopted by the Sandia National Labs, USA, on technology creation and incubation. He informed the audience that one of the first things Sandia did to forge industrial relationships was to develop an IP-centric view within its people. It encouraged researchers to disclose their inventions and helped them understand the strategic value of intellectual property in terms of financial rewards that can be garnered by licensing technologies. He stated that Sandia worked with due diligence towards attaining expertise in the patenting process, which they had lacked previously.

Moving on, Dr. Jones discussed the following three methods adopted by Sandia to put its incubators to effective use:

- Entrepreneurial development: Sandia provides entrepreneurs access to intellectual property, but only after training them in its nuances. It also helps them identify and engage an organisation for technology venture cooperation and development of business acumen.
- Licensing and partnering with existing companies: To keep the industry informed about its activities, Sandia publicises frequent press releases through its communications staff. It uses partnering options, such as CRADA and WFO, which follow certain specific federal intellectual property laws. The IP ownership policies and royalty sharing plans adopted by Sandia demand a royalty of 20 percent on any invention that is commercialised. The laboratory also monitors the licensees licenses are cancelled if a company does not commercialise the licensed technology.
- Special programmes and technology accelerators: Dr. Jones spoke about Sandia's involvement in collaborative research in certain geographies involving external funding and involvement of the target community/region. Referring to the 'industry-lab partnership' initiative in New Mexico of which many universities, government labs and other entities are a part he argued that this mechanism of partnering facilitates commercialisation of new products every three to five years. This programme, he pointed out, was very similar to the Jordan S&T initiative discussed earlier in this report.

Dr. Jones asserted that the transfer of technologies from lab to industry is a difficult task requiring the implementation of programmes in the lab itself and not just in the incubator. Finally, he emphasised the need for regional or national funds in addition to the allocated R&D funds, especially in the case of innovations.

The next speaker Mr. Peter Harman offered an overview of the business incubation industry in the UK. He informed the audience that the UK Business Incubation (UKBI), formed in 1987, is the national body that looks after the business incubation industry in the UK. He pointed out that there are many incubators in the UK, which, besides developing products and ideas, also focus on the need to develop entrepreneurs in order to take forward the culture of innovation. He further noted that virtual business incubation is fast gaining popularity in the UK, with almost 15 percent of the business incubators providing virtual environments. Moving on, he discussed about the National Business Incubation Framework, which follows a two-dimensional model. This framework, he pointed out, focuses on the importance of processes, people and infrastructure, and recognises that an intellectual property is developed in three phases: foundation phase, development phase and the mature phase (when the incubators attain complete functionality after a considerable period of time).

Mr. Harman stated that there exist more than 280 business incubation environments in the UK, which together form a diverse mix consisting of entities ranging from hi-tech firms to social enterprises (sometimes defined as social incubators). This development acquires special significance given the fact that business incubation in the UK was considered to be a failure about nine years ago, when this segment in countries such as the USA was miles ahead of the handful of incubators operational in the UK. The situation has considerably improved since, but most incubating environments are still at a nascent stage. Mr. Harman opined that entrepreneurs must be trained to run incubators through academic programmes, which would equip them with all the skills required for the job.

Mr. Harman pointed out that in the list of countries based on the number of incubation environments per capita, Finland is at the top; the UK, Sweden, Germany, the USA and New Zealand are placed roughly in the middle; whereas countries such as, India and China are placed at the bottom of the list owing to their large populations and fewer incubators.

He briefed the audience on a review undertaken to identify extremely innovative incubation environments in 43 developing countries by a global consortium of business incubation environments. The consortium found three such incubators located in Chennai, Vellore and Trichy in India, which are supported by the World Bank. He lauded the efforts of the Department of Science and Technology (DST) in promoting such incubators in India and hoped that similar efforts would be staged in the UK as well.

The final speaker Ms. Jane Davies referred to Science Parks as one of the agencies working towards bridging the gap between entrepreneurs and business. She asserted that unlike most which evolve from incubators and have only two to three employees, Science Parks contributes more towards economic growth by creating a larger number of jobs. (NOT CLEAR)She stated that the main objective of Science Parks is to create a wealthier community by promoting innovation and competitiveness in businesses and knowledge-based institutions.

Ms. Davies informed the audience that the very first Science Parks founded in the UK were economic development initiatives to offer an alternative source of jobs to the country's manufacturing industry, which was on a decline. These parks involved the participation of universities in both the public and private sectors. She cited the example of a Science Park established in Manchester in 1984 as a private company with public, private and academic stakeholders.

Ms. Davies informed that the UK Science Park Association, UKSPA, represents 66 fully operational Science Parks across the UK and plays host to approximately 3,000 hi-tech companies, a majority of which have fewer than 15 employees. These professionally managed Science Parks support business development and promote networking among companies, while providing business development advice and infrastructure. She pointed out that according to UKSPA Commission's independent research; on-park companies demonstrate higher growth rates in terms of employment and turnover in comparison to off-park companies. Further, on-park companies accessing VC and angel finance experience greater growth in their businesses.

Commenting on the future of the Science Parks, Ms. Davies argued that industrial research directors are swiftly tapping new innovations from smaller companies rather than spending on expensive corporate research. The universities are also recognising the fact that in some cases, licensing new technologies to existing companies is a better option as compared to forming spinouts. She also noted that technology-based Small and Medium Enterprises (SMEs) do not aspire to grow too big these days, rather preferring to focus on their core competencies and form flexible partnerships with other companies to exploit market opportunities. A Science Park provides such companies with a large pool of potential partners and collaborators and also enables them to establish contacts with universities. She opined that these Parks can also help foreign companies gain access to local networks and new markets.

Key Recommendations

- There should be a liaison office to every R&D institution to encourage commercialization of the research. These liaison offices would work together to encourage the close functioning of the industry and the academia such as CAR, IMTMA, NASSCOM, etc. These offices would also help in the close functioning of industry and the academia from different countries.
- The possibility of setting up large-scale incubation systems in the form of Science Parks should be explored, These Science Parks should be based on the 'open innovation system' to encourage SMEs to undertake research and promote overall competitiveness in the business. These science parks should support innovation, and provide pathways to access universities and research institutions, while generating wealth for the country.
- Incubation facilities to encourage pro-active innovation, i.e. the process stimulate early creation of technology-based high-growth competitive businesses in emerging economies should be established.

Plenary Session V

Science and Entrepreneurship

The fifth session of the 'India R&D 2006' conference was dedicated to discussions on science and entrepreneurship in the country. Prof. Dwarkanath D Kale, Consultant Research and Technology, Reliance Industries, chaired the session. Prof. Sanjay G. Dhande, Director, Indian Institute of Technology, Kanpur; Dr. Shailendra Vyakarnam, Director, Centre for Entrepreneurial Learning (SIEL), Judge Business School, University of Cambridge, UK; Dr. Suhas Patil, Chairman of the Board, Digite Inc., USA; and Dr. Shyam Rao, Head of Smart Card Technologies, Advanced Technology Centre, Tata Consultancy Services Ltd (TCS), were the eminent dignitaries who spoke on the occasion.

Prof. Sanjay G Dhande spoke about IIT Kanpur's policies on science and entrepreneurship and its achievements in the field of science and technology (S&T), research and innovation. He outlined the basic roles expected of a university as follows:

- Creation of knowledge
- Dissemination of knowledge
- Conversion of knowledge to wealth

Prof. Dhande lamented that a majority of Indian universities, apart from the elite ones such as the IITs and IISc, are not making much headway in the conversion of knowledge to wealth. He attributed this to the negative attitude of the academia towards entrepreneurship.

Prof. Dhande expressed approbation for IIT Kanpur's efforts to promote entrepreneurship similar to foreign universities such as MIT, which earn a significant amount of revenue through IPR. He cited a few essential steps that a university needs to adopt in order to create a culture conducive to innovation and entrepreneurship. These include:

- The faculty must be sensitised to the concept of entrepreneurship.
- Following the example of the IITs where IPR cells have already been established, the entire academia must strive to create IPR awareness among their corpus of teachers and students,
- Finally, policies need to be developed at the highest level of governance in order to encourage students and faculty to take up entrepreneurial vocations.

The software boom between 1995 and 1997 inspired many students to establish themselves as entrepreneurs in the software industry. The incubation centres at IIT Kanpur established in collaboration with the government extended commendable support to students, enabling them to set up successful ventures. Prof. Dhande cited some more successful incubations facilitated by IIT Kanpur. These include:

- A student developed a control system for aerospace systems and has subsequently been winning contracts from the Defence Research and Development Organization.
- IIT Kanpur is also involved in the Technology Development Mission for Railways, under which 12 different projects have been started in collaboration with the industry, Ministry of HRD and the Railways Ministry.
- Pioneering projects on RIFD technology, databases and operational management are also underway at IIT Kanpur.

Prof. Dhande stated that students who are engaged in various projects at IIT Kanpur are encouraged to set up business enterprises if their idea is deemed fit for commercialisation. They are urged to take on the mantle of job-creators rather than job-seekers. A facility called the Four-I Lab has been set up to achieve this end, with the 'Four-I' standing for 'Innovation, Implementation, Integration, and Incubation'.

Prof. Dhande said that in the past, entrepreneurship was viewed as the last resort for people who failed to get jobs! The concept of starting a company was merely perceived of as setting up a workshop and manufacturing machine components. He asserted that this ideology has almost faded out today and true entrepreneurial spirit is being accorded due respect and importance. He concluded his presentation by appealing to the academic community to commit itself to promoting entrepreneurship in the country.

Dr. Vyakarnam, the next speaker in the session, presented a case study on Cambridge University's Entrepreneurship Training Programme. He informed that in 1999, the UK Government decided to step up its efforts in promoting science entrepreneurship in universities such as Cambridge. Universities were awarded grants to establish 'UK Science Enterprise Centres' with the overarching objective of facilitating the inclusion of entrepreneurship education as a part of the curricula.

At Cambridge University, the original entrepreneurship centre was converted to the Cambridge Enterprise, which is basically a technology transfer office. The Centre for Entrepreneurial Learning was established as a sub-division of the Cambridge Enterprise, with the aim of promulgating the spirit of enterprise and administering entrepreneurship courses to students of science, engineering and technology. An integral feature of the Centre's modus operandi is to invite entrepreneurs to impart education on entrepreneurship. This process of entrepreneurship training is implemented in three stages: inspire, inform, and implement. The students are inspired to learn from the successes of real entrepreneurs; they are informed about basic practices such as writing business plans; and are finally helped by the Centre to implement their ideas through incubation. These programmes are mainly targeted at post-doctoral students so that their knowledge can be converted into successful businesses.

Dr. Vyakarnam apprised the audience that Cambridge has developed 14 entrepreneur networks, and about 200 entrepreneurs visit the campus regularly to interact and impart training at the Centre for Entrepreneurial Learning. The centre offers approximately 40 different courses and modules for post-graduate, undergraduate and doctorate groups. Some of the salient features of these courses cited by the speaker include:

- Action-learning programmes such as Student Business Plan Competitions which are organized to familiarize students with the process of entering the industry, raising resources and modes of industry and the fundamentals of business.
- A programme called 'Enterprisers' designed especially for undergraduates has been created in partnership with the Massachusetts Institute of Technology (MIT).
- 'Enterprise Tuesdays' have been designated for the local business community to interact with university students.

As a result of these initiatives, the Cambridge Cluster is now a large community of1400 hi-tech clusters with a cumulative GDP growth rate almost equivalent to that of India! Dr. Vyakarnam drew attention to the fact that the Centre for Entrepreneurial Learning at Cambridge University has managed to procure 157 VC deals and approximately 280 million pounds of investment in the period from 2003 to 2004.

The next speaker Dr. Suhas Patil spoke about the importance of entrepreneurship and the ecosystem required for fostering its growth. He asserted that entrepreneurs and not large corporations or governments need to act as engines of change in an economy. To support his argument, he cited the example of the United States, where more than half of the employment is generated by small companies.

Dr. Patil stressed on the importance of entrepreneurship as an integral part of the entire innovation lifecycle starting from university-level fundamental research. For the fruits of this research to percolate down to the

industry, proper supporting mechanisms and environment must be in place. The speaker opined that the success of the Silicon Valley can be attributed to a pre-established framework of mentoring, seed capital acquisition, IP creation, etc. This results in a highly concentrated environment which allows entrepreneurs to set up their business with minimum problems.

Dr. Patil reiterated the benefits of entrepreneurship to society, including the creation of wealth and employment and the germination and nurturing of broad-minded individuals. He urged all entrepreneurs at large to extend their support to young entrants, so that the latter can fruitfully convert their business ideas into businesses.

The last speaker in this session was Mr. Shyam Rao. Mr. Rao spoke about the need to synergise the efforts of the government, academia and industry so that the benefits of innovation can be extended to the society at large. He applauded the recent progress made by India in developing S&T infrastructure and innovation capabilities, as demonstrated by the establishment of R&D centres at major corporations in India. He attributed this to India's vast intellectual capital reserves and superior English language capability as compared to other countries such as China. However, he questioned the actual conversion of this wealth into tangible gains for the country.

Mr. Rao analysed the process of innovation from the perspectives of the entrepreneurs, government, investors, and citizens. Innovators, said he, are entitled to seek protection for their intellectual property from piracy, and a rigid legal system needs to be put in place for providing adequate protection from infringement. He stressed the government's role in creating legal infrastructure that will not only ensure the required level of IP protection but will also foster a pro-innovation environment. He asserted that the government should not only encourage the innovation and commercialisation efforts launched by large institutions, but also support and encourage small innovators to contribute ground-breaking innovations. He urged innovators and research institutions to disclose their inventions, thereby ensuring that the benefits of a useful innovation are extended to the masses.

Mr. Rao commented that most venture capitalists (VCs) perceive innovation in terms of return on investment and the quantum of risk involved. He argued that most innovations are worth taking a risk for since they emanate from the rigorous thought process of an intellectually well-endowed person or a group. He categorised investors as belonging to either one of the following two categories: the ones who are genuinely interested in innovation and focus on long-term benefits, and others who only look for opportunities that can potentially yield quick profits. Mr. Rao asserted that we need more investors of the first type, who will treat R&D seriously and be fully committed to the cause of innovation.

The speaker finally touched upon the apathy of the general public towards innovation and R&D; however, he expressed optimism that this viewpoint is showing signs of change as is evident from the public protests against certain varieties of R&D, such as the animal testing of drugs.

The talks were followed by an open-house discussion. The conclusions/key points/highlights/opinions from the discussion are summarised below:

- The Government is planning to set up new institutes and universities dedicated entirely fundamental research.
- Individual innovators who are sceptical about the government's efficacy IP-protection can approach the IITs for support.
- The choice to become an entrepreneur lies entirely with an individual, but an effective ecosystem must be in place nonetheless.
- Entrepreneurship training must be made a mandatory educational requirement. An individual must think like an entrepreneur even if he/she works as a part of a large organisation.
- The industry and the technical institutions must provide proper guidelines to the entrepreneurs and equip them in with appropriate training on manufacturing practices.

- Young entrepreneurs must be counselled on the choice of a career on a long-term basis; they need to be kept away from the tendency to find jobs and make quick money.
- The government must introduce programmes which inform young people about the potential of entrepreneurship. Awareness must be created about the most effective strategies to convert the knowledge gained from science and technology institutes to a successful entrepreneurial career.

Key Recommendations

- Entrepreneurship must be encouraged at research institutes and engineering colleges across the country to provide support to technology start-ups. The establishment of incubation centres IPR cells is a step in this direction.
- Ecosystems for entrepreneurship should be created by bringing together law firms, venture capitalists and the researchers in some concentrated geographical regions on the same lines of the Silicon Valley.
- Awareness and a culture of entrepreneurship should be created, by hosting events such as business plan competitions and by introducing courses and modules on entrepreneurship. Such courses should be conducted by the successful entrepreneurs so that they can provide the required motivation to the students.
- Fundamental research provides a strong technology background for the further technological developments. So Government should open up new research institutes dedicated to the fundamental research. While supporting the research activities, Government should also enforce a strict legislation to the intellectual property rights of inventors.

Plenary Session VI

Strategic Use of Intellectual property as a Wealth Generator

The sixth session of the India R&D 2006 conference was dedicated to discussions on the topic Strategic Use of Intellectual Property as a Wealth Generator. The session was chaired by Dr. Ajay Dua, Secretary, Department of Industrial Policy and Promotion, Government of India. Mr. Jon Dudas, Under-Secretary of Commerce for Intellectual Property and Director of the United States Patent and Trademark Office, co-chaired the session. Mr. Jon Sandelin, Senior Associate Emeritus, Stanford University Office of Technology Licensing, USA; Dr. Alison Campbell, Managing Director, KCL Enterprises, King's College, London; and Dr. R.R Hirwani, Head, CSIR Unit for Research and Development of Information Products, were the eminent dignitaries who spoke on the occasion.

In his welcome address, Dr. Dua remarked that ideas and knowledge are the real assets of an enterprise rather than physical assets such as factories and buildings. He drew attention to the fact that more than 50 percent of the national exports are based on indigenous IP in countries such as the US, whereas most other countries are largely unaware of IP as a potential source of wealth.

The next speaker, Mr. Dudas, spoke about the importance of intellectual property rights (IPR) in context of the US. He remarked that IPR has been an integral part of the US constitution ever since it was drafted. Consequently, the US has developed one of the strongest IP regimes globally. He drew audience attention to the fact that IP accounts for almost 45 percent of the US GDP. He referred to a World Bank study, according to which there is a direct correlation between the increase in the number of patents and the increasing economic growth of the US. He remarked that foreign inventors and investors have significantly contributed to the growth of intellectual property in the US as approximately 45-48 percent of all patents in the US are issued to foreign citizens.

Mr. Dudas further informed the audience that the US is home to a global IP academy for training American and foreign government officials in IPRs. Major efforts are also underway to educate small businesses in the US about IPRs and investing in foreign countries. He drew attention to the fact that small and medium businesses (SMEs) in the US contribute to almost 75 percent of the economic growth and 40 percent of total exports. He concluded his speech by highlighting the following benefits of a strong IPR regime:

- It facilitates technology transfer and FDI.
- It encourages R&D in universities and research institutes.
- It enables the pursuit of new technologies and businesses.
- It facilitates revenue generation from licensing, JVs and other IP-based transactions.

The next speaker in the session, Mr. Jon Sandelin, spoke about the importance of IP and various licensing models being used to commercialise it. He informed the audience that prior to the enactment of the Baye-Dohl Act, 1980, the 'open-science' model was prevalent in the US. As per the 'open-science' model, universities retained no IPR for its inventions because the findings were made public through publications and presentations. Since the research findings were almost exclusively owned by the industry, there was little incentive for the universities to invest in the potential applications of their discoveries.

Mr. Sandelin cited the following two reasons for the enactment of the Baye-Dohl Act:

- Strengthening the economy by using innovations created in the universities
- Commercialising government-sponsored innovation, which was earlier not being utilised for the overall betterment of society

Mr. Sandelin lauded the efforts of an organisation called the Association of University Technology Managers (AUTM), which has been highly instrumental in the success of the American IP regime. It has over 3500 members and facilitates networking among universities, industries and the government. According to a survey conducted by AUTM, universities across North America earned nearly USD 1.4 billion in royalty till the late eighties, translating into approximately USD 54 billion in licensed product sales in the same period. This resulted in the creation of 435,000 new jobs and led to 18,000 invention disclosures. However, after the introduction of the Baye-Dole Act, the royalties earned were negligible, with new technology requiring time to mature and become commercially viable. The speaker termed this phenomenon as the 'time-lag effect'.

The speaker remarked that the 'innovation model' is prevalent in Asia, where the focus is on forming new ventures and securing patents and not on valuation, selection and marketing. Government institutes in Asian countries produce a large number of innovations with commercial potential, compared to those produced by universities. In addition, compared to the US, there is greater utilisation of research parks and incubators in Asian countries. Continuing the comparison with the US, he remarked that in most Asian countries, barring India, governments are involved in this activity on a much larger scale.

He concluded by suggesting the creation of a professional association where innovators and entrepreneurs can network and discuss ideas through publications and conferences.

The next speaker in the session was Dr. Alison Campbell. She talked about the initiatives of the government and universities in the UK for promoting R&D commercialisation. She stated that the UK government recognises the importance of research in business; therefore, it actively encourages industry and academia to work together on R&D programmes. It has set up a Higher Education Innovation Fund (HEIF) to provide support to universities for knowledge transfer, apart from complementary mechanisms to encourage the application of IP, both at national and regional levels. Government initiatives, such as the University Seed Funds and Proof of Concept Funds, help nurture innovative ideas in their initial stages.

Dr. Alison remarked that like the UK government, universities also impart prime importance to the concept of a knowledge economy. University policies are increasingly embracing third-stream activities, i.e., knowledge transfer, in addition to accepted university functions such as teaching and research. She apprised the audience that every university in the UK, including King's College, has a knowledge transfer office that is staffed with trained professionals and offers support in the form of expertise, financial resources and networks. At King's College, the knowledge transfer office operates as a part of KCL Enterprises which is responsible for commercialising the IP originating from King's College. Its typical tasks include IP-protection; patenting and licensing; spinout company formation; and facilitating partnership with the industry. Dr. Alison cited the following two examples of successful incubation at KCL:

- It licensed 'personalised medicine', a system of diagnosis where a patient can be administered medication according to his/her response to it.
- A company called Proximagen, which was spun out from King's, raised 18 million pounds when it was listed on the country's stock exchange.

Dr. Campbell concluded her speech by citing the examples of two organisations that provide the necessary support for the commercialisation of innovations.

- UNICO: UNICO is a membership-based organisation for commercialisation and knowledge transfer professionals. It holds regular meetings and publishes best practice guides that cover almost everything from the execution of material-transfer agreements to obtaining a spinout company license. UNICO also works towards shaping the national agenda in favour of universities and the commercialisation process.
- Praxis: Praxis is a non-profit organisation that imparts training for technology transfer. The organisation conducts trainings in various aspects pertaining to the knowledge transfer process, including licensing,

spinouts and business development. These courses are conducted by volunteers who share their expertise in the processes involved in commercialisation, including business development, technology transfer, etc.

The last speaker in the session was Dr. R.R. Hirwani. His speech addressed the strategic use of IP information or pat-informatics. Pat-informatics is the science of analysing patent information to discover certain relationships and trends. This information can be extremely useful in determining the commercial and scientific value of a patent through the study of certain indicators such as the level of patenting activity in a field. For instance, a large number of patents in an area imply that a number of players are involved; their technological strategies can then be studied to determine the value of a particular patent. Pat-informatics provides insights in the following areas:

- Technology competition analysis: Pat-informatics can be used for technology competition analysis, where competitors' technologies can be studied and emerging technologies can be identified.
- The level and nature of diversification of a company and industry: This provides information about the area of diversification of each company and the way the industry is maturing as a whole. The speaker gave the example of the optical fibre industry in the 70s, when a majority of the patents were secured in the domain of optical fibre synthesis. However, in the 90s, most of them were related to the integration of optical fibres; this clearly implies a major shift towards integration.
- Identifying technology leaders: Pat-informatics helps in identifying technology leaders who may be potential partners for R&D alliances, joint ventures, partnerships, acquisitions, etc.
- Benchmarking a company's R&D programme: A company's R&D programme can be compared with those of other companies to determine the extent of its uniqueness, cost-effectiveness and market acceptance.
- Improving research allocation: Through pat-informatics, the R&D process followed by an inventor/company can be evaluated to ensure that only highly competitive technologies are focussed upon while undertaking research. Using pat-informatics, companies/inventors can also determine the growth rate of an industry.
- Patentability analysis: An inventor can study existing patents to conduct a patentability analysis of his/her own invention in an attempt to determine its novelty, non-obviousness and utility.
- Analysis of IP portfolio: A research institution or a company can analyse its IP portfolio to decide whether to license, sell or develop a particular patent. It can even discard a patent if that particular technology becomes obsolete.

He finally informed the audience that CSIR is actively involved in undertaking IP studies for both foreign and Indian customers. The scope of these studies includes technology scenario analysis, competitive intelligence, new product development, research planning; and patentability analysis and validation.

The following is a list of the findings/recommendations revealed at the end of the session:

- The patent protection time for drugs must be reduced so that even developing countries are able to enjoy their benefits before disease-causing agents become resistant to these drugs.
- The patenting process must be made quicker and cheaper so that a larger number of SMEs are able to patent their products.
- Universities should be given discounts on fees at various stages of the patenting activity.
- Patents are not important in the case of the software industry because software speed to market is extremely high and their cost of production is low, thereby enabling quicker returns. Thus, copyrights, which are easier and cheaper to obtain, are more suited for this industry.
- In India, information regarding patents is now publicly available, and all patent offices across the country have been networked with each other. This has increased the chances of a patent being commercialised for industrial use.
- Through an amendment in the Patent Act of India, only new improvements in food products, pharmaceuticals and agrochemicals can be patented. This amendment is meant to prevent market monopoly by individuals who own product patents.
- The legal framework should be strong enough to protect an inventor from the possible infringement of his rights.

Key Recommendations

- A training framework should be established to increase the awareness about IPR, especially for small and medium enterprises.
- Universities should support the entrepreneurial initiatives taken by the faculty of the institutes, by providing the required flexibility.
- Professionally managed knowledge transfer units should be, established with in the universities to commercialise the research done in the university. Such university enterprise can provide the patenting and licensing services to the faculty as well as provide a required networking with the industry.

Valedictory Session

India and R&D in 2020

The valedictory session of the 'India R&D 2006' conference 'Mind to Market' was chaired by Dr. R. A. Mashelkar, Director General, CSIR and Secretary, DSIR; Dr. Montek Singh Ahluwalia, Deputy Chairman of the Planning Commission, Government of India spoke on the occasion. The vote of thanks was presented by Dr. Amit Mitra, Secretary General, FICCI.

Sounding upbeat about the new face of India, Dr. R. A. Mashelkar expressed conviction that India would successfully effect the transition from mind to market.

Dr. Mashelkar pointed out that the journey from mind to market has become highly complex in the globalised world. It is heartening that India has managed to cope with the dynamic trends in this area; the country is fast emerging as a global R&D hub, with several companies setting up their R&D centres here. He also pointed out that 25-30 percent of the patents in most companies originate in India. He remarked that India is now experiencing a phase of 'Brain Circulation' as opposed to brain drain.

Dr. Mashelkar drew the attention of the audience to another interesting concept the shift in the geography of science. The speaker indicated that knowledge-creation activities are shifting base from the US and Europe to China, India, Singapore and other Southeast Asian countries.

Following this, Dr. Mashelkar compared the progress made by China and India in the field of R&D. He rued the fact that India is still languishing in the quest for the mind's supremacy over mindset. Though the Indian mind has shown futuristic impulses, our collective mindset has been inhibiting our growth. On the other hand, he observed, the Chinese mindset has undergone a complete metamorphosis over the years.

However, Dr. Mashelkar expressed optimism by stating that India will achieve success in the long run, thanks to the three Ds:

- Democracy the ability to think and act freely
- Diversity a veritable pool of experts in different domains
- Demography a large army of young minds oriented towards innovative thinking

Following this, Dr. Mashelkar referred to professionals such as Kiran Mazumdar who have emerged as icons not merely through their achievements in business but through their role in encouraging innovations as well. The youth of the country idolise them as role models, and their inspirational presence will help India along the journey from mind to market. He lauded the new act modelled on the lines of the Bayh-Dole Act that the Indian government has decided to introduce in India.

Dr. Mashelkar reiterated the fact that India's upcoming youth brigade would hold the key to her future success. However, the speaker reminded the audience that the country requires 'young innovators' and not just 'young minds'. Young innovators, he said, are people 'who don't know that it can not be done'.

Dr. Mashelkar touched upon the following points while concluding his speech:

- Innovation has become a buzzword for all enterprises.
- India is witnessing a proliferation of public private partnerships.
- India needs to ensure inclusive economic growth; the lower strata of the population must also benefit from the process.

The next speaker Dr. Montek Singh Ahluwalia indicated the areas in the field of R&D that merit special attention.

Dr. Ahluwalia argued that the liberalisation of the Indian economy is a powerful move towards technological modernisation. According to him, the demand for new, innovative technology would increase significantly in the days to come, and it would be impossible for companies to sell technologically inferior products.

Subsequently, Dr. Ahluwalia pointed out that India's intellectual capital reserves can match those possessed by any other country. Moreover, the country's burgeoning population signifies that even a small coterie of intellectuals translates into a sizeable force. However, even though India has a number of elite higher-education institutions, our annual output of engineering graduates is effectively not too high. In fact, argued the speaker, the perceived abundance of engineers in the country is a result of extremely low domestic demand. He urged all stakeholders to rethink their methods, so that the country's skilled and capable population can be employed domestically. This, he asserted, is the most important task at hand for the government.

Dr. Ahluwalia argued that public money should be spent on research in strategic areas that need indigenous R&D. In addition to this, he remarked that public money should be spent on commercialisation in laboratories, exposing universities to commercial currents and encouraging the community to set up incubation centres.

While concluding his speech, Dr. Ahluwalia drew comparisons between India and China. He praised the Chinese for their success in restructuring universities, en-route meeting the growing demands of a global and increasingly competitive research environment.

The last speaker in the session Dr. Amit Mitra broached the following points:

- The government needs to establish connectivity between the university system and the entrepreneurs.
- The research community in India needs to lay emphasis on interdisciplinary activities . It should, for instance, pave the way for dialogue between a mathematician and a biotech professional.
- The government needs to encourage the building of clusters of science and business.
- The university system needs a transparent structure to activate avenues of wealth creation.
- The government must intensify its involvement in the process of research and development.

Key Recommendations

- The universities should create extra wealth by conducting research for the industry and thus add to the compensation level of the faculty, using a transparent structure. Such a system would automatically regulate the academic salaries as well as create an interface between the industry and the academia.
- Indian research institutes should exploit the developed markets by using mechanisms such as licensing. The higher prices in developed markets would bring back higher royalties which can be utilised for further research and attracting the competitive talent pool.
- The applied research should be focussed towards producing the low cost technologies and products such as a computer costing USD 100, a car costing USD 2000. Such low cost products would not only serve the mass market of India, they can also compete effectively in global market owing to the cost-advantage.
- The educational system should focus on improving the average quality of researchers that are being produced so that the full potential of the existing cost advantage is realised.