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Liberalizing Research in Science and Technology: Studies in Science Policy — Report from an international conference

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The international conference held at IIT Kanpur February 4th–6th, 2009 was co-organized by Dr. Binay K. Pattnaik (Convener) and Dr. Nadia Asheulova. 52 papers were presented over three days by scholars from six countries: India, Russia, Mexico, China, USA and Canada. The largest contingent of foreign delegates was from the Russian Federation. After welcoming the participants on Feb 4th 2009 morning, the Convener spelled out the Conference rationale and objectives.

Rationale:

The impact of globalization acquires significance for developing countries in general, and in particular, for countries that pursued closed door policies for decades based on socialistic regimes. Research in science and technology (S&T) in these countries also tended to be inward looking (based on policies of self-reliance) and S&T in these countries was organized in different models (e.g. Russian Academy of Sciences, Chinese Academy of Sciences, etc.). It hardly needs emphasizing that globalization has led to liberalizing S&T policies in these countries in terms of becoming more outward-looking and relaxing policy barriers for interactions with international scientific communities. Liberalizing research policies also

involves removing policy barriers within S&T enterprises, which means promoting closer interaction among scientists in academia, industries and government departments (known as the triple-helix). Liberalizing research policies, thus, involves internal structural reforms in the organizational and operational principles of universities and academic institutions, industrial research laboratories and R&D based industries. Improved interactions and co-operation among institutions not only helps cross-fertilize ideas, but also helps to supplement strengths by filling in much wanted expertise.

By and large these have been the directions of liberalizing research policies globally. Hence, any attempt to study research policies requires such explorations as (I) outward-looking (internationalization) and (II) dynamically inward-looking (promoting triple-helix interactions). The theme of the Conference was, thus, conceived from the viewpoint of developing countries; in particular, those that followed closed door policies. Further, since the Conference was conceived on the basis of a 'triple-helix' model, it required participation from scholars in diverse areas S&T policy studies.

In view of this theme, scholars were invited mainly from developing countries and from countries that practiced closed door policies. India and Russia both had socialist regimes and have now switched over to free market economies through policy liberalization. Similarly, although it currently has a socialistic regime, China is fast moving toward a market economy through slow, steady, cautious policy liberalization. Equally pertinent are the experiences of some Latin American countries, for example, leaders like Mexico, which have nuanced S&T policies. Scholars and scientists from these countries have much to share and learn from each others' experiences.

The objectives of the conference were:

1. To assess the effects of liberalization (and restructuring) in S&T research policies so far (in the erstwhile socialistic countries and other developing countries) and their contribution to excellence in S&T research,

2. To emphasize the need for further liberalization and reforms in S&T research policies (i.e. excellence in research necessitates liberalization) through shared knowledge of attempts, strategies and experiences by international partners and;

3. To propose further possible areas and models of liberalization and co-ordination among the triple-helix components.

Presentations — Key notes and Thematic Sections:

The Conference was inaugurated by IIT Kanpur's Director, S.G. Dhande, who underlined the need for liberalizing research in S&T. To him, research liberalization in S&T means much more than removing or shrinking bureaucratic procedures for decision making, executing policies and allocating funds. Liberalization in this context means liberalizing the mindsets of people in S&T, shedding disciplinary boundaries and engaging in truly interdisciplinary research. The scope of interdisciplinary research, he noted, is in fact very wide, because it is not confined only to synergetic efforts among certain sister disciplines in sciences to address a phenomenon; even technological disciplines should be inducted (this in sociology of sciences is called model Mode II). Dhande transgressed interdisciplinary research boundaries further, saying that if S&T is to fight basic human and social problems such as hunger and nutrition, poverty, diseases, crime and other developmental issues like infrastructure and capacity building,

then it has to work with social scientists and historians as well. True liberalization would build upon a synergy of efforts among researchers from S&T and social sciences, while pursuing problem-oriented research.

Then followed key note addresses by invited speakers. P. Anandan, Managing Research Director of Microsoft India, spoke on industrial R&D in India. He pointed out the changing global perception of India as an intellectual power because of huge technical potential from Indian scientific and technological manpower. India is now increasingly shaping and participating in high technology endeavors worldwide. Other than select examples, however, industrial R&D in India is not comparable with that of the west. Anandan emphasized the extraordinary role R&D plays in innovation and development in industry. Drawing heavily on the 2008 EU Industrial R&D Investment Report, Anandan tried to show how Europe is emerging as the major R&D hub, and how India is benefiting from globalizing R&D and its subsequent out-sourcing policy. He particularly pointed out the movement toward knowledge-based economies, where academia has a great role to play in innovative research and collaboration with the corporate sector. Further, he pointed out the emergence of entrepreneurial universities, where research is market oriented, and universities earn huge revenues from patenting and industrial research consulting. Academics are becoming knowledge-based entrepreneurs themselves. Anandan argued strongly for enhancing research capacities by building adequate and quality infrastructure and by producing a large poll of competent scientific and technological manpower.

In the second key note address, O. N. Mohanty, V. C., Biju Patnaik University of Technology, discussed how to leverage the knowledge economy under globalization to enhance the high potential of India, particularly in the knowledge-based technology sector. He impressed the strong technological tradition in India with the example of the 'Damascus sword'. Further, while articulating the critical role of ICTs (particularly software) in India's technological future, Mohanty harped on developing a customized, mass production system to face fierce competition and co-operating to build technological capabilities through a technical manpower base. He further dwelled upon the importance of creating a knowledge base that includes indigenous locals through strong IPR cultural practices and of developing capabilities and mechanisms to translate this knowledge base to the market. Finally, Mohanty stressed India's need for research-oriented higher education in science and technology that is concerned with 'quality'. In this context, he referred to the recent internationalization of higher education in India, which itself is not good enough to meet the quality concerns when the wave of commercial S&T education is too strong. Lastly, he emphasized building a strong tradition of research in India, which is autonomous (free from bureaucratic mindsets and procedures), cultivates innovation and IPR, and promotes industry-academia interaction and a quality manpower base through a strong accreditation system.

In the other keynote address, Jaime Jimenez from the UNAM, Mexico, spoke about the practice of science and technology in Latin America. He pointed out that science was cultivated in Latin America in pre-historic times, but was mostly practiced in isolation. After the arrival of 'modern western science' through colonial regimes, science became international, whereby knowledge production was of a type called Mode I and then subsequently Mode II. International science is dominant in developing countries, as funds and policies are controlled by a few top scientists and technologists, who pursue research in certain established dominant areas in collaboration with colleagues in developed countries. This international science often does not show concerns for local, regional and na-

tional problems in Latin America. But Jimenez emphasized that with the advent of ICT and its extensive use by scientific communities in Latin America, international science has become global science, and at the same time it has given rise to news ways of doing scientific research in Latin America. Jimenez used the 'invisible college' model of C. S. Wagner (2008) to portray the recent changes in Latin American global science to become more interconnected, collaborative and network-based. He further pointed out the best examples of network-based ways of practicing science in Latin America are (1) the Regional Scientific Communities of Mexico and (2) Venezuela's Research Agendas. Unlike 'international science,' these new forms of practicing science are organized locally, on a smaller scale and even with the help of indigenous/local knowledge and participation. This appeared to be highly illuminating to the audience as most still practice international science not small, regional sciences.

In summary, both Anandan and Mohanty were prescriptive and assumed a top-down approach to science and technology development. Jimenez, on the other hand, referred to science and technology that is essentially small and regional and to development that follows a bottom-up approach.

"International cooperation and competitiveness in S&T"

E. Kolchinsky illustrated a radical transformation of academic networks caused by the removal of party/state control over the administration of science in Russia since the fall of the Soviet Union. He showed major shifts in the forms of international co-operation, the changing intensity of contacts, the migration of scholars and adaptation to new academic environments by Russian scientists.

Tatiana Yusupova analyzed the changing institutional bases and underlying value structure of scientific collaborations between these two national scientific communities, specifically Mongolia and the USSR-Russia.

T.C.A. Anant and Arun Bali gave the sole paper on international collaboration among social sciences in India. It was based on the experiences of the Indian Council of Social Science Research (ICSSR) and was articulated from the perspective of a developing country. Limited success has been achieved due to foreign domination, since the funds come from the overseas collaborative agencies.

J. Khanna addressed scientific collaborations between India and Russia. But she was more specific about the emerging Siberian knowledge based economy, where science and technology are undergoing reforms, and Siberia is emerging as a hub of S&T (Novosibirsk Science Centre).

The paper by B K.Jain, concerning '*international Cooperation in Science and Technology by the government of India* 'gave a broad panorama of India's S&T policy on international cooperation and collaborations with several countries including that of Brazil, Russia, China (BRICS countries) and South Africa. Bilateral and multilateral agreements by the Govt. of India have been carried out by the Department of Science and Technology.

Agarwal's paper with co-authors was not about international collaboration, but about international competitiveness through technology. They revealed an emerging link between growing R&D expenditures and growing export of technology based products.

"Innovation systems and the impact of IT under globalization"

M.U. Khan discussed the impact of Indian technology policy on the development of the Indian IT industry. To Khan, when Indian markets opened in 1991, competing developing countries like China, South Korea, Brazil, Argentina had already surged ahead. Comparative advantage in the growth of the Indian software industry, the author believes, is fully R&D based.

From a sociological perspective, R. K. Mohanty put ICTs (Information and communication technologies) as the driving force behind globalization processes in the last two decades. He noted that E-governance is a process of efficient and effective use of ICTs for goal-oriented governmental works and that healthy results have been achieved with Educational Information Management Systems (EIMS) based on web-based services in Indian school education.

Sujit Bhattacharya presented an empirical study of Indian software firms (with certification), which were of course mid-sized firms engaged in R&D. The main objective of the study was to find out if the firms were involved in research and innovation activities and had research partnerships to influence production outputs in any way. The results of the study were mixed, noting that firms take various paths to develop their enterprises.

S. K. Mathur tried to find out technical efficiency in the ICT sector in 52 countries based on global data from the early years of the 2000's. Mathur reported that productivity growth in the ICT sector in developing and newly industrialized countries is slightly larger than growth in developed and transition countries, which suggests developing countries and newly industrialized countries are catching up fast. Further he reported that technological readiness as a measure of agility, with which an economy can adopt existing technologies, has a positive impact on total factor productivity growth.

Lakhwinder Singh and Baldev Singh analysed secondary data to investigate global trends in terms of R&D input and output measures. They found that a liberalization era, starting with the WTO, has affected innovation systems and economic structures of developing economies. The authors discussed the role of innovation policies and institutional arrangements in certain countries where it has caused success.

"Socio-political Implications of Intellectual Property Rights (IPR)"

Jyoti Yadav discussed the Open Source Drug Discovery Project (OSDD) and emphasized its relevance in the wake of unavailable and unaffordable drugs pertaining to diseases prevailing in the developing world, including drugs tackling tuberculosis. The OSDD combines the power of the Internet with access to expert biologists, chemists, software professionals, clinicians, private enterprises and even students. The paper showed that OSDD contributors can utilize information on this platform only if they share relevant information from their side. Yadav, however, was unsure how IPR processes may affect the open source contribution to new drug discovery.

Deepthi Shankar drove home the point that under a global IPR regime traditional knowledge systems are subsumed. He suggested that documentation of traditional knowledge is a requirement for de-privileging IPR rights to non-natives and facilitating the process of making 'knowledge claims' by natives (indigenes). He also highlighted the role of human-social scientists in comprehending and managing technical issues like IPR that are directly related to human and market resources.

P. M. Prasad proposed a study of village knowledge centres (VKC) in the context of the IPR regime in India. Prasad assumes that the VKCs retain a mechanism for information generation among farmers/gardeners and sharing, same with the scientists (agricultural/horticultural, food processing etc.), which may lead to the formation of a process/product after systematization and can be patented/converted into any other form of intellectual property. This is bound to result in the creation of wealth at the village level (among farmers) by promoting the relevance of IPR particularly for the knowledge base that has been traditionally part of their experiences (ethno scientific/ethno methodological).

E. Haribabu in his paper on open source routes to innovation in agricultural biotechnology pointed out a loophole in the IPR system; even if nobody invents crop plant genomes, the propriety of technology based on genomic knowledge restricts access by others. Hence he proposed the feasibility of the open source model of innovation in biology (based on genomic knowledge available in the public domain) by illustrating Market Assigned Selection (MAS) technology. To him, this is likely to facilitate the development of pro-poor/farmer technologies in agricultural biotechnology, particularly for crops in rain-fed areas.

The concluding discussions pointed out that the global IPR regime puts the native population in developing countries on the receiving end. Developing countries have neither upgraded their IPR related laws (not being protective about their own exclusive intellectual resources and not being aggressively inclusive about others' intellectual resources) nor successfully protected their indigenous intellectual resources or ethnic practices, particularly those in the public domain.

"Science and technology in state and policy"

Elena Ivanova and Eduard Tropp portrayed aspects of change that Russian S&T has undergone in the recent past. Based on a targeted survey, the authors discovered the shortage of highly trained manpower in St. Petersburg and learned about the subsequent efforts to negotiate it. In that context, the Ivanova and Tropp pointed out the changing pattern of interaction among the researchers in institutions of the Russian Academy of Sciences and at Russian universities.

Tatiana Petrova and Valentina Lomovitskaya articulated the relevance of the scientific elite in post-soviet Russia. They traced the strong roots of scientific elites in Soviet society and pointed out that post-Soviet Russia has turned its back on the Soviet model of science under the pretext of lack of funds. This has led to the disintegration of great science and an exodus of Russian scientists. The scientific elite, however, have pushed back by redefining their role: (I) destroying the status-quo and linking themselves to state institutions, (II) managing S&T development and lobbying for the scientific community, etc.; (III) acquiring other functions; apart from their cognitive role, the elite must influence power and public opinion directly by its significance for social progress.

Galina Smagina and Marina Loskutova traced the genesis of the Russian Academy of Sciences to the regime of the Russian Emperor Peter the Great and pointed out the historic closeness of science and state in Russia. The authors referred to 18th century legislations and several other types of state influence that have shaped scientific organisations and practices in Russia. The authors pointed out the important role of politicians and public figures in the development of scientific life in Russia.

From a Chinese perspective, Wang Yuping spoke on the institutional development of S&T in China, pointing out the existence of a co-operative research system, where co-operation exists between state supported and NGO-supported S&T enterprises. If mega-bodies like the Chinese Academy of Sciences, the Chinese Academy of Engineers, the National Natural Science Foundation of China, etc. are state organs, then large professional scientific bodies like the Chinese Association of S&T (consisting of All China Federation of Natural Science Societies and All China Association for Science Popularisation) are non-state organs/NGOs. The example of state sponsored S&T in China in relation to its socialistic regime was a welcome contribution.

The paper by Canadian sociologist Gregory Sandstrom was a philosophical exercise with nuance, as he proposed M. McLuhan's 'Laws of Media' to comprehend technological growth and development. Within this practical framework, Sandstrom presented a collaborative and integrative approach to S&T, in which, thinking about S&T, acquires a social scientific and humanitarian dimension and also adds the blooming field of history and philosophy of science (HPS). This trio of perspectives will help to liberalize S&T policy, as it disallows a reductionist S&T view of the universe.

Munmun Jha compared S&T with human rights. Are contemporary developmental scientific projects to be associated with human rights violations, displacing communities from lands and depriving people of forests and life supporting resources, etc.? S&T is used by state powers to meet the basic needs of a population, to provide adequate food, clean water and thereby to protect human rights.

S. K. Saha made an in-depth review of the complex governance of S&T by parliaments. The author discussed how the parliaments deal with S&T legislation in auditing and scrutinizing their structures and processes. Borrowing from UNESCO's initiatives on inter parliamentary Fora of S&T, Shah suggests S&T policy makers, scientists, technologists, industry, parliaments, media, parliaments and civil society elements must engage in an active and effective dialogue for better governing S&T.

The session witnessed an interesting debate on the role of the scientific elite in shaping S&T. More interestingly measures were suggested for public accountability and public regulation of S&T not only through legislation, but also through other institutional mechanisms, e.g. debates in civil society (e.g. peoples' science movements) and other kinds of regulations through scientific professional bodies and associations.

"Migration Mobility and Innovation"

Mexican professor Dr. Judith G. Zubieta presented on the importance of building 'diaspora networks' in order to deal more effectively with 'brain drain' problems. Having estimated a high number of doctoral graduates from Mexico staying abroad, she explained the difficulties experienced by a developing nation in strengthening its S&T manpower base with large out-migrations. Her proposed '3R' orientation in terms of policy making is essentially a three-pronged approach: (I) restrict migration, (II) recruit/replace manpower and (III) repair losses of S&T manpower.

American professor Dr. Rubin Patterson credited the African diaspora of scientists and their national governments in sub Saharan Africa for gaining benefits from knowledge/skills and academic-corporate connections acquired by scientists and technologists, particularly in the USA. Patterson explored the feasibility of successfully transferring green technologies

(electrical and ICT) to sub Saharan countries through scientific links to the USA, with a migration-development model. Patterson suggested the Indian diaspora as a suitable model for Africa, since Indian scientists and technologists have organized themselves and made their presence conspicuous in the USA to woo FDI and knowledge transfers to India.

Nadia Asheulova's paper stressed the active participation and involvement of many countries in 'global science.' She proposed developing some common indices for measuring each country's contribution. These indices include measures for assessing numbers of joint publications, participation in international conferences, quantum and frequency of receiving international grants, teaching at foreign universities and participation in joint projects. She described the advantages of international mobility to harness global scientific capabilities and further stressed that world-wide research activities have grown with the association of different specialists from across the globe. She referred to three mobility patterns among scientists that have taken place in Russia, i.e. (I) Pendulum type, (II) Irreversible type and (III) Migration with feedback type. To her, the pendulum type is the most optimum and beneficial one, as it provides for active communication, interflow and sharing of information and activities. She advocated this as the preferred mode of mobility, which must be encouraged and facilitated.

Alexander Allakhverdyan expressed serious concern about the drastic fall in the strength of S&T personnel in Russia since 1991. The 1.9 million S&T personnel employed in Russia in 1990 has dwindled to as low as 807 thousand in 2007. The major reasons for outflow have been economic and social. Allakhverdyan pointed out that in a single year, 1994, as many as 160,000 researchers left the country. Further the average age of the S&T migrants was 49 years. Many of these personnel undertook contractual employment abroad and others changed their forms of employment within Russia.

Y. Madhavi in her paper referred to major changes in the Indian vaccine industry (post 1991) that permeated the entry of the private sector into vaccine manufacturing. As a result, the public sector involved in manufacturing vaccines felt competition to bring in technological advances. The overall impact of this was felt in the access and availability of vaccines in managing public health programmes in India.

This was followed by a highly appropriate presentation by Irina I. Eliseeva on economics. She traced the history of S&T in Russia to the early times of orthodox Marxism, involving total monopolies, fixed prices and controlled distribution of goods and resources. Russia moved on through the Perestroika stage (1985–1991) and the post-Perestroika stage (1992–1997), which were both marked by various developments in its economy. In recent years, much thought has been given to two main means of efficiency — privatization and restructuring — with a view to linking Russia's economy with the rest of the world. Some aspects receiving serious attention in the area of S&T are developing measures/indices and useful statistics to bench-mark Russia's intellectual capabilities, as well as developing appropriate ranking parameters for comparing S&T outputs with other countries. Thus, to Eliseeva, Russia is currently debating how to choose its own relevant economic paradigm.

Lively discussions followed the presentations. One point of emphasis was that, in spite of a great exodus of scientists from Russia, the quality of research work undertaken there is still extremely high. As patenting in Russia today is relatively low, one may mistakenly construe that the quantum of S&T work is also low. But despite low funding (because of the earlier strong system and mechanisms in place) and relatively low monetary returns, highly significant research work is still being carried out in Russia. In India, on the other hand, policies have been changing over the years in tune with changing demands. The Indian economy has been responding accordingly in line with other global developments.

"Science communication and culture"

Yu.I. Alexandrov debated the universality of the cognitive process. Having opened with the creativity of Chekhov and Dostoevsky, he said that cognitive processes are no longer considered to be value neutral and that reasoning is intertwined with cultural models; knowledge is culture-specific. As an example, Asian thinking is influenced by 'fields' and 'forces-over-distance' (that are socially and ethically not neutral), whereas western thinkers are influenced by Cartesian reductionism and are concerned with factors internal to objects. Alexandrov noted that some constructs of western social psychology are not valid in an intercultural, globalized world. He suggested that culturally-specific features of sciences may be effectively communicated through free intellectual exchange and cooperation. International scientific flourishing under globalization is the best platform for this purpose.

Manoj Patairiya spoke on the importance of synchronizing the head and hands to achieve excellence. Although India has invested heavily in science communication to develop a scientific temperament and attitude among the masses, equal efforts are needed in the context of hi-tech advances. Patairiya analyzed attitudinal the attributes of children understanding the factors affecting proper attitudes to excel; upbringing, environment, parenting, schooling, socio-economic cultural milieu, etc. She suggested ways and means to overcome these deficiencies via technological awareness through hands-on science.

B. K. Tyagi talked about the conceptual framework of science communication in India. Science communication in India has its roots in the scientific renaissance of the late nineteenth century in west Bengal and Punjab. In the last 10 years, there has been a sea-change in the methods of science communication for popularizing science. Tyagi discussed recent achievements made by NCSTC, *Vigyan Prasar*, and other voluntary organizations, which introduced a new conceptual framework of science communication based *on the socio-cultural milieu of the people*. This new framework has helped to attract an increasing number of academic institutions, science communicators, science clubs and interested people, resulting in a reduction of the divide between the urban and rural. Tyagi emphasized the need for more suitable approaches, strategies and methodologies, based on the concept of 'minimum science for all.'

Whereas both Russian papers brought out the cultural element in scientific communication, the Indian papers pointed to developing a scientific culture among the masses. Discussions that followed pointed out to the fact that the bulk of the scientific world is non-English speaking and, hence, culture-specific features in the cognitive process and *crosstalk* in scientific communication are legitimate. In a globalized world of scientific research, both English and non-English speaking scientific professionals must engage each other for mutual interests.

"Institutional Liberalization"

This was thematically the most central and dominant session of the conference. Svetlana Kirdina began addressing the limits and prospects of institutional liberalization in Russia, providing a deep insight with her Institutional Matrix Theory (IMT). Two types of institutional matrices were discussed that aggregate various national systems: X-matrix (communitarian ideology) and Y-matrix (individualist ideology). It was shown that all economic systems combine both X- and Y-matrices, but that one of the matrices is dominant over the other. To her, X-matrix institutions predominate in Russia. The 'institutional character' in Russia fixes limits on liberalization and actively implements a liberal market-oriented institutional policy only within the framework of a modern redistributive state economic system. S&T policy in Russia demonstrates this reality.

S. K. Jain and Rao Naik focussed on managing excellence in R&D, based on a study of scientists (247) at premier technology institutions in India. Having studied research facilities, human resources support, receptivity and adaptability of administration toward facility requirements, research funding, library support, etc., the authors found that for most factors, the gaps between the importance of the stated research facility and their availability exceeds 1.0. The authors recommend that premier Indian institutes of technology promote excellence in research, build flexible non-bureaucratic organisations with administrators' roles as facilitators, develop innovation performance measures for scientists, enable collaborative and cross-functional research and introduce unparalleled rewards for innovation to motivate scientists.

E. Ishkakov expressed a need for liberalizing of bureaucratic barriers and spoke of the secluded plight of scientific activities and scientists in Law Enforcement Organizations (LEOs). He stated an urgent need to liberalize scientific activities and related processes in LEOs on par with other academic institutions. The author suggested various measures of reforms to enhance the S&T performance of LEOs in Russia.

S. C. Roy pointed out changes in policy thrust and their impact on scientific research. To him, national boundaries are disappearing in research and scientists are gaining access to the latest information and state of the art equipment. To bring about world class innovations, processes and products, developing countries like India have to create a strong human resource base in S&T. Further, Roy suggested the need to build a value-based culture in S&T research, as well as high reward systems to promote the generation of innovative ideas. Government should clearly spell out its expectations from the scientific community.

Madhav Govind proposed to study the socialization process of science students along four variables: organization culture, socio-economic background, disciplinary culture and sources of funding. In view of the liberalization and globalization of S&T, Govind perceives the emergence of a changing value system and professional practices in S&T research, tending toward market-orientation. This has serious implications for research students that result in their half-hearted socialization, inability to make independent projects, their escapist theories and theoretical problems, etc. To him, time bound performances, based on funding models, have also changed supervisory practices.

Duru Arun Kumar provided the definitions and significance of big and little science (Derek J. de Solla Price). Both types of science projects, she said, are done in India without affecting each other. To her, little science projects are career oriented, whereas big science projects are extensions of the political prioritization of specific fields and, hence, provide public visibility and media coverage.

In speaking about undergraduate science colleges, B. Chakrabarti, a science teacher himself, expressed that college science education in India is pushed to the brink in terms of quality and quantity by its drive for a market orientation. Hence, he suggested giving research exposure to undergraduate science students and sending expert teachers on a transferable basis to science colleges. Further, and most importantly, some undergraduate science colleges should be converted into research institutions with programmes that produce committed and qualified science teaching faculty.

Discussions in this session revolved around the changes that Russian S&T is currently undergoing, i.e. coming out from behind the 'iron-curtain' and its 'nationalist' brand, and how Russia is slowly internationalizing itself. The systemic changes it envisages for itself could be similar to those of the institutional and ideologically conditioned minds of the Soviet regime. Similar questions were raised about S&T in China, with respect to how S&T is

gradually trying under a totalitarian regime to internationalize itself. But India's changes are slow and even not expected to be caught by surprise, although they are subsequently adapted to the national Indian system.

"S&T Policy and Industrial Interaction"

Karuna Jain and R. R. Hirwani studied the effects of liberalization on R&D in the Indian chemical industry. They developed a globalization index to capture R&D effects by taking into account twelve different variables pertaining to technology. They gave equal weight to variables defining the globalization index and collected data from 348 companies. Major findings of the study were: (a) companies, whether Indian or Indian affiliates of MNCs, are all reallocating their resources to R&D with a greater focus on honing human capital skills instead of products, processes and markets, and (b) there are substantial spillover effects on domestic R&D from global investments in R&D.

R. Sharan spoke of interaction between industry and academia in India, based on a case study of the Samtel centre at IIT Kanpur. The paper interestingly elucidated the importance of creating an efficient 'enabler' — a link between industry and academia. To the author, industrialists, technologists and academics need to fully respect each other's viewpoints and to understand each other's perspectives so that technology does not remain compartmentalized or underdeveloped and is freely transferred for commercialization. Critical issues to be dealt with include regulations for publication of ideas in journals, owning of inventions (patents) and remuneration, given by different stake holders in the industry-academia project.

Nimesh Chandra focussed on knowledge transfer strategies at the Indian Institutes of Technology. The presentation identified three distinct approaches to knowledge transfer and commercialization at I.I.Ts: (I) sponsoring research and industrial consultancy assignments that promotes industry interaction, (II) protecting inventions of institutes and formalizing technology transfers mainly through licensing, and (III) building an entrepreneurial culture for faculty and channelling ideas through incubation units, which facilitate and encourage start-up firms. The paper suggested the need to make separate legal entities of academia research centres and incubation centres to formalize technology transfers. A good model to emulate is the M.I.T. in the US.

Vinish Kathuria's paper pointed out that the absence of industry-academia linkage is not exclusive to India. Rather, it is common in most developing countries. He identifies a number of reasons for the absence of this much needed linkage: (I) theory and concept-oriented, but not problem-oriented syllabi in S&T education, (II) the faculty's dismal industrial experience, (III) research topics of PhD theses are mostly on the interests of the supervisors, (IV) publication-oriented research of academics to fetch quick promotions, (V) obsolete labs and equipment, (VI) the secretive nature of industrial research, and (VII) absence of a research funding culture in industry. He further pointed out that factors hindering the synergies between industry and university based research are more fundamental as there is a mismatch with regard to their: (I) nature of organization (non-profit/profit-orientation), (II) type of research (open, valuation through publication; closed, valuation through patents or product designs), (III) aim of research (expansion of knowledge/exploitation of knowledge for money), (IV) time frame of research (long term/short term and time bound), and (V) goal of research (communitarian/entrepreneurial). Lastly Kathuria said that the gap between academic and industry-based research can be bridged by creating proper interface between the two.

Enthusiastic discussions pointed out that industry in developing countries does not have an R&D culture as their annual investment rates in R&D have been very low (far below 1 % of turnovers). Technological dependence remains on foreign affiliates. In such a situation, industry-academia interaction becomes a difficult proposition. However, with globalization, developing countries like India and China are slowly moving toward the notion of an entrepreneurial university, maybe each with their own variant.

The conference ended on February 6th with votes of thanks to all participants, volunteers and sponsors and funding agencies.

Conclusions:

The conference underlined the current need for liberalizing S&T research. In the course of the event, the term 'liberalization' also acquired a broader meaning, as follows:

1. Breaking the national boundaries S&T researchers need to reach out to international scientific communities through collaborations and also to be part of international networks/ collegial bodies, both formal and informal. This would serve to internationalize the bases and mechanisms of evaluation in S&T,

2. Breaking away bureaucratic practices and cutting short its procedures to acquire more autonomy, of course, through self regulation of conduct, is also construed to be central to liberalization,

3. Breaking away organizational role patterns and their conventional interactional patterns in the domain of S&T (e.g. Triple helix type of interaction among university/academia, industry/laboratories and government to facilitate innovations and making of entrepreneurial universities),

4. Breaking the boundaries of ideologies and ideological blocks of S&T (e.g. nationalist S&T),

5. Breaking the boundaries of disciplines and making research more interdisciplinary in S&T,

6. The role of S&T should be subject to parliamentary scrutiny and public debate.

Policy implications:

General:

1. The top-down approach of modern S&T can be supplemented by a bottom-up approach, where S&T is organized on a small scale and on a low-cost basis in order to address local problems with local people's participation and with inputs from traditional knowledge systems,

2. If the goal is the internationalization of S&T, this will be achieved only through the introduction of institutional changes and liberalization.

Specific:

1. To follow open source IPR policies,
2. To make use of diaspora links for S&T developments,
3. To foster university-industry interaction,
4. To move towards the Entrepreneurial university model.