Summary Record of Discussions of the Twenty-first Meeting of Scientific Advisory Committee to the Cabinet (SAC-C) held on 10th November, 2010, at New Delhi.

The twenty-first meeting of the Scientific Advisory Committee to the Cabinet (SAC-C) was held on 10th November, 2010, under the Chairmanship of Dr. R. Chidambaram, Principal Scientific Adviser to the Government of India (PSA to GOI) and Chairman, SAC-C.

The agenda of the meeting and the list of participants are at **Annexure-I** and **Annexure-II** respectively.

M21A1 Opening remarks by Chairman, SAC-C.

The Chairman welcomed all members and invitees to the twenty-first meeting of SAC-C and stated that the agenda of "General discussions on Enhancing Academia-Industry Interaction" which was deferred during the previous SAC-C meeting (20th SAC-C meeting) will be taken up for discussions. He requested that in addition to presentations, a brief write-up on the activities related to 'Academia-Industry Interaction' may be sent subsequently for inclusion in the minutes of meeting.

M21A2 General Discussion on "Enhancing Academia-Industry Interactions"

Before taking up presentations by different ministries, Chairman had requested Dr. P.S. Goel, President, Indian National Academy of Engineering (INAE), to explain briefly about the note of INAE already circulated among the participants. Dr. Goel stated that visiting professorship scheme from Academia to Industry was started in 2000 and has been running since then successfully with good response from both industry and engineering institutions. However, the reverse scheme, i.e. from industry to academia has not become very popular, perhaps, due to lesser number of fellows from industry. This situation would be improved in future. He also brought out that annual symposium for young scientists (NatFOE) was started in 2006 and this scheme has been found very useful by the students due to the participation of engineers from industry. He also explained about the study project on "Impact of R&D on Chemical Industry" and about a meeting held with CEOs of Chemical Industry. He added that INAE would work out an operational mechanism for sustaining this dialogue with chemical industry.

Dr. Goel had further explained about the study project "Impact of R&D on Mining Industry". He brought out that no significant R&D inputs have been used in Mining Industry during the last twenty-five years. The Chairman suggested inclusion of the subject of 'green mining' also in these studies.

Dr. Goel stated that a study project on "Impact of R&D in Steel Industry" has also been planned. The Chairman mentioned that special steel would be needed for Advanced Super Critical Technology. Dr. R.K. Sinha, Director, BARC, Mumbai, added that large forgings of special steels are to be made available within the country particularly for fuel processing. Dr. Goel pointed out that marine grade steel has already been indigenized by DRDO. The note of INAE is at **Appendix 'A'**.

M21A2P1 Presentation by Dr. R.B. Grover, Principal Adviser, Department of Atomic Energy, Mumbai.

Dr. R.B. Grover had given detailed presentation on interactions of DAE with Academia and Industry. A summary and the details of his presentation are at **Appendix 'B'**.

M21A2P2 Presentation by Dr. V.S. Hegde, Outstanding Scientist & Scientific Secretary, ISRO, Department of Space, Bangalore.

Dr. V.S. Hegde had given detailed presentation on interactions of DoS with Academia and Industry. A summary and the details of his presentation are at **Appendix 'C'**.

M21A2P3 Presentation by Dr. V.K. Saraswat, SA to RM, DRDO, New Delhi.

Dr. Saraswat had given detailed presentation on DRDO's interactions with Academia and Industry. A summary and the details of his presentation are at **Appendix 'D'**.

M21A2P4 Presentation by Dr. T. Ramasami, Secretary, Department of Science and Technology, New Delhi.

Due to unexpected last minute official commitments, Dr. Ramasami could not attend and give his presentation as planned.

M21A2P5 Presentation by Dr. S. Sivaram, Director, National Chemical Laboratory, Pune.

Dr. S. Sivaram had given detailed presentation on interactions of CSIR with Academia and Industry. A summary and the details of his presentation are at **Appendix 'E'**.

M21A2P6 Presentation by Dr. M.K. Bhan, Secretary, Department of Biotechnology, New Delhi.

Dr. M.K. Bhan had given detailed presentation on interactions of DBT with Academia and Industry. The details of his presentation are at **Appendix 'F'**.

M21A2P7 Additional Item.

Chairman requested Dr. M.S. Ananth, Director, Indian Institute of Technology Madras (IITM), to give a brief on IITM Research Park. Dr. Ananth gave his presentation, the details of which are at **Appendix 'G'**. He stated that out of three planned tower blocks in the research park, one block has been completed and space for twenty-six R&D centres of industries has been provided. These include a DRDO centre and eight incubatee companies. The major clients belong to engineering and design, financial services and telecom. Automobile industry is showing more interest. However the interest shown by bio-pharma industry has not been substantial so far. He brought out the difficulties encountered in building the research park. He recommended the need for policy support to such research parks.

M21A3 Comments of Industry Associations.

Representatives from Industry Associations could not attend. However, general discussions among the participants brought out the following salient points:

- To a query from the Chairman about the usage of offsets in defense, Dr. Saraswat replied that technology transfer was not part of offset and that while selecting offsets more emphasis would need to be placed on our own requirements than what OEMs would prefer to offer. He also added that DRDO had recommended sectoral multi-disciplinary sub-committees for categorizing the weapon systems to be made available for armed forces (buy, buy and make and make categories).
- Prof. Pramod Tandon, Department of Botany, North-Eastern Hill University, Shillong, had suggested targeted development of technologies for industries at a cheaper cost, particularly in the areas of food productivity and storage, ICT for public distribution systems, clean drinking water, renewable energy and plant based industries in North-East Region.
- Prof. S.K. Joshi, Vikram Sarabhai Professor & Honorary Emeritus Scientist, National Physical Laboratory, New Delhi, suggested an analysis of the status in Academia-industry interaction by professional consultants who can bring out suitable recommendations for the future.

The meeting ended with a vote of thanks to the Chair.

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Annexure-I

Twenty-first Meeting of the Scientific Advisory Committee to the Cabinet (SAC-C)

Date : 10^{th} November, 2010.
Time : 1030 hrs.
Venue : Committee Room 'A', Vigyan Bhawan Annexe, New Delhi.

Agenda

M21A1 Opening remarks by Chairman, SAC-C.

M21A2 General Discussion on "Enhancing Academia-Industry Interactions"

M21A2P1 Presentation by Dr. S. Banerjee, Secretary, Department of Atomic Energy, Mumbai.

M21A2P2 Presentation by Dr. K. Radhakrishnan, Secretary, Department of Space, Bangalore.

M21A2P3 Presentation by Dr. V.K. Saraswat, SA to RM, DRDO, New Delhi.

M21A2P4 Presentation by Dr. T. Ramasami, Secretary, Department of Science and Technology, New Delhi.

M21A2P5 Presentation by Dr. Samir K. Brahmachari, Secretary, DSIR & DG, CSIR, New Delhi.

M21A2P6 Presentation by Dr. M.K. Bhan, Secretary, Department of Biotechnology, New Delhi.

M21A3 Comments of Industry Associations.

M21A4 Any other item with the permission of the Chair.

M21A5 Concluding remarks by the Chair.

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Annexure-II

List of participants of the twenty-first meeting of the Scientific Advisory Committee to the Cabinet (SAC-C)

1.	Dr. R. Chidambaram, Principal Scientific Adviser to the Government of India, Vigyan Bhavan Annexe, Maulana Azad Road, New Delhi – 110011
2.	Dr. M.S. Ananth, Director, Indian Institute of Technology Madras, I.I.T. Post Office, Chennai – 600036
3.	Dr. Mustansir Barma, Director, Tata Institute of Fundamental Research (TIFR), Homi Bhabha Road, Navy Nagar, Colaba, Mumbai – 400005
4.	Dr. R. K. Sinha, Director, Bhabha Atomic Research Centre (BARC), Trombay, Mumbai – 400085
5.	Dr. (Mrs.) K.A. Dinshaw, Flat 201, Samudra Setu, Saher Agiary Lane, Bhulabhai Desai Road, Mumbai 400026
6.	Prof. S.K. Joshi, Vikram Sarabhai Professor & Honorary Emeritus Scientist, 252, National Physical Laboratory, Dr. K.S. Krishnan Marg, New Delhi – 110 012
7.	Dr. Debashis Mukherjee, Chair Professor, Raman Centre for Atomic, Molecular and Optical Sciences (RCAMOS), Indian Association for the Cultivation of Science, 2A & 2B Raja S. C. Mullick Road, Jadavpur, Kolkata 700032
8.	Prof. Vijayalakshmi Ravindranath, Professor and Chairman, Centre for Neurosciences, Indian Institute of Science, Bangalore - 560012
9.	Dr. S.K. Sikka, Scientific Consultant, Office of the Principal Scientific Adviser to the Government of India, Bhabha Atomic Research Centre, 6th Floor, Central Complex, Trombay, Mumbai – 400085
10.	Dr. S. Sivaram, Director, National Chemical Laboratory (NCL), Dr. Homi Bhabha Road, Pune – 411008
11.	Prof. Pramod Tandon, Department of Botany, North-Eastern Hill University, Shillong – 793022
12.	Dr. M.K. Bhan, Secretary, Department of Biotechnology, CGO Complex, Block No. 2, Lodhi Road, New Delhi – 110 003
13.	Dr. V.K. Saraswat, SA to RM, Defence Research & Development Organization, DRDO Bhawan, New Delhi – 110 011
14.	Dr. V. M. Katoch, Secretary (Department of Health Research) & Director-General, Indian Council of Medical Research, Post Box No. 4911, Ansari Nagar, New Delhi

15.	Prof. S.S. Mantha, Chairman, All India Council for Technical Education (AICTE), 7th Floor, Chandralok Building, Janpath, New Delhi-110001
16.	Dr. P.S. Goel, President, Indian National Academy of Engineering, Chairman, Recruitment and Assessment Centre, DRDO, Ministry of Defence, Govt. of India, Lucknow Road, Timarpur, Delhi – 110054
17.	Prof. Asis Datta, President, The National Academy of Sciences, India, 5, Lajpatrai Road, New Katra, Allahabad - 211 002
18	Prof. S.V. Raghavan, Scientific Secretary, Office of the Principal Scientific Adviser to the Government of India, Vigyan Bhavan Annexe, Maulana Azad Road, New Delhi – 110011
19.	Shri P.V. Kumar, Chairman, National Technical Research Organization, Block No. 3, 4th Floor, Old JNU Campus, New Delhi - 110016
20	Shri B. Rajendiran, Adviser, Office of the Principal Scientific Adviser to the Government of India Room No. 313A, Vigyan Bhawan Annexe, Maulana Azad Road, New Delhi – 110011
21.	Dr. R.B. Grover, Principal Adviser, Department of Atomic Energy, Anushakti Bhavan, C.S.M. Marg, Mumbai – 400 039
22	Shri D. K. Agrawal, Executive Director, NETRA, NTPC Limited, NTPC Bhawan, SCOPE Complex, Institutional Area, Lodhi Road, New Delhi – 110003
23	Dr. V.S. Hegde, Outstanding Scientist & Scientific Secretary, ISRO, Department of Space, Antriksh Bhavan, New BEL Road, Bangalore – 560094
24	Shri Shantanu Bhatawdekar, Officer on Special Duty, Department of Space, 3rd Floor, Lok Nayak Bhavan, Khan Market, Prithviraj Lane, New Delhi – 110511

Appendix 'A'

Note circulated by Dr. P.S. Goel, President, Indian National Academy of Engineering, New Delhi

Introduction

Technology development and upgradation requires intense interaction between Industry and Academia. There have been interaction in the past, but these have to be enhanced greatly if India has to emerge as fully developed country in the foreseeable future – economically developed, scientifically advanced and militarily strong. Different mechanisms for Academy-Industry Interaction are needed for technology upgradation in mature industries and for green field industries based on newly generated knowledge in the laboratory. The role of industry in guiding academic activities in the direction of industry interests – human resource development, R&D prioritization in applied research, choice of areas of international cooperation etc. - all these would be possible if Academia-Industry Interactions grow into partnerships. The academia expertise should be utilized by industry for technology assessment, upgradation and absorption.

The following initiatives have been taken by Indian National Academy of Engineering (INAE) during the last few years to enhance Academy-Industry Interaction:

(a) AICTE-INAE Distinguished Visiting Professorship Scheme
(b) INAE-AICTE Distinguished Industry Professorship Scheme
(c) Discussion Meetings between eminent experts from Academia and Industry
(d) Revision of Curriculum in Engineering Colleges/Institutions to meet the changing needs of Industry
(e) Annual Symposiums on National Frontiers of Engineering
(f) Research Schemes

AICTE-INAE Distinguished Visiting Professorship Scheme

INAE undertook a major initiative together with AICTE to strengthen the bond between Industry and Academe. An MOU between AICTE and INAE was signed on September 01, 1999. According to this MOU, the INAE launched jointly with AICTE, the Distinguished Visiting Professorship Scheme, which is primarily aimed at promotion of Industry-Institute Interaction by facilitating the dissemination of knowledge and expertise of experienced and renowned professionals from Industry, to integrate industrial experience with the academic component.

The objectives of this scheme are as follows:

(a) Deliver lectures on state-of-the-art of industry, industrial ambience, and problems to the students and faculty of technical institutions.
(b) Guide student projects / theses pertaining to industrial problems.
(c) Help curriculum development, keeping in view, the changing industrial needs.
(d) Develop cooperative undergraduate and postgraduate programmes with Industry, having potential benefit to faculty, students and industry.

In order to nurture the Scheme, a Steering Committee was constituted. The first meeting of the above Committee was held on November 09, 1999 in the office of Vice –Chairman, AICTE. It was decided to approach various Industries as well as Engineering Colleges/ Institutions to identify the industry experts.

Thirteen Industry Experts were selected during the year 2000; eighteen each in 2001 and 2002; fourteen in 2003; ten in 2004; thirteen in 2005; fourteen during the year 2006, fifteen during 2007; eleven during 2008; eighteen during the year 2009; and nine industry experts were selected during 2010 by a high level selection committee of experts from Academia, Industry and representatives from AICTE and CII.

The scheme has been running successfully and has received good response from industry as well as engineering colleges/institutions. The success of the scheme is largely attributed to active participation of experts from renowned industries like TATA Steel, Larsen & Toubro Ltd., Hinduja Automotive Limited, ArcelorMittal, JK Industries Ltd¸ Kirloskar Brothers Limited, TVS Motor Company Ltd., Tata Consulting Services, GE India Technology Centre Pvt Ltd, ST Microelectronics, Grasim Industries Limited, Bharat Earth Movers Ltd, Bharat Heavy Electricals Ltd, M/s IP Rings, Indian Oil Corporation Ltd, Andromedia Communications Pvt Ltd, Solar Semiconductor Pvt Ltd, Tata Research Development & Design Centre, Aditya Birla Group (Cement Division) and Jindal Stainless Steels Ltd etc.

Periodic Review Meetings are also organized in different regions of the country in which the concerned Industry Experts as well as Heads of affiliated engineering colleges/institutions participate and suggestions regarding further improvement and strengthening of the scheme are discussed. Besides this, suggestions/views are sought from the industry experts as well as affiliated engineering colleges/institutions through a Feedback Report after each visit by the industry expert. Some representative feedbacks from engineering colleges/institutions are given below.

- "So far as Bengal Engineering and Science University is concerned, the AICTE-INAE Distinguished Visiting professorship Scheme has a remarkably positive impact on the overall academic environment, especially on the research activities of the University" - Head, Department of Civil Engineering, Bengal Engineering and Science University, Shibpur.

- "The students get first hand information about developments in industry. In general, such schemes further strengthen industry/institution interaction and motivates staff and students in paper presentation and research activities" -Registrar, SASTRA University, Shanmugha Arts, Science, Technology & Research Academy, Thanjavur.

- "The availability of an expert from the industry, with high calibre has been of immense help to the post-graduate students in the Department. His lectures have been well received by the students and he has been available for them for discussions on their seminar and dissertations. "INAE-AICTE should continue with such good initiatives so that students in Technical Institutions will benefit hearing from experts in the field" - HOD, Civil Engineering, National Institute of Technology, Karnataka, Surathkal.

- "The feedback received from the students is very good as they have learnt many new techniques, its engineering applications and the state of art technologies that are adopted and used by leading industries. This type of lecture on industrial applications have helped students and met the objectives of the said scheme" -Head, Mechanical Engineering, SJ College of Engineering, Mysore.

- "The AICTE-INAE Distinguished Professorship system is good and encouraging. New projects in advanced engineering and sciences are planned that will be helpful to students in doing applied projects in new frontiers"-Assistant Professor, Department. of Mechanical Engineering, Indian Institute of Technology, Guwahati.

- "The visit of the Distinguished Visiting Professor and interaction with the students and faculty results in useful student projects and inputs for R&D. This can be encouraged in a big way" -Professor, Department of Electrical and Electronics Engineering, Sona College of Technology, Salem.

- "The interaction was very fruitful for technical collaboration and start of new activities is envisaged." -Head, Department of Electrical Engineering, Indian Institute of Technology, Madras, Chennai.

Since the lectures delivered by the industry experts are found to be very useful it was decided that these should be published as a book to be used as reference material in libraries in engineering colleges/institutions. With this objective in mind, the first volume of "Current Trends in Engineering Practice" - a compilation of papers based on the lectures delivered by industry experts in engineering colleges under this scheme was brought out in the year 2006. The second volume of this series – "Current Trends in Engineering Practice Volume II" has been brought out in the year 2010. Complimentary copies of both the volumes have been distributed to AICTE; Engineering colleges/institutions; concerned industry experts; DSIR, DST; SAC-C; CII, ASSOCHAM; and all other professional bodies. Several letters have been received appreciating the content and quality of the material contained in these books.

INAE-AICTE Distinguished Industry Professorship Scheme

A new scheme in the reverse direction INAE –AICTE Distinguished Industry Professor Scheme was launched in the year 2007, as envisaged under the MoU signed between AICTE and INAE on Oct 10, 2005.

Under this scheme, faculty from Engineering Institutions will spend a short period of 1-2 months during summer in industry to contribute to the industry as well as gain exposure to the industrial environment/requirement. For engineering faculty, this would provide the opportunity to learn about the State-of-the-Art technologies and get exposure to current industrial and commercial practice. The interaction with captains of the industry will lead to bringing new and innovative ideas, thereby enhancing credibility of the teaching imparted at the institution. The advanced research and technological inputs given by the visiting faculty can be thus gainfully utilized by the industry. This can initiate the development of longer-term relationships between the institution and the industry, by way of joint projects, joint student practical training programmes, research and consultancy contracts, donation of equipment and software to the institution and placement of students.

Under this scheme Prof SS Murthy, CEA Chair Professor, Dept. of Electrical Engg., IIT Delhi visited General Electric (GE) Research Lab., Bangalore and Trident Power Craft Pvt. Ltd., Bangalore; Prof VT Ranganathan, Dept. of Electrical Engg., IISc., Bangalore was associated Integrated Electric Company, Bangalore and Prof Indranil Manna, Dept. of Metallurgical & Materials Engg., IIT Kharagpur was associated with Tata Steel Ltd., Jamshedpur.

Discussion Meetings between eminent experts from Academia and Industry

During meeting of SAC-C on Industry-Academia Interaction held on February 21, 2003 under the chairmanship of Dr. R Chidambaram, Principal Scientific Advisor to the Govt. of India, it was recommended that INAE should conduct Seminars/Debates on All-India basis for enhancing the interaction between Academia and Industry.

Consequent to above, INAE held its preliminary meeting on October 30, 2003 at New Delhi to discuss SAC-C initiatives in this regard and the role of INAE. A number of suggestions as to how INAE can play an important role for enhancing the Academia-Industry interaction were discussed and deliberated at length. It was also decided to held detailed Discussion Meetings on the subject on regional basis all over India.

The first Discussion Meeting of the Academy was held at ISRO Satellite Centre, Bangalore on March 25, 2004. Forty one participants comprising INAE Members of Governing Council, Industry Executive Forum; Forum on Engineering Education; Programme Committee; Bangalore Chapter, selected Fellows at Trivandrum, Hyderabad, Kalpakkam and Chennai and representatives from SAC-C, DST, TIFAC-Core Centres, IISc., IITs, and Industry participated and shared their views/experience. The second Discussion Meeting was held on June 27, 2004 at IIT Kharagpur which was attended by forty two participants comprising members of Faculty of IIT Kharagpur, other educational institutions & invitees from industries in eastern regions, members of INAE Governing Council, INAE Industry Executive Forum, Programme Committee and Forum on Engineering Education to brain storm and evolve some concrete proposals to strengthen this important interface.

A Wrap-up Discussion on Academia-Industry Interaction was held on December 11, 2004 during the AGM of the Academy. Summary Discussion of all these meetings were forwarded to the Office of SAC-C by INAE. The Executive Summary recommendations of the final Report sent to SAC-C are given below.

(a) AICTE-INAE Distinguished Visiting Professorship scheme is a great success. Continue it.
(b) A similar scheme in the reverse direction (Academia to Industry) to be initiated.
(c) Summer Industrial Opportunities Programme for young faculty to be initiated.
(d) Mission REACH and CORE Centres of relevance and excellence of TIFAC have been a great success. Their number may be raised to hundred in another two years.
(e) Initiate steps to encourage pursuit of Ph.D. programmes by engineers from the Industry. In particular, INAE recommends initiation of a Scheme similar to what has been successfully implemented by Danish Academy of Technological Sciences (ATV) in collaboration with Danish Agency for Development of Trade and Industry.
(f) Examine the end role and revival of the Technology Incubation Centres (TIC) in campuses. Technology Incubation Centres to be located where there is a cluster of small and medium Establishments.

Revision of Curriculum in Engineering Colleges/Institutions to meet the changing needs of Industry

The representatives from industry including our Fellows have often pointed out that engineering curriculum have not undergone any change and has almost lost relevance to the current industrial, construction and fabrication practices. In India, which is a developing nation, hard manufacturing and conventional metallurgy continue to be important, but at the same, our students should also get exposure to emerging areas of Nanotechnology and Biomimetics etc. In this context, the need for periodic revision of curriculum for Materials Engineering was emphasized in one of the INAE meetings. The task of revision of preparing a new curriculum for Materials Engineering was entrusted to Dr. T Mukherjee, Deputy Management Director (Steel), Tata Steels Ltd., Jamshedpur and Former Convener of SC-VIII (Metallurgy, Mining & Materials Science). He along with Prof. Indranil Manna of IIT Kharagpur and Dr. Debashish Bhattacharjee of Tata Steels Ltd., Jamshedpur formed a team for this purpose.

First of all, they studied the syllabi of some of the leading engineering institutions and found that these were quite obsolete and not in tune with our industrial needs. They further studied in-depth, the syllabi being followed in all the IITs as well as NITs and other leading engineering institutions in the world. A brief on this was circulated to major engineering institutions in India to elicit comments. A draft syllabus was then prepared and once again sent for detailed comments. After incorporating the views/suggestions received, the draft Curriculum was revised. The course summary with break up of credits and detailed contents of the courses were worked out after consultation with academicians from IIT Kharagpur, Bengal Engineering and Science University, Jadavpur University, NIT Durgapur and NIT Jamshedpur. Finally, a meeting on new Curriculum on Materials Engineering was held on January 5, 2006 at India International Centre, New Delhi in which the following experts participated.

1. Prof. R Natarajan, FNAE, Vice-President, INAE
2. Dr. Placid Rodriguez, FNAE, Vice-President, INAE
3. Dr. T Mukherjee, FNAE Deputy Managing Director (Steel), Tata Steel Ltd., Jamshedpur
4. Dr. Debashish Bhattacharjee, Chief R&D & Sc. Services, Tata Steels Ltd., Jamshedpur
5. Prof. Indranil Manna, FNAE, Vice-Chairman, CRF and Professor, Dept of M&M Engg. , IIT Kharagpur.
6. Dr. RK Ray, FNAE, Visiting Scientist, R&D Division, Tata Steels Ltd., Jamshedpur
7. Dr. Pradip, FNAE, Group Leader, Minerals & Materials Processing, Tata R&D Design Centre, Pune
8. Dr. K Rajendra Udupa, Head, Dept. of Met. & Materials Engg., NIT, Surathkal
9. Prof. PK Mitra, Dept. of Metallurgical & Materials Engg.,Jadavpur University, Kolkata
10. Prof. T Srinivasa Rao, Professor & Head, Dept. of Metallurgical & Materials Engg. NIT, Tiruchirappalli
11. Prof. AS Sinha, Dean Academics, NIT, Hamirpur
12. Dr. V Ramaswamy, FNAE, Visiting Professor, PSG College of Technology, Coimbatore
13. Dr. SK Ray, FNAE, Head, MTD, IGCAR, Kalpakkam
14. Dr. DK Mondal, Head, Dept. of Metallurgical and Materials Engg., NIT, Durgapur
15. Dr. SK Mitra, Dept. of Metallurgical and Materials Engg., NIT, Durgapur
16. Dr. Anandh Subramaniam, Materials Group, Dept. of Applied Mechanics, IIT Delhi
17. Dr. Rajesh Prasad, Dept. of Applied Mechanics, IIT Delhi
18. Shri KK Sinha, FNAE, Ex-Chief Executive, NFC, Dept. of Atomic Energy, Hyderabad
19. Dr. Surendra Singh, Associate Professor, Dept. of Metallurgical and Materials Engg., IIT Kharagpur
20. Prof. NB Ballal, Dept. of Metallurgical and Materials Science, IIT Bombay
21. Brig SC Marwaha, Executive Secretary, INAE

Aftter inforporating the views/suggestions of the participants, the Curriculum for Materials Engineering was finalized. This was sent to the Chairman, AICTE for circulation to various engineering institutions in the country for their academic bodies to examine and adopt with or without modifications/changes in accordance with their perspective of the subject. AICTE was also requested to examine whether this could become a model document for other disciplines of engineering.

Annual Symposiums of National Frontiers of Engineering (NatFOE)

The first Symposium on National Frontiers of Engineering (NatFOE) was organized by INAE jointly with IIT Kanpur during February 4-5, 2006. The aim of the Symposium was to bring together about 40 outstanding engineers (age 30 to 45 years) from Industry, Engineering Colleges/Institutions and R&D Laboratories to discuss leading edge research and technology and share ideas in different fields of engineering. It focused on four themes viz. Interface of Engineering with Biology and Medicine; Natural Disaster Simulation and Mitigation; Wireless: Challenges and Opportunities and Nanotechnology. The speakers focused their talks on current cutting-edge research in their disciplines. They addressed pertinent issues such as major research problems and distinctive tools of their fields and the current limitations in advancing the field. They sought to derive insight from other fields to overcome these limitations. The speakers gave presentations in each of four selected themes followed by Q&A and discussion. The schedule was so arranged that there was ample opportunity for discussion among the participants outside the formal sessions. The programme also included a Panel Discussion wherein panelists spoke on topics of their choice related to the themes of the Symposium.

Having seen the success of this event towards enhancement of Academia-Industry Interaction, the Governing Council of INAE decided to make this as an annual flagship event of the Academy. Thereafter, each year, INAE has been organizing such Symposiums on National Frontiers of Engineering (NatFOE) as under.

Event	Date	Venue	Selected themes
First NatFOE	Feb 4-5, 2006	IIT Delhi	Interface of Engineering with Biology and Medicine; Natural Disaster Simulation and Mitigation; Wireless: Challenges and Opportunities and Nanotechnology
Second NatFOE	March 31-April 1, 2007	IIT Delhi	Water, Energy, Knowledge and Transport
Third NatFOE	Oct 24-25, 2008	IIT Madras	Manufacturing and Automobile; Materials; Aerospace; and Infrastructure
Fourth NatFOE	Sep 16-17, 2009	IGCAR, Kalpakkam	Energy, Materials & Manufacturing, Structural Integrity, and Communication & Networking
Fifth NatFOE	Aug 3-5, 2010	Siksha 'O' Anusandhan University, Bhubaneswar	Energy: Micro and Smart Grids, Use of Satellites in Energy Systems, Energy Markets; Material Science: Smart and Micro-Electromechanical Systems (MEMS); Signal and Image Processing: Sensor Networks, Biomedical Signal and Image Processing; and Intelligent Computing: Soft and

			Evolutional Computing Applications in Electrical and Electronics Engineering

Research Studies

There has been growing recognition of the importance of universities and academic research to industrial innovation and performance. There has also been greater recognition of how the role of academic research has changed over time especially over the last 15-20 years as many universities have become more directly involved in the commercialization of the fruits of their research. With the objective of assessing the impact of R&D in Chemical Industry and Mining Industry, the following two Research Studies have been instituted by INAE.

(a) **Impact of R&D on Chemical Industry – Current Status and Future Strategies**

A study on Impact of R&D on Chemical Industry – Current Status and Future Strategies was initiated by INAE during May 2009 to enhance the relevance of basic and applied research to promote and strengthen industrial growth, innovation and competitive performance. Dr. KV Raghavan is the Chairman of the Study and Shri D P Misra, Director, ICC and TCE Consulting Engineers, Mumbai; Dr M O Garg, Director, Indian Institute of Petroleum, Dehradun and Prof A N Maitra, formerly Professor, Delhi University are the Members of this Study Group. The project aims to make macro and micro level studies on the R&D impact on Indian chemical industry with specific reference to the following factors: R&D intensity and investment; linkage with universities and R&D institutions; utilization of government funded R&D for deriving the benefits of innovation policies; fostering new entrepreneurs and start-up ventures; export of knowledge intensive chemicals and services; generation of intellectual property and its utilization and utilization of new knowledge and knowledge intensive services and human capital and its turnover.

Dr. KV Raghavan gave a presentation to SAC-C on Sep 7, 2010. Several valuable responses from the members of SAC were received. Final report will be completed by Dec 2010.

(b) **Impact of R&D on Indian Mining Industry Performance – Identifying the new priorities and strategic initiatives**

The INAE Project on "A Study on the Impacts of R & D on Indian Mining Industry Performance- Identifying New Priorities and Strategic Initiatives" is being supported by the Office of the Principal Scientific Advisor to the Government of India. Prof. A.K. Ghose is the Principal Investigator for the project along with Prof. R.N. Gupta, Prof J. Bhattacharyya and Dr. M.P. Dikshit as co-investigators. The project seeks to examine in depth the impacts of R & D on mining industry performance, including productivity, safety and environment in a holistic way. The impetus for the study comes from the widely held perception that mining continues to be a technological laggard where R & D has made only marginal impact and calls therefore for evaluation of the past and current R & D portfolio of the industry and what needs to be done in future. The study has relied on two-rounds of Delphi questionnaires circulated throughout the industry to be able to home in on the priority areas of research and development which could help in bringing about innovative changes in mining industry's espousal of new high-tech systems which could propel the industry to be more productive, cost-effective and competitive with upgraded safety and environmental performance. A workshop on the outcomes of the questionnaire has been conducted to identify the agenda of research priorities. Likewise, a separate exercise has been undertaken on skill deficit in the mining industry for future R&D initiatives. The final report on the project is now being compiled and would be circulated for evaluation by the end of December 2010.

Appendix 'B'

Summary record of the presentation made by Dr. R.B. Grover, Principal Adviser, Department of Atomic Energy, Mumbai

Research and development must be pursued with the ultimate aim of deploying the results for societal development. In case of the Department of Atomic Energy (DAE), the very structure of the department is geared towards achieving this objective. It consists of research and development units, public sector undertakings and industrial units, grant-in-aid institutions and deemed universities. Through this composite character, the department aims to ensure that all activities in the chain beginning from basic research to technology deployment are implemented and human resource development is pursued in an environment of research with faculty consisting of practicing professionals and active researchers.

With regard to deployment of results of research, department pursues a two pronged approach. Results of research in the area of nuclear power engineering are deployed by companies and industrial units set up by the department, but for deployment of results of research in non-power areas, the department resorts to transfer of technology with deployment done by agencies in public and private sector outside the department.

Basic mantra followed by DAE for technology transfer whether within DAE or to outside agencies, is hand holding during initial phase of technology transfer as well as during subsequent phases to iron out any implementation issues that might arise. For deployment of any major technology, all units of DAE depending on their specialization, cooperate and ensure the success of the technology. For example, to set up the first fast reactor in the country experience and expertise of BARC, IGCAR and NPCIL has been pooled in and a new company has been set up. Overall for technology transfer or management[1], every possible mechanism has been utilised and these include the following,

- In-house technology deployment
- In-house technology transfer
- Development of vendors and technology spill-over

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[1] For further details, see the paper titles, " Technology Management by the Department of Atomic Energy", INAE Symposium on Technology Management, Pune, October 2001.

- Technology transfer (of technologies developed as per mandate and spin-off technologies)
- Technology diffusion

To meet the demands of rapidly expanding economy energy infrastructure in the country requires significant expansion. In view of the fact that India is fuel resource deficient country, all sources of energy need to be exploited to their full potential. This calls for pursuit of a closed fuel cycle approach to exploit full potential of our modest uranium resources. Pursuit of closed fuel cycle approach is also necessary to exploit vast thorium resources available in the country. With regard to pursuit of closed fuel cycle, no other country has the same urgency as India and therefore, India has to rely on indigenous research and development.

To meet challenges in the years ahead, many initiatives are underway. Two initiatives are worth mentioning. As indicated earlier, hand holding is necessary for success of technology transfer. To provide an institutional mechanism for this purpose, BARC is setting up a centre for incubation of technologies. It is envisaged that scientists and industry representative will work in cooperation to ensure transfer and successful implementation of technologies through this centre. This will be useful for building manufacturing capability in the country for hi-tech, low volume products such as sophisticated instruments say spectrometers, radiation detectors etc. At the other end of the spectrum, for manufacture of heavy equipment, DAE has approved setting up of two joint ventures: one between NPCIL and L&T for heavy forgings and the other between NPCIL, BHEL and ALSTHOM for manufacturing Turbo-generators for large nuclear power plants.

Figure 1 illustrates various mechanisms for interactions with outside agencies. Board of Research in Nuclear Sciences (BRNS) plays a major role in case of interactions with universities and national laboratories. Besides funding research projects it also funds setting up of major research and testing facilities, scale up studies and academic programmes. BRNS can be said to be a pioneer in the funding collaborative research projects where one component of research is done in a university or a national laboratory outside of DAE and the other in a unit of DAE.

DAE has been taking care of its human resource requirements for a long time. In fact it is also contributing towards human resource requirements of the country in highly specialised areas. BARC Training School and graduate schools at TIFR and other aided institutions have been running for decades and now with the setting up of two deemed universities, DAE is set to increase its contribution in this vital area.

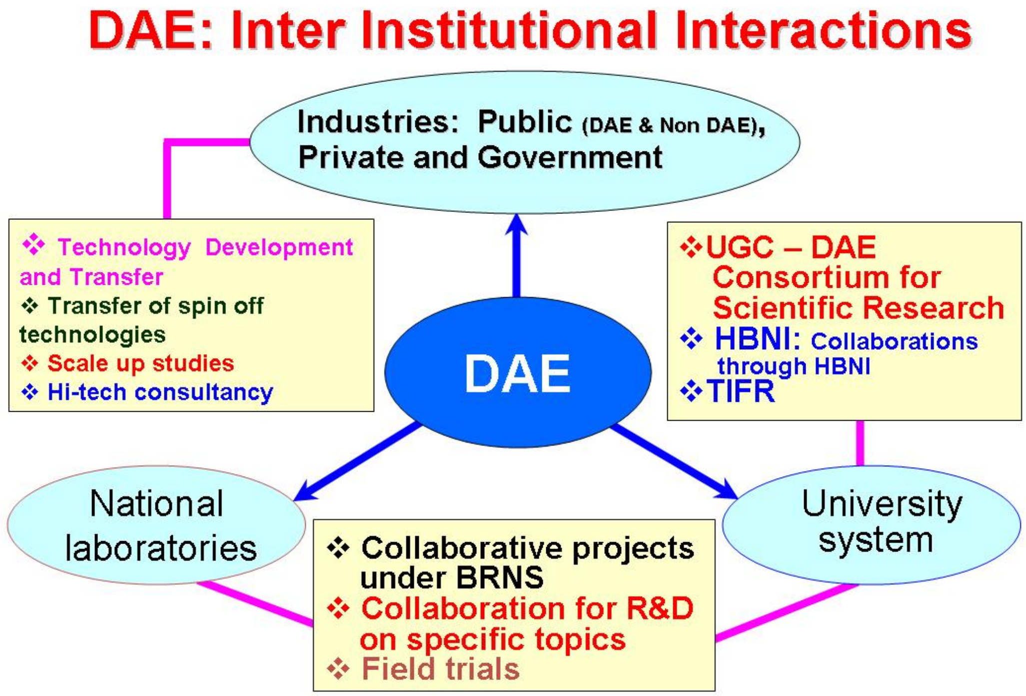
DAE: Inter Institutional Interactions
Industries: Public (DAE & Non DAE), Private and Government
❖ Technology Development and Transfer
❖ Transfer of spin off technologies
❖ Scale up studies
❖ Hi-tech consultancy
❖UGC – DAE Consortium for Scientific Research
❖ HBNI: Collaborations through HBNI
❖TIFR
DAE
National laboratories
University system
❖ Collaborative projects under BRNS
❖ Collaboration for R&D on specific topics
❖ Field trials

Figure 1

Appendix 'C'

Summary record of the presentation made by Dr. V.S. Hegde, Outstanding Scientist & Scientific Secretary, ISRO, Department of Space, Bangalore

♦ **ISRO-Industry Interface**

Over the past several years, ISRO–Industry partnership has been constantly growing and made significant forays in space based services. Interface with industries began as an experimental phase with the fabrication of Motor cases, Inter-stage structures etc. Since then, the industry partnership has been gradually nurtured through the development phase in 80's by enabling industries for production of major hardware (viz. Mobile service tower for ASLV/PSLV, liquid engines, propellants, avionics system, development of special material, etc) to operational phase by developing end-to-end capability of industry (viz. Electrical harnessing of subassemblies, Fabrication of aviation package, precision components & solar panels, deep space network, operations of facility, turnkey contracts etc).

Presently, ISRO associates with more than 500 small, medium and large scale industries in diverse areas of technology having transferred over 290 technologies for production and provided more than 270 consultancies. The share of industries in the space budget has grown from ₹ 540 crores (1999) to ₹ 1500 crores (2009).

With the increasing demand of space products and services, Indian industries participation will significantly increase in the coming years to meet the challenges of advanced technology and handling complex manufacturing jobs in satellite and launch vehicle programs.

▪ Industry participation strategy and Industry sustenance

ISRO is striving to further build on the partnership for maximum utilization of industry capacity in space, ground and launch vehicle segment and put Indian industry on a better pedestal to take up certain relevant R&D activities for space programme. Following are some of the strategies proposed by ISRO towards industry sustenance and developing industry as risk sharing partner:

- To realize higher levels of aggregates for space qualified subsystems, services from industry and to dwell follow-up teams in major Industries.

- To minimize investment in in-house production facilities. Such facilities may be funded and owned by ISRO, but built and operated by industry. However, strategic items will continue to be produced in-house.

- To commit production quantities on a long term basis for government approved programmes to ensure the continuity of procurement.

- Operation of existing facilities by industry/entrepreneur either as ISRO owned facilities or transfer the facility to the industry on fair valuation of the facility. e.g. SPROB (Solid Propellant Booster Plant) established by ISRO and maintained by industry.

- Considering the risk factors (viz. huge investment in R&D, low ROI, large gestation period, export control norms, limited market etc) to assure buyback of minimum quantities for sustenance of the industry and realize fabrication of aggregated systems through consortium approach with ISRO as lead partner.

- To evolve suitable guidelines for migration /deputation /lien of ISRO personnel to industry to ensure adequate technology transfer/quality compliance.

▪ Issues to be addressed

- Industry need to further invest time and money to fine tune the product for competing in international market.

- Because of low volume requirement and lesser return of investment (ROI), capital investment and hand holding from ISRO is envisaged. Industry also needs to explore and tap export potential.

- In order to encourage innovation it is essential to create innovation clusters in different parts of the country and intensify efforts to promote initiatives. Patents / copyrights and licensing to industry for commercialization should be encouraged.

♦ ISRO-Academia Interface

ISRO supports R& D projects and scientific activities at the academic institutions and R& D labs in the country under various Programmes viz. Space Science, EOS/NNRMS, PRL, RESPOND etc. Major activities encompass research projects in science, applications and technology relevant to space programme, in addition to support for conferences, symposia and publications.
The prime objectives of the endeavor is for creation of a wide research base in academic institutions, generation of high quality human resources and utilisation of intellectual expertise available in academia to support the Space Programme. The interface mechanism encourages academia to dwell on basic research in certain identified areas of relevance to Space with identification of direct deliverables

▪ Growth of ISRO-Academia Interface (1980 – 2010)

- Introduction of courses and establishment of facilities in the areas of Remote Sensing & GIS in more than 100 universities.

- UN-CSSTEAP training programmes in RS/GIS, Satellite Communication and Space Science

- Launch of dedicated thematic satellite to provide bandwidth for providing quality education to rural mass.

- Establishment of five Space technology Cells at IITs (Madras, Bombay, Kanpur, Kharagpur) and IISc for carrying out advanced technology research and five research chairs at IIT-Kharagpur, NIAS, IISc, Pune & B'lore universities.

- Planetary Exploration Programme by PRL & Joint Astronomy Programme in IISc.

- Financial and technical support for micro satellite (ANUSAT, JUGNU, STUDSAT etc) building activities by the student community of Anna Univ., Bangalore Consortium, IIT-K, IIT-B etc.

- Over the years under sponsored research programme, ISRO has supported more than 700 projects with a budget of ₹ 150 crores. More than 350 PhD's and 1200 high quality scientific publications have emerged out of these projects apart from fulfilling the objectives at individual project level.

- ISRO-Academia partnership holds a promising future, with ISRO providing innumerable research opportunities to academia in the following areas of Space Science, Space Technology and Space Application.

  Human Space Project: Technologies to be realized in the areas of Thermal, Structure, aerodynamics, propulsion, orbit mechanics, re-entry techniques; scientific experiments in the areas of micro-gravity, bio-technologies and bio-medical fields.

  Space Science: Opportunities for scientists to work on enormous scientific data sets with the launch of Astrosat and Chandrayaan in the near future.

  Interplanetary missions: Terrain simulations, orbit estimations, design of Lander/rover/robotics, design instruments to understand science of planets/moon.

  Atmospheric Models and Climate Change Studies: Integrating satellite data and ground based observation data to develop high precision predictive atmospheric models. Participation in scientific research and modeling activities in the area related to Climate Change.

Appendix 'D'

Summary record of the presentation made by Dr. V.K. Saraswat, SA to RM, DRDO, New Delhi

1. Introduction

1.1 Defence Research & Development Organisation (DRDO) a Department under Ministry of Defence is dedicatedly working towards enhancing self-reliance in Defence Systems and undertakes design & development leading to production of world class weapon systems and equipment for the three services.

1.2 DRDO is working in various areas of military technology which include aeronautics, armaments, combat vehicles, electronics, instrumentation engineering systems, missiles, materials, naval systems, advanced computing, simulation and life sciences. DRDO while striving to meet the cutting edge weapons technology provides ample spinoff benefits to the society at large thereby contributing to the nation building.

1.3 DRDO has further established strong mechanisms for interactions with Academic institutions across the country. DRDO continuously makes effort to enhance the participation of more academic institutions as well as enhance Private sector participation in the design and development of indigenous systems. The part I of the paper addresses DRDO – Academic Interactions and Part II deals with DRDO – Industry interactions

2. <u>DRDO-Academia Interaction</u>

2.1 Research sponsored in academic institutions under the Grants-in-Aid scheme focuses on research on phenomena or observations that are not understood, and that lack of understanding is recognized as an obstacle to scientific or technological progress in the broad topic area of relevance to military R&D. The knowledge-base so generated is embodied in high-quality technical manpower and in the new understandings, techniques and design-tools developed through the basic research funded. Such new knowledge can also provide pathways to significant advances in the mission-effectiveness of traditional military roles.

2.2 Collaterally with the expanded knowledge-base created, a primary end-result of the research that is funded under the Grants-in-Aid is a networked group of qualified people whose expertise resulting from the research can be drawn-upon to build an exploitable area of new technology that has potential military applicability.

2.3 The scheme also supports the instrumentality of Memoranda of Collaboration (MoC) between DRDO Laboratories/Establishments and academia. These MoC invariably involve more than one DRDO establishments and cover explorations and investigations on a range of topics within a broad subject arena that generically cross-link the research activities of the collaborating Laboratories and the research-disciplines of the selected collaborating academic institution. Such institutional cross-linking is organic, not episodic, and is made operational in an MoC through a management structure which includes in its standing arrangements representation of directors of the collaborating DRDO institutions.

2.4 Setting up of Centre of Excellence (COE) in the areas of cutting edge technologies is also undertaken under this scheme. The COE is managed jointly by DRDO and grantee institution.

2.5 DRDO also establishes DRDO Chairs at academia/DRDO labs in S&T subjects/disciplines of relevance to DRDO. The Chair is awarded to an accomplished and eminent person.

2.6 The scheme also provides financial assistance for organizing conferences/seminars/workshops on the topics related to DRDO's activities.

2.7 Channels are Directorate of Extramural Research & IPR, four Research Boards at HQs (LSRB, NRB, ARMREB, ARDB) and CARS (Contract for Acquisition of Research Services) by DRDO Labs.

2.8 Under the scheme there are about 350 on-going projects costing about Rs. 150 crores and involving more than 175 institution including IITs, NITs, IISC, Universities, Colleges, Societies etc. Under these projects about 300 students are working for Ph.D. Further, about 250 conferences/seminars involving Rs. 2.50 crores are supported every year.

2.9 Centres of Excellence set up so far include: High Energy Materials S&T (ACRHEM) at Univ of Hyderabad, mm Wave devices at Kolkata Univ, System Design & Engg at IIT Bombay, Life Sciences at Bharathiyar Univ, CFD Centre at IISc, Bangalore, Composite Materials at NAL, Bangalore (involving IISc, IITK, IITKgp).

2.10 DRDO is also planning to establish a DRDO Research & Innovation Centre at IIT (M) Research Park that would enhance DRDO, Academia and Industry engagement to a higher level.

3. DRDO's strategies for increasing participation of Private Sector industries in Defence

3.1 The existing Defence Industrial base in India consists of 08 DPSUs, 39 OFs, Large Industrial houses and the SMEs (Small and Medium enterprises). Ordnance Factories organization is the largest and the oldest Govt. run production organization and is engaged primarily in the manufacture of Defence Hardware. The OFs were setup by British to manufacture the hardware based on British design especially small arms & ammunitions and low technology items. The present structure has been identified from the pre-independence era and is not structured to carry out in-house Research & Development and develop products of their own.

3,2 After independence, DPSUs were created. DPSUs started manufacturing of Defence Systems primarily under license from foreign OEMs. These licenses were meant for manufacturing of a fixed number of systems and further the DPSUs and OFs never had any formal technology absorption centres to receive the technologies from the OEMs. DPSUs continue to see ToT for production for every new product. Hence these efforts didn't result in transfer-of-technology in reality. Within these establishments, there is no whole hearted effort to carry out their own R&D to improve the designs and take initiative to come out with MK II, MK III etc. Even today many of the DPSUs are looking at turnovers with hardly any value additions in what they produce.

3.3 Since 1947 till 1991, Defence production was kept in the public sector. In 1991, the Defence Industry was opened to Private sector participation. In 2001, 26% FDI was allowed in the Defence Industries. The promulgation of DPP 2006 provided a thrust for enhancing the role of the private sector in Defence production. The OFs and DPSUs have their own limitations to achieve high level of self reliance. With more and more DRDO developed systems getting User acceptance, the capability to build complex indigenous systems and platforms have been established in the country. However these are not getting into production in adequate numbers with the existing production capacities and because of that the self reliance index has not seen much change. Now there is increased realization that the goal of achieving self reliance in Indigenous Development of Defence systems cannot be achieved without enhancing the Defence Industrial base in the country that could take up production of indigenously developed systems. The only way to achieve this is by creating additional capacities in production in private sector Industries also – both the large Industries (as System Integrators) as well as the SMEs for niche systems.

4. Private sector participation in Defence Sector - DRDO's Contribution

4.1 Defence Research & Development Organisation (DRDO) was established in 1958 with a very limited mandate of advising Armed Forces in systems analysis, decision making and helping the Defence Production units in sorting out their design and development related problems. This is the reason why most of the DRDO establishments are co-located with the major Defence Production Units, as most of the manufacturing was undertaken within these establishments.

4.2 Till 1991, the private sector participation was only through DRDO projects and that too only in the development stages. DPSUs and OFs were reluctant to get involved with DRDO development projects due to risks in these projects and also due to the fact that their order books were full with the manufacture of licensed products.

4.3 DRDO started its work with a Zero Defence Industry base in the country other than the Defence Production Units. Because of the nonexistent Defence Industry Base, enormous difficulties were faced for outsourcing even small developmental tasks to Industries.

4.4 The dawn of 1980s saw DRDO undertaking Major Projects viz. IGMDP, MBT followed by LCA and EW systems. Radar development was integral to missile development programme initially and subsequently taken up as independent projects. The technological complexities and mega size of these projects demanded a very strong Defence Industrial base in the country.

5. DRDO Technology development and infrastructure establishment

5.1 The DRDO programmes like IGMDP, MBT, LCA, Electronics and Naval systems are large multidisciplinary complex projects and called for ab initio design and development advanced technologies in the area of propulsion (liquid and Solid), guidance and control, structures, gas turbine technologies, advanced materials, modeling and simulation, precision mechanics, optoelectronics, electronic devices and components, high power microwave devices, advanced control systems, very high temperature materials and composites, metallics and non metallics, electro mechanical devices, hydraulic components, high accuracy ruggedized sensors, computation techniques and many more. The technology base got established for the first time in the country in these advanced fields through DRDO efforts with active participation of Academic institutions, National S&T labs, Indian industries both public and private that included more than 500 SMEs from all over the country and large private sector industries like L&T, TATA, Godrej etc. Indian Industries through their participation in DRDO projects could get hands on experience in defence technology areas and were exposed to quality standards and certification requirements unique to military equipments for qualifications. Development of advanced systems also called for establishing world class test facilities and both were not readily available to India for various reasons including sanctions. Many of the test facilities were established in many DRDO labs with the active participation of Indian Private Sectors. It took nearly two decades of nurturing, to groom the industries in various aspects of Defence production i.e. design, simulation, prototype manufacturing, testing, quality control, performance evaluation, technical and user trials. Post successful trials, the limited series production of the systems were carried out with the Industries, wherein the engineering for production process were established. In all these DRDO ensured that the Indian private sector industries were very intensely involved. Thus DRDO enabled these industries to get exposed to the technology, processes involved and quality standards of both Military Standards and Aerospace Standards.

5.2 Some examples of successful DRDO – Industry partnership:

MTAR, VEM Technologies, ASTRA Microwaves, Data Patterns, Resin and Allied Plastics, Zetatek, TATA Power SED, L&T, Godrej, SEC, Hyderabad, Ananth Technologies, High Energy Batteries, Ajay Sensors, MACMET, Apollo Micro systems, Deepti Electronics, Dynamatic Technologies, Alpha Design, Micro precision and many more. These industries never had any exposure to military technologies. Through their participation in DRDO projects and programmes exposed to the stringent requirements of military systems. They got benefitted by working for DRDO and learnt military quality, certification requirements, military standards and aero space requirements etc. These industries also got many retired DRDO scientists and knowledge through them. DRDO opened up high tech test facilities for the these industries for testing and evaluation of the systems manufactured by the industries.

6 Progress of Indian Defence Industry in Value Chain

6.1 DRDO also encouraged industries to participate in the development projects in different modes depending on the complexities and these include:

Consortium among industries

DRDO – Private – Foreign partner: for Design and Development

DRDO – Private – Academy : for Research and Development

By involving the Indian Industries during the development cycle, many of the Indian Private Sector industries have moved up the value chain from **Built to Print (B2P), Built to Specification**

(B2S), Built to Design (B2D) and **Built to Requirements (B2R).** Today some of these companies can also take up the responsibility of **Lead System Integrators (LSI)** and many of them can manufacture technologically advanced products that are in conformity with the MIL and AERO standards and of world class. By participating in DRDO projects, today there are at least 500 Indian Private Sector Industries all over India, who are capable of manufacturing High Technology Systems/Sub Systems/Components in the fields of Missiles, Avionics, Electronic Warfare, Naval Systems, Combat Vehicles and Life Sciences. Many of these companies may not have large turnover but their technological specialization is world class and sometimes unique. This has catapulted many of these industries from "suppliers of products to DRDO" to "suppliers of products to multinationals". In fact many of these industries are working as Tier- Two and Tier- Three companies for world's leading technological giants.

6.2 Thus the capabilities established in these firms are exploited by the Foreign industries more than by Indian MoD, due to absence of proactive policies for Private sector participation.

7. New Engagement Models

7.1 DRDO is evolving a new ecosystem between DRDO, University, Industry and Users that would provide a framework for enhanced collaborative research and effective management of design, development, technology development, system integration and ensure industry support for production & upgrades and life time support of indigenously developed systems. This eco system provides an advantage of easy networking, adequate financing, easy migration of people and easy knowledge sharing for sustainable growth in Hitech areas for next two decades.

7.2 DRDO has also created a 3 Tier Industry Interaction Model based on the Lead System Integrator concept where DRDO laboratories interact with SMEs (L1 & L2) for product development, testing, production and qualification, engage with large scale industries (L3) for major subsystem and select one of the L3 as lead system Integrator for production and subsequent scaling up, documentation, delivery to services and warranty & product support. This model provides a framework where technology group, product group and Services interact with the various industries for various phases of product development.

8. <u>Measures recommended to enhance the participation of private sector industries</u>

8.1 Creation / Establishing National Design Houses: Post US sanction, a National Team was formed (DRDO + CSIR (NAL) + academy) that successfully designed and developed the Control Law "CLAW" for LCA TEJAS. To harness the strength of R &D organizations in the country including academia and industry, it is essential to establish National Design Houses in the areas of Aeronautics, Propulsion (rocket, gas turbine, alternate propulsion, AIP, electric), Long Range Radars, Advanced control systems, Advanced materials / composites.

8.2 Defence Technology Development Fund: Indian Industries would require funding support to undertake Defence technology related tasks. To encourage them to undertake high risk development tasks Kelkar committee had recommended creation of Defence Technology Development Fund (DTDF) for use by Indian Private Sector Industries. This fund was never created as accountability became an issue. Rs 100 Cr allocated and not used. The fear of accountability should not become an obstacle in the implementation of Defence Technology Development fund. Undue control measures should not be introduced which may become a deterrent for the industries to join the scheme. DRDO to be assigned management of this fund as DRDO is the right agency which understands technology.

8.3 Creation of DRDO Research & Innovation Centre: Establishing DRDO's Research and Innovation Centre in IIT(M) Research Park for advanced research in high technology areas involving academia, research fellows, student community, industries and DRDO scientists. This new initiative would help in creating new start ups in high technology areas. It could also incubate industries in high technology areas effectively.

8.4 Creation of additional / parallel capacity: DRDO has derived benefit from the enabled Indian Defence Industry base and could come out with variants of several more complex systems like Advanced missile systems (Interceptor, Astra, Long range missiles, Shourya, underwater launched missiles), LCA variants, ARJUN variants like BHIM, BLT, variety of radars and EW systems, Sonars etc in a much shorter time frame. In spite of the fact that the Indian Defence Industry have enthusiastically participated in the development programme, there is no assurance of production. In cases where the production has taken place, the volumes are ridiculously minimal that deters Private Sector industries to participate in future projects. All nations that have reasonable level of maturity in defence technologies ensure acquisitions of substantial number of indigenous systems as soon as the first milestone is achieved. Firm orders are placed as soon as initial level is demonstrated. Whereas in India, very often procurement action is initiated only after all milestones are achieved and that too for small numbers. Actions for subsequent orders get initiated almost after the first batch of production is complete. It is pertinent to note that many times most of the production of DRDO developed systems takes place in DPSUs and OFs in the unused / reserve capacity that can handle only a few numbers of batch production as their normal production lines are busy with their own regular production of systems for which ToT has been received from OEMs. To accommodate within that reserve capacity, often the volumes of indigenously developed systems are kept so small, it often becomes economically unviable and also the quality suffers. The opportunities to export indigenous systems are also lost for want of adequate indigenous capacity. It is therefore very important that new capacities and in some cases parallel capacities are created in Private sector so that the requisite numbers could be built faster, better and even cheaper. Such a step would enable Indian Private Sector to participate in all future indigenous development with more vigor.

8.5 Merit based selection of Development cum Production Partner: Any development involves taking risk. High technology defence projects involve higher risks. Once the decision is taken to undertake a specific defence technology intensive project, then financial prudence lies in ensuring that the project becomes successful. For that, it is essential that the choice of development partners are done technical merit (T1) rather than on commercial basis (L1). The L1 model normally adopted in most of the acquisitions may be prudent for off the shelf items. But for development systems, selection of development partner based T1 model is better suited. By allowing the DRDO project team to choose the partner on technical merit, the project team would be more accountable and likely to participate with full enthusiasm and the chances of success is likely to be more. Once the development is completed, the cost becomes transparent (as the cost every module/task would have been captured during development) and the question of industry dictating the price is not that easy and there could be different models by which one could effectively control. The financial managers could then play a very active and crucial role in negotiation to ensure the right price is paid based on efforts and quantity. Such measures would motivate the industries to improve their skill sets so that they compete with each other to become T1, which is the key requirement for success for high risk technology projects. Incentives could also be built into this model for rewarding completion ahead of time. For development projects the competition should be to become T1 and not L1 as the risk of failure would be too expensive. This in the long run will ensure a strong and sound Indian Defence Industry base of world class and internationally competitive and would also contribute positively to our GDP apart from ensuring National Security through Self Reliance.

8.6 Automatic Grant of Industrial license to Indian industries participated in DRDO projects: Most of the DRDO developed systems have been extensively evaluated by the Services and many systems have met the user requirements and are getting inducted into services. Invariably indigenously developed systems are often compared with the international systems. In a way, DRDO systems that are accepted for induction are thus bench marked against international standards and therefore comparable to world class. The industries through their involvement in the development stage and subsequent acceptance of these systems post development, clearly demonstrated their capability to absorb and produce high end defence technology systems. These industries should be given license to manufacture through automatic route and also could be recognized for manufacture of similar class of defence equipments. No further evaluation by DDP or any other agency would be required for licensing. In defence technology capability building is very essential and it is achieved capacity building could be achieved far more easier through adequate support measures like grants, soft loans, incentives, tax holidays etc.

8.7 Acquisition of critical technologies through Offsets: Since access to critical technologies from abroad can accelerate the development of systems through Make decisions, DRDO should be given the role of identifying the technologies that could be sought through offsets. Based on the analysis of LTIPP and DRDO S &T roadmap, DRDO in consultation with the HQIDS, 3 Services and Department of Defence Production would identify the list of critical technologies that would be required to be acquired through offset route. Specific technologies from within this list could be targeted in large value procurements for acquisition under offsets.

8.8 Commercial Arm of DRDO: Creation of DRDO commercial arm for commercialisation / marketing / export of DRDO technologies / products and services.

8.9 DRDO role in categorization of Projects: DRDO should play a major role in all 'Make' decisions of DAC. Sub categorization of 'Make' into 'Make by DRDO' or 'Make by Industry' should be done by Defence R&D Board & its progress monitored by Defence R&D Board. With the technical knowledge & experience as well as with the experience of developing several critical defence systems through Indian Industries, DRDO is better placed than any other Indian MoD Department in assessing the technical competence and also identify potential Indian Industries & Govt. agencies / labs that have the capability to absorb and manufacture high quality defence systems.

9. Conclusion

9.1 DRDO, the largest research and development organisation in the country has the requisite knowledge in design, system engineering and integration of large complex multi disciplinary platforms, weapons and systems. DRDO has demonstrated the capability to manage large complex defence programmes. Further DRDO has also established capability to fully harness the potential of private sector industries, academic institutions and other S&T establishments. In parallel, Indian private sector industries have successfully demonstrated their strength to assimilate the high technologies developed by DRDO and manufacture quality systems to the international standards. Many private sector industries have demonstrated their strength through innovations in designs, solving problems and providing industrial solutions. In addition, the private sector industries have their inherent strength in flexibility in operation, competiveness, networking and their commitments.

9.2 Having successfully participated in the design, development and manufacture of complex weapon systems like Missile systems (Agni, Prithvi, Akash, Nag, AAD, Shourya etc), Combat Aircrafts, Main Battle Tanks, Radars etc, many of these private sector industries could be certified as "Approved Development Partners and Certified Production Agencies". Some of the industries could be readily recognized as Lead System Integrators. To harness the strength of both DRDO and Private sector industries, DRDO should be allowed to select the development cum production partners from among the certified private sector industries for all its mission mode projects.

9.3 Implementing the various measures recommended above like Creation of additional capacity outside DPSUs and OFs, automatic grant of Industrial license to Indian industries participated in DRDO projects, DRDO role in categorization of Projects, Acquisition of critical technologies through Offsets, Defence Technology Development Fund, DRDO R&D efforts for Indian Private Industries, Merit based selection of Development cum Production Partner, Creation of technology incubation centres, creation of a new body to promote private sector participation in Defence sectors, establishing DRDO Research and Innovation centres in research parks for engaging academia and industry at the very early stage of development, would help in creating a new ecosystem. This new ecosystem will enhance the participation of more academic institutions as well as enhance Private sector participation in the design and development of indigenous systems.

Appendix 'E'

Summary record of the presentation made by Dr. S. Sivaram, Director, National Chemical Laboratory, Pune

Dr. Sivaram made a presentation titled "Translating Science into Technology and Products: A View from CSIR". He stated the forces of change gripping the industry at the present time. He pointed at a unique phenomena of "Innovation Deficit" that every nation and industry is currently facing as we search for the next big break through. He alluded to several global issues that make breakthrough innovation difficult to target or achieve. CSIR too is searching for a new paradigm, in this fast changing global scenario. CSIR is trying to put in place new processes and methods to identify innovation within its laboratories and quickly demonstrate the proof of concept of a new discovery. CSIR believes that partnership is essential, more than ever before, to take processes and products quickly to the markets and to convert knowledge to wealth. Classical technology transfer models have outlived their utility in these times, when capital is scarce and technology becomes obsolete at a rate faster than the time it takes to create them.

He then described several new initiates of CSIR such as public – private partnership programmes (NMITLI), knowledge alliances, creating publicly funded and privately managed facilities for R&D, industry consortium models for development of generic or platform technologies and creating new ventures out of early stage discoveries, new strategies for licensing of IP's. Dr. Sivaram pointed out that the critical weakness of the Indian Innovation System is that is too much focused on research and scientists with far less attention paid to the host of other skills and competencies needed to convert science into useful technologies. The Indian Innovation eco-system is woefully short of human skills needed for commercialization. CSIR is also taking steps to address this critical need.

Dr. Sivaram exemplified successful process and product introductions from CSIR in the recent years. This covers many diverse translational models. While practicing these models, there is a need for a change in mindset. Technology transfer is not a baton passing race; it is essentially a tango. In this partnership, either you succeed together or fail collectively.

He also compared modern technology development endeavor to a 100 piece orchestra. Organizing scientific research on the scale of a big operatic and theatrical production is still something new in science. Dr. Sivaram in his presentation highlighted some of the useful lessons learnt by CSIR. While science is a product of inspiration, technology development and implementation is more perspiration. The former is romantic, individual centered and personally rewarding. The letter is hard work involving many, individually unrewarding and efforts of groups often go unrecognized. This is the reason we often fail to attract the best minds to focus on the latter. He also emphasized that true partnership is a union of equals. However, there is a tendency on the part of the academic and scientific community to assume a high pedestal and look down upon those who toil to take technology to markets. Unless this attitude undergoes a transformation, true public – private partnership will stay as a mirage.