Detailed Project Report

National Institutes of Sciences (NISc)

Allahabad, Bhuvaneshwar, Chennai & Pune

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University Grants Commission
Department of Secondary & Higher Education
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Executive Summary

In the emerging global scenario, the competitive advantage of a Nation is determined by its scientific capability and technological competence. While Science is universal and freely available, Technology is private, a preserve of one who develops it and has a price tag to it. Its transfer is becoming increasingly difficult and each Country has to make substantial investments to continue to reap its benefits.

India has one of the finest R & D infrastructures in the World. Our National Labs, Research Institutes and Science Agencies have weaved a number of success stories. India has inherent advantage in the R & D sector because of availability of trained manpower at low-costs. This makes the outlook for R & D services in India positive and provides the country new opportunities in this knowledge led sector. Yet there are weaknesses. The gap in research productivity, between India and the developed countries, is continuously widening as per an assessment of R & D capabilities across the nations published in Nature recently. Large number of scientists in our R & D institutions are retiring in the coming years. Their replacements are difficult to find. There is a wane in the interest of young people in science for their future careers. Therefore, we are not able to attract bright young people for science education. Although, India has potential to become a Global R & D Hub, but for that, we need to address the challenges that science education today faces, on a priority basis.

Science Education plays a crucial role in advancement of scientific R & D that is essential to move us further on the road to a Knowledge Society. Advantages of low-cost manpower in India, complements the large Talent Pool for the R & D Sector. However, our education system has to continue to feed to this talent pool to give us sustainable competitive advantage. There are several concerns in this regard. Standards of science education are continually declining. Our bright boys and girls are shying away from science after 10+2 stage. Though science and technology have come close to each other and all emerging technologies are all essentially science based, we do not provide composite science and technology education in our institutions. Our competitive advantage in the R & D sector may be lost unless we ensure that the country produces, on a continuing basis an adequate number of competent and motivated young boys and girls who would man and lead our National Labs / Science Agencies, Knowledge-based Industry and provide a composite model of science education that would attract bright students to science.

Task of improving overall science education is stupendous. A uniform approach is neither feasible nor desirable. Interventions required should therefore be contingent to the situation. An important intervention is to

selectively raise the standard of science education for a select group of bright students through a new model of science education that is both exciting and rewarding.

For this purpose, it is proposed that a number of new science Institutes need to be set-up at different places in the country to be the Centres of Excellence in Science Education. These Institutes would be designed to occupy, in the near future, prestigious position in the global setting for science education as IITs and IIMs presently occupy for engineering and management education. These Institutes would attract the brightest science students from all over the Country.

Realizing the importance of the above initiative, scheme for support for setting up of National Institutions for Sciences in the Country has been included in the UGC's 10th Plan Outlay. Initially four (4) National Institutes of Sciences shall be established in the proximity of the prestigious universities in the four regions of the Country. These institutes would be established at Allahabad near Allahabad University, at Chennai near Anna University, at Pune near Pune University and at Bhuvaneshwar near Utkal University. They would primarily offer integrated five-year basic and applied science education programme, leading to a Masters Degree and would have linkages with National research labs science agencies and industry right from their inception.

These institutions shall be fully autonomous and have flexible and responsive academic structures. The Institutes would offer a large menu of courses from which students can choose depending upon their liking and aptitude. The integration will be sought to be achieved in terms of time and discipline, undergraduate and post graduate education, education and exploration, learning and research, pure and applied sciences. Unique feature of the academic programme of these Institutes would be its internship programme in the last semester spilling over to the adjoining summer vacation.

The Institutes would attract the brightest science students from all over the country. Faculty positions shall also be filled up from amongst the brightest in the Country. Faculty would be either core (tenure) faculty, on joint appointments with R&D institutions in the neighborhood, Visiting Scientists both from India and abroad and Adjunct Faculty from the Industry. In addition, Science Agencies and Industry shall be encouraged to institute Chairs in frontier areas of science through endowments.

Total student population at any time will be around 1000 in various academic programmes with around 200 Research Fellows / Post Doctoral Students in each Institute. Core faculty will be around 100 for each Institute. In addition, at any given point of time there would be around

100 faculty members in the form of joint appointees, visiting and adjunct professors. Non-academic staff will be limited to the barest minimum. All necessary support services will be provided on contract basis through reputed agencies.

Campus of the Institute shall have lecture room complex, experimental laboratories, R & D laboratories, Information Resource Centre cum Library, Administrative and Residential facilities. Cost-estimates for buildings and services work to Rs. 3705 lakh per Institute over the next three years. Cost of equipment would be Rs. 2600 lakh for the first three years. Ultimately, equipment worth nearly Rs. 7000 lakh may be required. Possibility of getting additional support from the national laboratories, science agencies and industry for setting up labs shall also be explored. Recurring cost is estimated as Rs. 1100 lakh during the next three years. The science agencies of the Govt. and Industry are expected to assist by creating endowment chairs, equipping laboratories and by sponsoring research development projects.

Strategically, these Institutes would be driven by the national research laboratories, science agencies and Industry acting in concert. The Institutes will have full academic autonomy and flexibility and will be structured to quickly respond to changes while being stable, innovative and efficient. The management structure of the Institutes shall provide for autonomy, flexibility, quick decision-making and efficiency in its academic functioning and in the use of resources, with both internal and external accountability. These Institutes shall be set up as Autonomous Societies under the Society Registration Act. Initially, they will be autonomous institutes of the link universities with link universities granting educational and research degrees but the Institutes will be fully free to set up their own courses of studies, system of teaching and evaluation, etc.

Total investment in each Institute would be Rs. 74.5 crores during the Tenth Five Year Plan. Both recurring and nonrecurring expenditure would be supplemented by project funding, consultancy, etc. Eventually, these Institutes would be brought under the formula based funding arrangement with outcome focus. As per the operational plan, these Institutes would enroll the first batch of students from July 2005.

These Institutes would not only meet requirement of high quality well trained young boys and girls to man and lead our national laboratory system and mission oriented agencies but also help the Country to move up the value chain in the global R & D sector, where India is favorably positioned. In addition, these Institutes would provide a new model for composite science education that is both exciting and rewarding and help in restoring the interest of the young people in science education and opting for science as a career.

It is strongly believed that discovery itself is the greatest and the most effective form of teaching, and that teaching and learning are viewed as an adventure in discovery. These Institutes will thus lay stress on acquisition of knowledge and on the ability to use that knowledge to solve academic and societal problems. Therefore, these Institutes would not only provide exciting academic programmes, but also promote first-rate R & D in frontier areas of science under one roof. In order to foster a spirit of innovation, these institutes shall forge strong and productive interfaces with national research laboratories, science agencies and industry.

I. Role of Science and Technology in Development

1.1 Science and Technology have been increasingly playing a dominant role in shaping our lives on this planet. Over the last two centuries, science and technology have come to occupy centre-stage in the thinking and living of man. While science is an endless quest and unceasing exploration to understand Nature and a variety of natural phenomena, technology is the application of the knowledge gained through the pursuit of science to reach the benefits of science to the people and to the society. Historically, science and technology initially grew independent of each of other but today, technology has become totally science based. Science and technology have become inseparable and in fact not only are they complementary but each one also feeds into the other. Good science has thus become the most important precursor for innovation and technology development. It may therefore be recognized that unless India creates a culture for scientific excellence and captures, nurtures and nourishes scientific talent, it will be left behind in the race to a knowledge society, despite the advantage of rich human and material resources. It is now well recognized that science education has played and will continue to play, in increasing measure, crucial and pivotal role in advancement of scientific research and development, so very essential to move on the road to a knowledge society. Advances in science and technology are self-perpetuating. Each new scientific and technological innovation triggers further innovations and in a kind of chain reaction science grows exponentially and technology becomes increasingly sophisticated, fueling long-term economic growth. In technologically advanced economies, economic growth has continued for nearly two centuries without running out of dynamism or even slowing down.

1.2 With Indian economy opening up and integrating with the global economy, fierce competition is at our doorstep. This competition is throwing up new challenges that we had never grappled before. This also opens out new opportunities that we had never imagined. Technology transfer from outside to trigger economic growth was relatively easy (except in strategic areas) earlier.

However, the exponential growth in science and ever increasing sophistication in technology, resulting in continually shrinking of the time of obsolescence and ever decreasing time lag between a major scientific discovery and its technological exploitation, have seriously questioned the model of basing economic growth on the import of technology. Further, technology transfer has become increasingly difficult. Consequently, in order to become globally competitive and retain that capability, it has become necessary to depend more and more on our indigenous R & D capabilities, not only for our economic development but also for reverse transfer of technology from India to other countries.

1.3 It may be realized that R & D services can also be used to support industry abroad. This is more likely to happen in knowledge-based areas rather than in manufacturing sector, as Indians are traditionally recognized world over for their best analytical minds. This is useful because it creates wealth, provides job opportunities, and diffuses technology in the country. Recent trends of a large number of MNCs setting up their R & D Centres in India indicate that India has a potential to become the Global R & D Hub. However, we must keep at the back of our mind the possibility of the demand for our R & D services to be switched off either because other countries become more competitive in terms of cost and competence or for strategic considerations. It is therefore very important for us to move up the value chain. Moving up the value chain would imply – need for better skilled and more knowledgeable S & T Manpower and developing new and innovative products and processes based on our own R & D. For this, not only the Govt., the Govt. science agencies but also the Industry in the country must support R & D and S & T education for manpower development.

1.4 India has one of the finest R & D infrastructures in the World. Our National Labs, Research Institutes and Science Agencies have weaved a number of success stories. India has inherent advantage in the R & D sector because of

the availability of trained manpower at low-costs. This makes the outlook for R & D services in India positive and provides the country with new opportunities in this knowledge led sector. Yet there are weaknesses and these concerns need to be addressed urgently. The gap in research productivity between India and the developed countries is continuously widening as per an assessment of R & D capabilities across the nations published in Nature recently. Large numbers of scientists in our R & D institutions are retiring in the coming years. Their replacements are difficult to find. There is a wane in the interest of young people in science for their future careers. Therefore, we are not able to attract bright young people for science education. Although, India has potential to become a Global R & D Hub, but for that we need to address the challenges that science education today faces on a priority basis.

II. Status of Science Education In India

2.1 Since independence, there has been a phenomenal growth in the number of universities and colleges imparting science education and the number of students enrolling in the science stream. Despite impressive growth in the numbers, percentage of students opting for science after 10+2 has declined from 31% in fifties to around 20% during nineties. It is not the decline in the percentage that causes concern but the fact that in the fifties, the top 31% from amongst those passing 10+2 examination opted for science. However, today the lower middle level 20% students opt for science. There is an unmistakable growing trend of brighter boys and girls shying away from science. Even those who win International Olympiad Medals are reluctant to opt for career in science. This trend is further substantiated by a comparatively lower percentage of marks needed for admission to science stream in our colleges as compared to other professional streams.

2.2 A large number, nearly 90% of undergraduate students in sciences are educated in affiliated colleges. Most of these colleges are over crowded, under

equipped in laboratory and library facilities and are also poorly staffed. Undergraduate science education has now become entirely chalk-talk-rote routine without any emphasis on understanding of the basic concepts and the application of this understanding to innovate technology. Classroom demonstrations and open-ended experimentation have all but disappeared from the undergraduate science education programmes, despite the fact that science is truly experiment based and is an endless exploration. Examination system has contributed further to the deterioration of science education as it is solely based on the ability to memorize and the ability to vomit in the examination. There is presently nothing in the system that excites the curiosity of young minds, communicates a sense of excitement in doing science, nourishes and nurtures creativity and innovativeness, imparts necessary skills and generates self-confidence. All this results in not only an alarming rate of dropouts and fallouts, as high as 40%, but also in our young boys and girls emerging out of colleges devoid of curiosity, unexcited and unimaginative, lacking in creativity and self confidence and frightful of their future. There are of course, few institutes that still heroically seek to offer science education comparable to that available in advanced countries. However, they are confronted with outdated curricula and also rigidity of the institutional set up and of the universities to which they are affiliated, and are thus unable to make any significant impact on the general scene.

2.3 Poor undergraduate science education programmes have led to still poorer post-graduate science education programmes. This clearly presents two related problems. A large number of talented students simply do not opt for a career in science because they do not consider it as rewarding and satisfying. At the same time, a large number of unmotivated and uninterested students crowd in our science colleges. Thus the present system has neither the selectivity nor the atmosphere conducive to motivation, innovation and creativity. The consequences of all this are obvious and unmistakable. If this trend continues, even strategically important sectors such as space, atomic

energy, defense, biotechnology etc., will find it difficult to recruit young scientists of high caliber needed for these nationally important programmes. In fact, many of these institutions have already lowered their selection criterion. In addition, standards of teaching of science would further decline.

2.4 All this manifests itself in several ways. There is a decrease in research productivity in the country in most scientific disciplines. Science and technology output indicators such as publication of research papers and filling of patents are stagnant or decreasing compared to those of even South Korea, China etc. The centre of gravity of research and development in science and technology has therefore shifted from teaching and academic institutions to bureaucratic research institutions. This is not sustainable. It is only the face to face confrontation and critical dialogue between experienced professors and their bright inquisitive students, without the constraints and inhibitions that generally operate in the non-university type system that provides stimulus to original thinking and to the expansion of the horizons of human knowledge. The wisdom and the knowledge of one and the desire to surpass on part of the other provide the right combination in the universities for their mutual growth. It is the only recipe to build science. Science teaching /education and research must be inextricably linked. In the absence of clear perception and adequate realization of the mechanism of building self-generating, sustainable and enduring base for science, we have dried the source and resource that feeds into the system of research and technology development. With research only in research laboratories, in the absence of a steady flow of well talented and innovative young boys and girls, we are making our research laboratories unproductive. Indeed, National research institutions and agencies are facing an acute shortage of quality manpower. This problem would become very critical by 2010. Recently, the Hon'ble Prime Minister also observed that the Govt. of India should tackle the challenges of recruiting the best scientific talent into our research institutions and retaining them there. Also the Science and

Technology Policy of 2003 has laid great stress on basic research in educational institutions.

2.5 Addressing the problems of science education requires a multi-pronged approach. Issues relating to curricula, lack of experimental facilities, absence of research culture and atmosphere, non-availability of high quality teachers, lack of good library, workshop and other facilities will have to be addressed. Most important is the one concerning the serious shortage of high quality teachers in pure and applied sciences. This is both a cause and an effect of the problem facing science education. There is also a need for well planned institutionalized collaborative linkage between academic institutions on the one hand and , research and development laboratories, science agencies and industry on the other. As a matter of strategy, efforts are required to enhance ambience for science education in all the institutions across the country to bring it to a certain threshold level and also to promote excellence in a limited number of institutions to make them world class.

2.6 University Grants Commission (UGC) is seized of the problems of science education in the country. It has identified gaps in academic infrastructure for science education at the degree level i.e. laboratory and library facilities, curriculum, training of teachers, creating ambience which would promote innovation etc. It has taken a series of measures. These include enhanced support for institutions with potential for excellence and using innovative technologies to enhance and improve teaching –learning process. Access to high quality multimedia learning material and e-library for all is being ensured. Exclusive research council is being set up for more focused and better-targeted funding research in basic sciences. These steps, though in the right direction are not sufficient. These are required to be scaled up further for greater impact and more comprehensive coverage.

2.7 The concern regarding the state of science education is not unique to this country. It is a part of the global phenomenon. Basic sciences are no more attracting the brightest students at the graduate and the postgraduate levels. There is a fall in enrolments in basic sciences as compared to applied / professional programmes, particularly in developed countries. This decline is partly due to the perception of people in these countries that all the present ills of the world are due to science and technology. The evolving demographic picture in these developed countries seems to accentuate the situation in those countries. In fact, this could be seen as an opportunity for India. India has the potential to become global player for high-end science and technology sector. We can exploit the advantage of numbers and large gene pool that we have. We could also deploy appropriate strategy to selectively nurture excellence in science education that could meet the requirement of our national research system and also move up the value chain and as a destination for high end R and D services. We could truly become the *Research Laboratory* for the world.

III. Setting up National Institute(s) of Science

3.1 Task of improving overall pure and applied science education is stupendous. A uniform approach to improve the standards of pure and applied science education is neither feasible nor desirable. Interventions required to do so have therefore to be contingent on the situation. Accordingly a five-pronged strategy is recommended:

(a) to selectively nurture excellence by imparting quality education in pure and applied sciences in an environment of productive and innovative research and development;
(b) to identify, motivate, nurture and nourish the talented to pursue pure and applied science as a career;
(c) to provide avenues and opportunities for those engaged in science to refurbish and enlarge upon their knowledge and skill base on a continuing basis.

(d) to devise strategies to retain the best in active science;
(e) to involve national research laboratories, science agencies and the corporate sector in pure and applied science education.

3.2 Education in basic sciences is being imparted today by multi faculty colleges and universities and none of them even vaguely acquaint the students to the application to which science can be applied. There is no exclusive institute, excepting Indian Institute of Science at Bangalore for science education. Even IISc, Bangalore offers post B.Sc. programmes. As a result, meritorious students who take science at the 10+2 level tend to opt for professional programmes, at the first-degree level. In the sector of professional education such as in technology, management, medical sciences etc., there are high quality institutions on par with the global level that impart related quality education at the undergraduate level. It is now urgently necessary to selectively and preferentially raise the standards of pure and applied science education for a small section of the overall population of talented students wishing to opt for science. For this purpose, it is proposed to set up a number of new institutes exclusively devoted to imparting pure and applied science education in the ambience of creative research and development. These Institutes of Science should serve as Centres of Excellence for science education and occupy, in the near future, prestigious position in the global setting for science education as IITs and IIMs presently occupy for engineering and management education. These Institutes would be so designed as to attract the brightest science students from all over the Country. The selected candidates will be enrolled in an integrated five-year science education programme leading to Masters Degree.

3.3 Need for exclusive institutes for imparting education in pure and applied science beyond 10+2 level in the ambience of creative research and development has been felt for a long time. In this regard, Hon'ble Human Resource Minister has observed that, '*the undergraduate education in pure*

sciences is a matter of concern. We are going to face a shortage of good researchers in a few years time, particularly in our premier research institutes in the field of atomic energy, oil exploration, communication and so on. We have to catch them young for five year integrated programme with a possibility of exit after three years'.

3.4 Need for a new model of pure and applied science education in the ambience of creative and innovative research and development has been discussed and debated over the last decade. Search for this model had zeroed in, a few years ago, to the proposal for the establishment of Advanced Centre(s) for Science and Technology Education, on the pattern of IIT's to attract bright young boys and girls to science after the 10+2 level. The strategy was to provide a prestigious and a viable option to bright students for taking up careers in science. Such centres were supposed to be set up in collaboration with the National Science Agencies, such as DAE, CSIR, DBT, DRDO etc., and the leading industries who would be the beneficiaries of the products of these centres. This was approved in principle by the DST, MHRD, and the Planning Commission during the 9th Five Year Plan. However, only a token amount for preparing Detailed Project Report could be provided in the 9th plan. Realizing the importance and the urgent need for setting up such National Institutes of Sciences, this proposal has been approved as a part of the UGC's 10th Five Year Plan. Recently, it was recommended that such Centres could be more appropriately called as National Institutes of Sciences. To work out academic, administrative and financial details, a High Powered Committee was set up by the UGC in early 2003. Composition of the Committee is given at ***Appendix I***. The Commission also gave its in-principle approval to this proposal on April 9, 2004. In course of working out details, several stakeholders and eminent people were consulted. Their list is given at ***Appendix II***.

3.5 In view of the above, it has been decided to establish initially four National Institutes of Sciences in the proximity of the following four

universities, in the four regions of the country. These Institutes (NISc's) would be established at Pune, near the Pune University, at Allahabad near the Allahabad University, at Chennai near the Anna University and at Bhubaneshwar in close proximity of the Utkal University. In future, many more such institutions could be set up possibly at places such as Calcutta, Chandigarh etc. These Institutes shall be fully academically, administratively and financially autonomous and will have flexible academic programmes and supportive administrative structures. They would offer five year integrated programmes in pure and applied sciences, work in the ambience of productive and innovative Research and Development and would have close linkages with national research laboratories, science agencies and industry right from their inception.

3.6 These Institutions would be specialized and pace settling institutions offering a large menu of courses from which students can pick and choose according to their aptitude and liking, with a focus on basic sciences, integrating teaching and research, integrating education and exploration, imparting knowledge and skills and promoting the ability of students to solve societal problems. The unique feature of their academic programmes will be the internship in the last semester spilling over to the adjoining summer vacation. Products from these institutions would have career opportunities in the national laboratories, science agencies, educational institutions for higher science and industry. The R & D activities in these Institutes would essentially be sponsored by mission oriented agencies and industry and thus, supplement and complement R & D efforts of the national laboratories and science agencies. Faculty will be encouraged to evolve productive and strategies alliances with National Research laboratories, the industry and mission oriented Science agencies. The spirit of innovation, creativity and excellence should remain the guiding spirit of these institutes.

IV. Vision

4.1 These Institutes are envisioned as academic institutions of excellence imparting quality education in pure and applied sciences leading to post-graduate degree in the ambience of creative and innovative research and development and ensure an adequate supply of highly talented, highly skilled and highly motivated S and T manpower to lead R and D groups in our National Laboratories, Mission oriented agencies and in Industries. These Institutes will strive to be at the frontiers of science and at the cutting edge of technology.

V. Mission

5.1 The Mission of these National Institutes of Sciences is to be Global Centres of Excellence for education in basic and applied sciences, research in pure and applied sciences and also cutting edge technology development in interdisciplinary areas of importance to the country.

5.2 The Charter of the Institutes is summarized below:

- To provide education and training in pure and applied sciences to persons of outstanding abilities who would provide leadership to Indian Science in globally competitive economic environment

- To carry out R & D activities in basic and applied sciences, both on its own and on sponsorship basis forging a strong interface between science education imparted in these institutions and R & D carried out in national laboratories, mission oriented science agencies and in close collaboration with Industry.

- To evolve a new model of science education by selectively nurturing excellence in science education and thus become pace setting institutions for science education in the country.

- To provide continuing education programmes for faculty/ scholars from other institutions and industry.

- To organize conferences, seminars, workshops and such other activities for the dissemination of knowledge.

- To take all steps to exploit the knowledge generated in the Institutes for the benefit of the society and the country.

VI. Strategy

6.1 The proposed institutes should serve as interdisciplinary institutions for education and research in the areas of Basic sciences, Electronics, Communication and Information sciences, Material science, Life sciences, Biotechnology etc. and / or such areas which are of interest to the region in which they are located or of interest to the industries located in the nearby regions of each of the four Institutes. These Institutes shall become pre-eminent national centres for creation and dissemination of knowledge and would catalyze the development of high technology and its use in science agencies and in industry. These institutes shall focus on the creation of a pool of highly talented and creative individuals with specialized knowledge. These Institutes would have National Character in terms of body of its students, faculty profile and also its mandate to work with national level institutions with a national mandate. This would be retained at all costs, nurtured and further strengthened.

6.2 Apart from in-house academic and research and development activities the Institutes shall engage in directly benefiting the National Research Laboratory system and the Indian Industry and other academic institutions to integrate this new body of knowledge and practices in pure and applied science education in their programmes of human resource development, pure and applied research and technology development. Accordingly, strong interface

and close cooperation with other academic institutions, research institutes and knowledge intensive industry shall be the key features of these Institutes.

VII. Interface with Research System and Industry

7.1 An important requirement for achieving the vision and mission of these Institutes is to build strong and enduring linkages and interfaces with partners and stake-holders, including other academic institutions in chosen areas, both in India and abroad, the national laboratory system, the mission oriented agencies, the industry, government and the public at large. This would include:

- Involvement of the Institute in projects of national importance,
- Involvement and participation of the national laboratory system and industry in the educational and research and development activities of the institute.
- Creation of a suitable structure for generating know-how and, exploiting and commercialization of technology through technology incubation, transfer and licensing.
- Collaborative research projects, student and faculty exchange, etc.

7.2 In the changed and dynamic scenario, the need for creating synergistic partnership between educational and research institutions, technology development establishments, mission oriented agencies and industry is an absolute necessity. Continuous up gradation of curricula to meet the demands of the emerging scenario, creation of an ambience of creativity and innovativeness, building interface with leading R & D institutions, sharing of human resource and research infrastructure, with national laboratories, research institutes and industry, etc. for mutual benefit, are some specific areas where partnership with national laboratory system, science agencies and industry would benefit these national Institutes of Sciences. Considering the above, the proposed 'National Institute of Sciences' are expected to be co-sponsored, funded, supported and driven by the science agencies of the Government, and the industry. These institutes will have the governance and

management structure designed specifically to provide for autonomy, flexibility, accountability and for building productive interfaces with national laboratories, science agencies and the industry.

VIII. Academic and Research Activities

8.1 Academic programmes define the philosophy of an educational institution. These institutes would primarily offer a five year integrated science educational programme leading to postgraduate degree in basic and applied sciences. The integration is sought to be accomplished in terms of time and discipline, education and exploration, teaching and research, acquisition of knowledge and the ability and the capacity to use that knowledge for exploring the laws of nature and solving societal problems. The assigned role of the proposed Institute is a result of the firm conviction that the most effective form of teaching comes from discussion with peers and happens when teaching and learning are viewed as an adventure in discovery. There is perhaps no greater stimulant for young minds than to see discoveries and inventions occurring in their midst and in their presence.

8.2 There will be an exit route at the end of the third year, for those who cannot cope with this exacting and exciting science education programme. Similarly, at the end of the third year, there will be an aptitude test to test the ability of the student to continue with basic or with applied sciences. Bright students who have done their B.Sc. or B.E. in other institutions could join these National Institutes as exceptional cases, these institutions for their postgraduate degree in pure and applied sciences.

8.3 These Institutes would offer a large menu of courses from which students could choose according to their liking and aptitude in consultation with faculty adviser(s). The choice of courses will not be restricted to any conventional stream, but will also be available across the streams and beyond. For exceptional students, who demonstrate special insight in any given

discipline, the formal structure, will not be imposed on them and they will be encouraged to pursue their discipline at their pace.

8.4 Some of the significant science and technology trends of the future are likely to be at the intersection of the basic science with information and communication sciences, Materials science, biosciences etc. Therefore, the educational and research programmes are not expected to be organized in watertight compartments. However, for administrative convenience, these institutes could be centered around 4 to 6 Schools. Each Institute could identify its own areas depending upon the strength of Link University, nearby research and development laboratories or of interest to the region in which these Institutes are located.

Integrated Masters Programme

8.5 The main educational programme offered by the Institutes shall be the five year Integrated programme leading to M.Sc. in pure and applied sciences, after the 10+2 standard examination. In this programme, there shall be a common curriculum for all in which students will be exposed to basic physical principles, mathematical tools and techniques, computer and computational techniques, basics of life sciences and the current excitement in life sciences. In the laboratory, students will be enabled to learn various skills and techniques and carry out open-ended investigations. At the end of the first year, there will be rigorous year-end examination to assess the student's ability to cope up with this exciting and exacting educational programme in subsequent years.

8.6 Each course shall have emphasis on acquisition of latest knowledge and information, cultivation of different kinds of skills and development of competence in related techniques, nurturing and nourishing creativity and innovativeness, and inculcation of desired attitudes and outlooks conducive to social commitment. Besides, the classroom work packed with demonstrations,

there shall be laboratory lectures conducted in research laboratories and tutorials with emphasis on learning of skills and techniques, open ended investigations and projects rather than stereotyped experiments with known end results.

8.7 There shall be total flexibility in programme design having a lot of options with a core of liberal sciences. There shall be credit based evaluation system with possibility of fast track completion of programme, possibility of advanced degree and exit option after third year. The first three years could mainly be designed to strengthen the fundamental aspects of the subject and the last two years on specialization. The themes for specialization could be in challenging fields like for example, detector systems and electronic devices which are relevant to science instrumentation development, modeling and simulation of complex phenomena of the atmosphere, space astronomy and cosmology, geo-sphere - biosphere interactive system, process science and experimental techniques etc. There could be similar set of themes related to other areas of specialization like alternative sources of energy, material science, biotechnology etc. The special themes could be suitably distributed between the four Institutes depending on the availability of teaching expertise and facilities in the region.

8.8 The specialization should also include practical aspects of project work in the last half a semester and hands-on experience in R&D projects. This would help the students to improve their skills not only in pursuing research work but also in other areas of development as career prospects. During the internship, students will carry out research or development project in any one of the laboratories of science agencies, such as, DAE, DBT, CSIR, DRDO etc.; or in an industry. In case of students pursuing basic or theoretical sciences, they will spend their internship programme with an eminent professor in their discipline in a reputed research institute such as IISc, Bangalore, TIFR, etc. In exceptional cases, students of exceptional merit having passed B.Sc or B.E.

degree examination form any other reputed institution may be admitted for the subsequent two-year post graduate educational programmes in basic or applied sciences.

8.9 In order that majority of students pursue the field of science after completing the M. Sc. degree, the amount of the fellowship should have parity with the starting salary amount offered by Government Science Departments / Organizations for such candidates. These students may either join NISc or other academic, research institutions in the country. So far as funding of research activities is concerned, many science agencies like ISRO has schemes such as RESPOND, Space Science Fellowships etc., which could be utilized by submitting necessary proposals.

Research Programmes

8.10 Apart from offering educational programmes leading to M.Sc. degree in pure and applied sciences, the Institutes shall not only offer doctoral programmes but will also serve as productive and innovative research and development laboratories. Teaching and research laboratories will be brought under the same roof and in close contiguity so that students, right from the day one, can participate in creative endevours in research laboratories and study in exciting and creative atmosphere. Creative research atmosphere is an essential part of a good educational institution as discovery itself is the greatest and the most effective form of teaching and teaching and learning are viewed as an adventure in discovery.

8.11 Doctoral programme will include some specialized course work along with original research carried out either in the four schools or in an industry or in a reputed research laboratory under the joint supervision of a faculty member of NISc and a guide from a laboratory or an industry. The thesis need to include necessarily published research work in refereed journals or patents taken or applied for. To a great extent, the reputation of and the atmosphere

in these Institutes for nurturing and nourishing creativity and innovativeness will crucially depend upon the quality of research work it produces. The areas round which theses institutes will function will offer rewarding academic challenges and tremendous technological or applicative opportunities. Research programmes in these areas would not only be comparable to the best anywhere but would also be such as to be a harbinger of a new and revolutionary development and a source of economic growth. Most of the research programmes will be sponsored by or worked in collaboration with national research laboratories, research institutes or industries. Faculty will be encouraged to evolve working and strategic alliances with the industry. This nexus between these institutes and the industry will be mutually beneficial since it will ensure smooth and fast transfer of technology developed in the institutes and in turn facilitate nurturing research effort in the NISc by the industry.

Admissions

8.12 Admissions to the Institutes will be strictly based on the merit determined through a well-designed national level identification process and discussion with the faculty to assess the aptitude of the students. A certain number of foreign students may also be admitted. Foreign students and Indian nationals living abroad will be admitted on the basis of their performance in SAT-II test. For admission to Ph.D. programme, eligible candidates will be selected for admission on the basis of a written test and/ or interview conducted by the Institute.

Continuing Education Programmes

8.13 The human resources required for meeting the challenges posed by global competitiveness have to constantly upgrade their competence. Continuing Education Programmes will be organized on a regular basis in the form of short-term courses primarily for knowledge up-gradation of scientists and researchers to bring to them the cutting-edge science and technology. The

duration of these courses may vary from one week to one month depending upon the level of course and the fee chargeable will depend on the duration of course and number of participants.

R & D Activities

8.14 Research and development activities of the Institutes will be primarily for generation and assimilation of new knowledge for developing problem solving tools and techniques. These will be mostly supported activities by National laboratories and mission oriented agencies and Industry. Small projects may be handled through undergraduate students in the form of summer projects or through regular course projects. Major projects will be assigned to postgraduate students with the support of project staff specially hired for the purpose.

8.15 Projects will be put in three categories namely (i) Institutes core projects, (ii) Sponsored research and development projects and (iii) Consultancy projects. Sponsored projects will be funded by national research laboratories, mission oriented science agencies, industry, international agencies etc. Sponsored research and development projects will generally be of longer duration with defined output requiring involvement of more than one faculty member. In many cases, faculty from other institutions, scientists from sponsoring agencies could work jointly on these projects. Consultancy projects, mainly problem solving type, will be of shorter duration. Alternately, Institute can be a permanent consultant to an industry on a retainer basis. Appropriate overheads will be chargeable to all such projects. Most of the postgraduate / doctoral and postdoctoral students will be supported by these projects through appropriate research fellowships.

Curriculum Design

8.16 Curriculum will be designed and prescribed by the committees for curricula. These would be approved by the Academic Council. The committee

for the curricula shall comprise of the concerned faculty in the Institute, the joint appointees, concerned visiting faculty and experts drawn from national research laboratories, mission oriented agencies and industry in respective areas. The process of curricula design and prescription shall be simple and quick so that curricula could be modified and updated without much delay and with ease. There are some important notions that may be followed for designing the curricula.

- The emphasis would be laid on basic concepts, how they were evolved, what they are and their implications. Indeed, greater emphasis will be laid on the applications of basic concepts and on provoking students on conceiving and developing many more applications.
- Teaching and learning should be considered as an adventure in discovery. Consequently, greater stress will be laid on self-learning rather than on teaching. In fact, learning which is deep occurs best when a student tries to apply his learning to unstructured designs situations.
- The whole education programme is based on three basic principles namely, learn how to learn, learn how to do and learn how to live.

8.17 Accordingly, flexibility in course scheduling and heavy emphasis on project work would form essential elements. To ensure holistic education, subjects like sociology, behavioral science, patent and business laws, intellectual property rights, history and philosophy of science, environmental and sustainable development issues, economics, art and music appreciation etc., would also be taught through weekly colloquia by experts in the related fields.

Learning Environment:

8.18 In theses institutes care would be taken that the best, the country can afford, shall teach. To ensure this the faculty in these Institutes would comprise of (a) core faculty very carefully chosen, (b) joint appointees holding

appointments in these Institutes and in prestigious national R and D laboratories in the neighborhood, (c) visiting faculty from all over the country and abroad. At any given point of time, 20 % of the faculty shall be the visiting faculty, out of which not less than 10 % shall be from reputed universities and research establishments abroad, and (d) adjunct faculty from successful technologically oriented industries. The ratio of the core faculty to the other faculty should be around 60:40. Indeed, it should be considered as an academic honour in the country to be invited to be the visiting faculty at these Institutes. Service conditions for the staff would be similar to those available in the IIT's.

8.19 Formal classroom lectures packed with demonstrations would be supplemented by tutorials. Tutorials will be conducted by the junior faculty supplemented by teaching assistants. This would be supplemented further by the use of multimedia educational packages and Internet services. This approach to learning will hopefully help in developing an ability of self-learning and an attitude for continuing education which has become essential in today's world of rapid change.

8.20 The library of the Institute will be essentially be a Digital Library supplemented by reference books and journals. This library would serve the needs of its educational, research and development programmes. A digital library system with appropriate networking will provide access to online world library and permit downloading of papers and abstracts, searching the classification of references, etc. from personal desktops. Accordingly, the Institute shall benefit both from UGC InfoNet and the Indian Digital Library in Engineering Science and Technology (INDEST) Consortium right from its inception. Library will have adequate reprographic facilities.

IX. Students, Faculty and Staff

9.1 Total number of students enrolled for the five year integrated programme would be 1000. In addition there would around 200 doctoral / post

doctoral and research fellows. Some seats could be kept for International students. Year-wise break-up of number of students is given in Table 1 below:

Table 1: Cumulative Number of Students: Year-wise

	1st Year	2nd Year	3rd Year	4th Year	5th Year
5-Year Integrated Programme Students	200	400	600	800	1000
Research & Post Doctoral Students	5	50	100	150	200
Total	205	450	700	850	1200

9.2 On the basis of student strength, teaching load and requirement for research and development activity, the faculty strength should be minimum of 100. This low student to teacher ratio (10:1) is very essential, for the Institutes that impart exciting and stimulating education at the frontiers of pure and applied sciences in the ambience of a highly creative and innovative R & D environment. Any further increase in the student to faculty ratio will only compromise the quality. The core faculty would be under a Flexible Cadre System as in IITs.

9.3 The Core Faculty shall be supplemented by (a) Joint Appointees holding appointments in the nearby reputed National R & D Institutes and the Link university, (b) Visiting Faculty drawn specifically from reputed research institutions in the country and abroad (c) Adjunct faculty drawn from Industry. Ratio of core faculty to the other faculty is likely to in the ratio of 60:40. This kind of faculty structure will ensure involvement of national laboratories, mission oriented science agencies and industry in the academic activities of the Institutes. Care would also be taken to ensure that at any given point of time, there is at least 15 to 20% visiting faculty out of which nearly 5% would be from

abroad. This will ensure the National Institutes to remain in line with the international trends.

9.4 The guiding principle in recruiting the academic staff will be that the very best the country shall teach and carry out research in the NISc. Consequently, extreme care will be exercised in the recruitment of core faculty and in inviting visiting faculty. It should become a matter of prestige to be invited to teach and work in these Institutes. For attracting quality, retaining them and ensuring their continued high performance, possibility of tenure track teaching cum research faculty, as in the higher education system in the US will be explored. Under tenure-track faculty system, a person is hired as an Assistant Professor on contract for a period of five years. After that period, his teaching work and research output is evaluated and the person is tenured (i.e. made permanent). The process of the grant of tenure position is taken very seriously. When tenure position is offered, the person is promoted as an Associate Professor. If the person is not given a tenure position, he would be asked to leave. In addition to the above process of faculty recruitment, eminent people with excellent track record for teaching and research would be offered Associate Professors or full Professors positions.

9.5 Pay scales and benefits for faculty shall be at the same level as in IITs. Provision of top up salaries or liberal increments at the time of first appointment, contractual appointments for star faculty from Industry or from o abroad, concept of top up salaries with necessary funding from industries and other sources could be explored in order to attract and retain quality faculty.

9.6 The Institutes would have skeleton administrative staff. Routine services like security, cleaning, maintenance, canteen etc., would be given out on contract. Administration will be made paperless using new technologies. Accounts will be computerized. However, adequate technical staff would be required for academic and research labs and library etc.

9.7 Numbers of Core Faculty, Technical Staff and Support Staff with year-wise break up are given in Table 2.

Table 2: Cumulative faculty / Staff Numbers – Year-wise

	Year 1	***Year2***	***Year3***	***Year4***	***Year5***
Core Faculty	20	40	60	80	100
Technical Staff	10	20	35	60	80
Administrative & Support Staff	15	25	40	50	60
Total	***45***	***85***	***135***	***190***	***240***

X. Location

10.1 Location of the four (4) Institutes has been decided upon through a consultative process. This is as under.

At Pune

Director, of the National Chemical Laboratory of CSIR has kindly agreed to make available for the National Institute of Sciences a plot of land admeasuring 50 acres. The land has an independent entry from the Baner road and is in proximity to the University of Pune and other National Laboratories in Pune.

At Chennai

Vice Chancellor of the Link University, Anna University, Chennai has assured UGC to provide the required land for the purpose and adequate administrative and logistic support, on the campus vide his letter dated 1st Aug 2003.

At Allahabad

Vice-Chancellor of the Link University – Allahabad University is in the process of acquiring a large piece of land in Jhansi area in exchange of their Beli Farm land situated within the city belonging to the university. This area is close to the Harish Chandra Institute, the G.B.Pant social science Institute and the

Geomagnetic Centre. Vice-Chancellor has agreed to provide the necessary land for the National Institute of Sciences, vide his letter dated September 10, 2003.

At Bhubaneshwar

A Team of Senior Officials of the State Government has identified a land measuring 75 acre for the purpose in the proximity of Bhubaneshwar Municipal Area and the State Government of Orissa has agreed to provide this land free of cost.

XI. Infrastructure and Equipment

11.1 Each of the Institutes will be provided with about 50 acre of land to start with. There shall be zoning of land for academic and research activities such as for lecture room complex, laboratory buildings for teaching and research work and residential facilities like - faculty housing, guest house, students hostels etc. Site development will involve landscaping, plantation, lawns and gardens, boundary wall, road lightings, optical fibre network for communication, water supply, sewage disposal, etc. The major services to be provided would include electric substation, central air conditioning, tube wells, telephone exchange, etc.

11.2 Total built up area is estimated to be around 55032 sq. meters. Civil construction and infrastructure development will be carried out over a period of eight to ten years. It may also be stressed that the pace of development of all the four Institutions would not be the same and consequently available financial resources would be deployed as and when necessary. The suggested civil construction during remaining period of the 10^{th} five-year plan will be as under.

Table 3: Space Requirement *(in sqm)*

Details	***Plinth area***
Academic Complex	
Academic cum Administrative Building	3,000
Lecture Hall Complex	3,000
Research and Teaching Laboratories	10,000
Computer Centre	1,000
Auditorium	2,000
Workshops	1,000
Activities Centre / Cafeteria	1,000
Sub Total	21,000
Residential Complex	
Student Hostels with Common facilities (600 seats)	10,000
Housing Units (50 Nos.)	5,000
Transit Hostels for Faculty (50 units)	3,000
Guest House (60 seats)	3,000
Community Centre	1,000
Gymnasium	1,000
Sub Total	23,000

11.3 The economic and functional specifications for various buildings will be made to optimize on costs. The cost estimates for buildings and bulk services work out as under:

Table 4: Cost Estimate for Buildings and Bulk Services

S. No.	***Items***	***Amount***
1.	Academic Complex (21000 sqm @ Rs. 7000 per sqm)	1470
2.	Residential Complex (23000 sqm at Rs. 7000 per sqm)	1610
3.	Internal Roads / water drainage, landscaping horticulture etc.	140

4.	Electric supply, Gen sets, External lighting	160
5.	Water supply, water treatment, sewerage etc.	120
6.	Boundary wall	50
7.	Air-conditioning	200
	Total	***3750***

Equipment

11.4 Both teaching and research and development activities would need equipment and supporting infrastructure. In these Institutes, teaching and research laboratories would be integrated so that the students do their open-ended experiments and projects in the creative atmosphere of research laboratories. Secondly, although the schools would need specialized, state of the art equipment pertaining to their fields of specialization, there would also be common facilities that would be used by all the four schools.

11.5 Efforts will be made to update equipment and infrastructure continually. However, in the remaining part of the 10th five year plan, greater emphasis will laid on establishing laboratory equipment for teaching and on core research facilities. The research facilities will grow over the years and will also be augmented through sponsored projects by the national research laboratory system, science mission agencies and the industries. However, to attract the sponsored research funding, these Institutes will need to have core equipment. in the Institutes. The suggested provision for equipment and supporting infrastructure is shown in Table 5

Table 5: Equipment Requirement *(Rs. In Lakh)*

Sr. No.	***Details***	***Amount***
1.	Teaching Laboratories	850
2.	Research Laboratories	1000
3.	Computers, software, etc.	150
4.	Accessories, spares and additional auxiliary equipment	200
	Audio –visual aids	50
5.	Library books and Journals	50
6.	Optical fibre networking	50
7.	Classroom/ library furniture	100
8.	Miscellaneous	50
	Total	***2600***

XII. Governance and Management

12.1 From strategy flows the structure. Strategically, if the Institutes are to cater to the needs of the National laboratories and mission oriented agencies and the knowledge intensive industrial sector, the Institutes, should have the capability to adapt quickly to changes while being stable, innovative and efficient. The *Management Structure* of the Institutes has to take into consideration rapid advances in the areas of science and technology. It is now realized that professionally trained skilled manpower can make a significant impact on competitiveness of the existing and location of new economic activities. In addition, the Institutes are also expected to act as resource centres for creation and dissemination of knowledge.

12.2 The governance structure should

- Be capable of fostering a partnership with research labs and industry such that they play a role beyond that of employer of the graduates. It

implies that the research labs and industry are involved in keeping the institute dynamic and innovative.

- Be capable of nurturing innovation, creativity and excellence in academics.
- Have efficient decision making processes capable of responding quickly to the fast pace of changes taking place all around.
- Provide accountability to all its stakeholders.
- Be capable of providing an environment conducive to the development of aptitude, attitudes and skills in young students so that they become globally competitive and are responsible citizens.

12.3 To meet these, a structure with the following characteristics is required:

- Autonomy in its operations including academic planning, recruitment and management of staff, and financial management.
- Flexibility to develop partnership with other academic institutions, research labs and industry to build on synergies and suit the specific requirements.
- Transparent, responsive, cooperative and decentralized so as to ensure the system to function harmoniously and efficiently.
- Decision processes which results in quick and timely decisions to keep pace with changing nature of activities.
- Efficiency in utilization of its resources.
- Internal accountability of all faculty and staff through an effective performance appraisal system.
- External accountability to its stakeholders through identified mechanisms.

12.4 Accordingly, the Institutes would be set-up through the UGC as Registered Societies. Initially, these Institutes would be, for academic purposes, autonomous institutions of the Link Universities with full academic, administrative and financial autonomy. Although the link university will award

educational and research degrees to the scholars and students of this Institute in the initial phase, these Institutes will have complete and total freedom to lay down their courses, frame suitable course structure, method of teaching and evaluation. These Institutes will have total autonomy to frame statutes and regulation in this regard. This organic link with the Link universities would be very crucial in the initial phases. Established Universities would help to nurture the Institute till they mature to be on their own. Possibility of associating reputed universities from abroad right from inception shall also be explored. Depending on experience further autonomy may be given to the Institutes to enable them to plan their own programmes based on the needs of the society, and keep the programme constantly updated and to attract good faculty, who would expect academic freedom.

12.5 The Management structure will consist of the following:

(a) The Governing Council
(b) The Governing Board
(c) The President of the Governing Council
(d) The Chairperson of the Governing Board
(e) The Director
(f) The Academic Council
(g) The Registrar
(h) Such other authorities and officers as may be constituted/ appointed by the Governing Body.

National Co-ordination Committee

12.6 There shall be a National Co-ordination Committee for the National Institutes of Sciences for overall coordination between the NIScs and between NIScs and various Government science agencies. This Committee shall be chaired by the Minister for Human Resources Development, Govt. of India. Chairman (UGC) shall be its Vice Chairman. Suggestive composition of this Committee is given at Annexure II.

The Governing Council

12.7 The Governing Council shall be a body, which will serve as the society for the purposes of the Society Registration Act. The Governing Council shall be chaired by the Chairman, UGC.

The Governing Board

12.8 The affairs of the Institute shall be managed, administered, directed and controlled, subject to Rules and Regulations and Byelaws by the Governing Board of the Institute. The Governing Board shall be chaired by the chairperson of the Governing Board. The Chairperson of the Governing Board shall be an eminent scientist / technologist / industrialist from amongst a panel of three proposed by the outgoing Governing Board, to be appointed by the Chairman, UGC. The first chairman shall be appointed by the Chairman, UGC through a search cum selection process. The Governing Board will be assisted by the various committees dealing with specific and well-identified activity or functions of the Institute. For the purpose of performance audit and ensure accountability, the Governing Board could also appoint an Academic Advisory and Review Committee under Chairmanship of an eminent scientist from outside.

Director

12.9 The Director of the Institute will be the principal academic and administrative head and will provide academic leadership to the faculty and ensure smooth functioning of the Institute. He shall be responsible for proper administration and for funds of the Institute. By his academic eminence, enlightened vision, compassion and understanding, he will ensure that **NISc** is not only a first rate educational institute and a flourishing research establishment operating at the frontiers of science and at the cutting edge of technology but also make the Institute a non-feudal, internally democratic,

academically autonomous and internationally exciting institution dedicated to creativity, innovativeness and entrepreneurship.

12.10 The Director will be appointed by the President of the Governing Council, on the recommendations of the Search Committee constituted for the purpose by the Governing Board comprising of not less than three and not more than five eminent scientists/ technologists/ industrialists. The Chairman of the Governing Board shall be the Chairman of the Search Committee. The Committee shall meet the faculty members of NISc, solicit their views, as also receive suggestions from eminent scientists/ technologists in the country, before submitting a panel of names to the Chairperson of the Governing Board. The term of appointment of the Director will be for five years and the term can be renewed for further period of five years at a time, or till he attains the age of sixty five years whichever is earlier.

Academic Council

12.11 There shall be the Academic Council of the Institute, which shall serve as an apex academic authority regarding all matters concerning (a) academic programmes, (b) academic calendar, (c) admission rules and procedures, admission of students for degrees and research activities, (d) registration of candidates for various degrees, (e) approval of courses (f) statutes and regulations regarding teaching and evaluation, (g) teaching, research, technology development and evaluation, (h) research and technology development projects, thesis evaluation, etc. subject to the overall control of the Governing Board. Academic Council may constitute its own committees for (a) courses and curricula (b) research and technology development (c) for framing extension, consultation and technology transfer policy. (d) Academic Policy, (e) Academic Programmes, (f) Student Governance to advice it on all matters falling within its purview. Suggestive composition of the Academic Council of National Institute of Science, Pune is given at Annexure IV.

Registrar

12.12 Each Institute shall have a Registrar who will assist the Director and the faculty of the Institute in administrative and financial matters. They will be appointed by the Director on recommendations of the selection committee constituted for the purpose.

Systems

12.13 Systems comprising of appropriate processes that cater to the need for flexibility and quick response time are essential for an adaptive organization of the future. Effective and efficient functioning of the Institution would critically depend on its support systems. Lack of such systems can significantly hamper the realization of goals no matter how good the human and other resources are. Therefore thrust would be on creation of support systems that will offer reliable and quick services. Information Technology would be exploited to enhance efficiency and effectiveness of support services. Processes shall be kept simple and transparent. Convenient and efficient workflows would be part of the development of this system. Implementation should be time bound. Many problems faced by the faculty, students and staff will get addressed and solved when such a system is put in place.

XIII. Financial Implications

13.1 Details of total investment year-wise per Institute are given in Table 6. It may be emphasized that all Institutes would not develop and grow at the same pace. The following indicates the limits for investment per Institute.

Table 6: Capital Investment Year-wise (in Rs. Lakh)

	2004-2005	***2005-2006***	***2006-2007***	***Total***
Buildings & Bulk Services	500	1500	1750	3750
Equipment	300	1200	1100	2600
Total	***800***	***2700***	***2850***	***6350***

13.2 Details of recurring cost year-wise are given in Table 7. Three percent of the capital cost has been kept for real estate maintenance and five percent of the cost for equipment maintenance. All the staff will be under CPF scheme and covered by the Group Medical Insurance. Security services, water supply, sewage disposal, sanitation, horticulture, catering services, hospitality management, transport telecommunications, civil maintenance, electrical maintenance, air conditioning maintenance, and stand-by power shall be outsourced. Some of this may be covered in maintenance budget; however, major part of it may not be covered. Therefore, a separate maintenance budget head has been kept for which funds would be provided, as required. If the maintenance budget for buildings, equipment, etc. is not fully utilized, a depreciation fund may be created by the Institutes for special maintenance of the buildings and replacement of the equipment.

Table 7: Recurring Costs -Year-wise (Amount in Rs. Lakh)

	2004-2005	***2005-2006***	***2007-2008***	***10th Plan***
Pay and allowances (inclg. Joint Appointees / Visiting faculty)	50	150	350	550
Outsourcing Expenses	50	50	50	150
Real Estate Maintenance	0	5	5	10
Equipment Maintenance	0	5	10	15
Departmental Expenses (including cost of consumables, chemicals etc.)	40	85	140	265
Administrative Expenses	16	24	30	70
Water/Electricity/Phone & Service Charges	8	12	20	40
Total	***164***	***331***	***605***	***1100***

13.3 Total investment in each Institute would be Rs. 7450 lakh during the Tenth five-year plan. This investment will enable the Institutes to attract funding from mission oriented science agencies, national laboratories and industries. Full development of these Institutes is expected by the end of the 11th five-year plan though first batches will come out of these Institutes by 2010. All the four Institutes will not grow at the same pace.

Table 8: Total Investment – Year-wise (Amount in Rs. lakh)

	2004-2005	***2005-2006***	***2007-2008***	***Total***
Non-recurring	800	2700	2850	6350
Recurring	164	331	605	1100
Total	***964***	***3031***	***3455***	***7450***

13.4 Tuition fee of Rs. 25000 per annum for the five-year integrated educational programme will be charged. Several students will be given Rs. 10000 p.a. for a research fellowship. For meritorious students there will be tuition fee waivers. Students may also opt for interest free deferred payment arrangement, so that bright students are not deprived of education in these Institutes for want of their ability to pay the tuition fee. Deferred payment shall become due on employment. This arrangement transfers the risk of unemployment from the student to the Government. International students could be charged higher fee levels. Boarding and lodging expenses will have to be paid by the students on the actual basis. Details of the expected year-wise revenue from tuition fees are given in table 8.

Table 8 : Fee Revenue – Year-wise (in Rs. lakh)

	2004-2005	***2005-2006***	***2006-2007***	***Total***
Fee Revenue	53	106	159	318

13.5 The Institutes are expected to generate additional funds from national laboratories, mission oriented science agencies and the industries. These agencies can endow chairs, equip teaching or research laboratories and sponsor research. In addition, industries will finance these Institutes by paying for testing, consultancy and technical know-how generated by these Institutes. This source of funding will start generating resources for the Institutes after these Institutes have established basic core facilities for carrying out research and development and this is expected by the end of the 10^{th} five year plan. Possibility of these Institutes getting additional support from the charitable

trusts, philanthropic individuals will also be explored. However all this will start happening only after core facilities are established and the Institutes are fully functional.

13.6 Eventually, these Institutes would be brought under the Formula based funding arrangements, with output as focus as has been decided by the IITs recently. Under this funding arrangement, support is linked directly to the output in terms of number of students, research output, etc. These Institutes would continually strive to be world class educational Institutes and creative and Innovative research and development establishments working at the frontiers of science and at the cutting edge of technology with accountability to the stake holders and beneficiaries. There shall be a framework of national goals and standards against which performance of these Institutes would be monitored and assessed. UGC will continue to provide bulk funding for the Institutes and shall serve as Principal provider. UGC funding will be supplemented by increased contributions from other sources.

XIV. Operational Plan

14.1 Planning Committee(s) shall be set up for detailed planning of the Institutes. Officer on Special Duty will be appointed for each Institute as soon as Government approval is received. The operation plan for establishing the Institutes will require various steps. These are summarized below -

- Approval of the proposal by the Government. (3 months)
- Identification of National Labs, Industry partners etc. for each Institute (2months)
- Registration as a 'Registered Societies'. (1 month)
- Selection of the Chairman, Governing Board. (1 month)
- Constituting the Governing Board (1 month)
- Appointment of the Director of the Institute. (3 months)
- Transfer of land for the Institute. (1 month)
- Transfer of funds by UGC etc. (4 months)

- Identification of Architect for developing the Institute campus. (2 months)
- Site preparation and construction of boundary wall. (6 months)
- Establishing the admission procedure, fee structure, etc. (3 months)
- Preparation of details of academic programmes giving details of semester-wise courses, course contents, lecture-wise break-up, recommended books, etc. (3 months)
- Approval of building plan. (2 months)
- Tendering and identification of contractors. (2 months)
- Construction of buildings for classrooms, laboratories, hostels, etc. for accommodating first and second year students. (9 months)
- Recruitment of faculty and staff members. (6 to 18 months)
- Development of library, laboratories, design studios and computing facilities. (6 months)
- Notification for admission. (1 months)
- Starting of first year classes: July 2005.
- Construction of buildings and facilities for accommodation of subsequent batches, recruitment of faculty and staff, development of laboratories, etc. to continue.

15.2 Many of these activities can be taken up in parallel and therefore target date may not be the sum of periods referred to above. It would be fair to say that Institutes can take the first batch of students from July 2005 if the time schedule proposed is adhered to.

XV. Conclusions

15.1 The proposal to set up National Institute(s) of Science is a response to an in depth analysis of the present state of science education and research in the country. Science education suffers from several defects and deficiencies. The proposal addresses these concerns. This would help in blurring the unwanted divide between pure and applied sciences. A distinguishing feature of these Institutes is close and intimate relationship with its beneficiaries namely the

various science agencies and the industry. They are being associated right from conceptualization stage.

15.2 Setting up of the National Institutes of Sciences would be landmark in the science education system in the country. These Institutes would not only help the Country to meet the requirement of high quality people in science to man and lead our national lab system and mission oriented science agencies, but also to move up the value chain in global R & D services, where India is favorably positioned. These Institutes provide for a new model for science education in the country characterized by flexibility and a holistic approach to science education. Adaptive management structure provides these Institutes the ability to respond to challenges of the future in the R & D sector. This would provide sustainable competitive advantage to Indian R & D system in the increasingly globalized economic environment.

15.3 The concept of these Institutes, its structure and functioning both academic and administrative, is a result of collective wisdom of a large number of eminent practicing scientists, science educators, who are not only intimately aware of the ills of the present system but also of the exacting needs of the emerging scenario. This model is expected to create a new ethos in the field of science education. Hopefully, this model, in course of time, will be duplicated at several places in the country and will seep into our present university system so that it can transform once again into creative and innovative temples of learning.