

tute of Fundamental Research may not be aware of this nor of the conditions under which the universities in India deteriorated.

I would now like to answer the question – why this National Science University? It is very well known that advanced societies are supported by twin pillars, namely (1) innovative science and technology and (2) rational, systematic, spirited and enterprising management. The former provides the basic substance and the essence of material progress, in which, whether we like it or not, we are weak, while in the latter we are strong and it is recognized all over the world. Further, we have ample talent which has to be fully harnessed. There has been substantial societal and governmental commitment to science and technology although it is unfortunate that during the last few years our budgetary allocation to science and technology has been reduced. I am sure, the government will, sooner than later, realize this and will increase the allocation to at least 2% of the GNP before the end of the century.

We have an energetic and ambitious new generation that exhibits new mind

set keen to learn, explore, take risks and innovate. We have only to provide proper facilities and environment for them to grow. Our national laboratories, which have better research facilities and consume most of the budget allocation for science and technology, and a number of our good institutions such as Indian Institute of Science, Bangalore, Tata Institute of Fundamental Research, Bombay and the newer universities (including central universities), do not have undergraduate teaching and hence lack proper and effective mechanism for regeneration. I would like to know in which first-rate teaching institution in the world undergraduate teaching is not done? In fact, the best scientists teach the undergraduates to trigger the young minds. In the last Court meeting of the Indian Institute of Science, Bangalore, held only a few weeks back, I suggested that the Institute may examine if they could initiate a small integrated 5-year MSc programme. One should only have seen the alarm that was raised, as if the Institute would collapse if the suggestion was even examined, what to talk of starting the programme. However, it was heartening that some of

the members such as M. Vijayan supported the idea. I am, however, sure that no effort will even be made to examine it.

The universities in India are impoverished, may have facilities only for one-third the number of students that they admit, have little incentive and few facilities for quality research and thus cannot attract the best of minds to carry teaching and training responsibilities, and above all are too rigid to change. It is fortunate for us that there are some exceptions to such a situation but the number of such universities is very small. The separation of teaching and research is fundamentally flawed and detrimental to both.

The time to think about this is now, even though it is already late. Economic liberalization implies global competition; creation and rapid application of new scientific knowledge is vital for economic survival in this area. We cannot afford to live on borrowed imitative ideas in science and second-rate imported technology.

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The proposal to establish a National Science University as a consequence of a nonresident Indian initiative was highlighted in the 10 October 1994 issue of Current Science. The publication of the preliminary NSU proposals generated much comment. We reproduce below the final report of the committee set up for the 'concretization' of the NSU concept.

– Editors

National Science University: Final Report

Synopsis

After due deliberations the committee appointed to examine the conceptual proposal for the establishment of the National Science University (NSU) strongly recommends that the Government of India should make immediate and appropriate commitments towards turning this concept into reality.

1. It is recommended that the Government accept the conceptual report, and allocate Rs. 100 crores as start-up capital and contribute another Rs. 100 crores towards the formation of a Permanent University Fund (PUF) to be invested and administered by a Trust. The income from these investments will provide the resources for the normal running of the NSU.

2. For the NSU to meet its goals, an annual recurring expenditure of Rs. 30–45 crores will be needed. The PUF, therefore, must be built to the tune of Rs. 300 crores. The balance of the money (Rs. 200 crores) will be raised from the nonresident Indians and from the industry/business and people of India.

3. The management of the Incorporation (Nonacademic part of the University) will be left entirely to the Trust to which the Government of India will nominate its (identify by name, but not by generic titles) representative(s). The academic parts will be managed by the faculty alone. An international advisory committee to provide initial guidance and eventual 'watch dog' role will also be constituted.

4. Once the conceptual report is accepted, a preparatory office will have to

be established, and a committee appointed to work out the details for the launching of the University.

5. Academic programmes, curricula, modes of assessment, etc., will be worked out 'dynamically' by the faculty, who will also take care that the university is actively engaged in identifying as well as participating in newly emerging areas of study and research. It is expected that at least about 20 Indian scientists of repute settled in United States will return to India as faculty members of this University.

6. To provide continuing excellent education and research training, the university will recruit students immediately after secondary schooling. In later times, it is hoped that the influence of the new University (and of others based on similar models) will be felt in at least

National Science University – A chronology

May 1993	UGC appoints a Committee ¹ to prepare a document on the concept of NSU
Dec. 1993	Committee submits a report
April 1994	Presentation based on report to the Prime Minister
May 1994	Ministry of Human Resources Development asks UGC to constitute another committee for developing a document on the structure of the NSU
June 1994	UGC constitutes the Committee ²
Jan. 1995	The Committee finalizes the document on the structure of NSU ³

¹P. N. Srivastava (Delhi), P. Rama Rao (Delhi), S. K. Joshi (Delhi), Gopi Arora (Delhi), A. S. Nigavekar (Pune), S. M. Mahajan (Austin), S. K. Khanna (Delhi).

²P. N. Srivastava (Delhi), J. V. Narlikar (Pune), G. Mehta (Hyderabad), Gopi Arora (Delhi), M. M. Sharma (Bombay), A. Sen (Gandhi Nagar), P. M. Bhargava (Hyderabad), Deepak Kumar (Delhi), C. N. R. Rao (Bangalore), A. S. Paintal (Delhi).

³Report reproduced in this issue.

some of the secondary schools where a much improved modality of science teaching (aided and abetted by the NSU) will replace the current, static, memory-based stagnant methodology. The degrees awarded by the NSU is a relatively minor issue and will be dealt with at a later time.

7. The admission to the university will be made through a competitive process which could consist of possibly an examination and a personal assessment by the faculty members. We wish to keep enough flexibility that some extremely bright people who do not do well in the examinations are not lost to us due to the 'mechanical rigidity' of the admission system.

8. Much time and effort will be spent in choosing the student who joins the NSU. It is, therefore, essential that once admitted a student must not be allowed to drop out due to family financial constraints. Those who can afford to pay should pay and those who cannot must be fully supported by the university through outright grants, work study programmes, interest-free loans, etc. The elitism in the new university will be based only on raw talent and dedication and on nothing else.

9. With the expected resources the university should be able to support a faculty of about 200 with a total student body of 1000–1500 at the aspired levels of excellence. The optimal division between the undergraduates and graduate students

(working towards a Ph D) will be determined by the wisdom acquired through experience.

10. The faculty and student will be the principal citizens of the NSU, and the administration will have its natural supporting role. Independent career ladders will be provided for the faculty and for the administrators; no scientist should ever feel the need to become an administrator merely because more facilities and privileges go with the latter. The administration as well as the administrative expenditure will be kept at rock bottom level necessary to maintain smooth operations. Administrative rules and regulations will be the minimal possible.

It must be stressed that the concept of NSU is a fundamental departure from what is existent; it is anything but an extension of the current university concept. If the spirit of the enterprise is not fully respected, it will not be worth our while to attempt this experiment. The University should be funded with the full recognition that almost every modality proposed is new; we need all this 'newness' to be scientifically and technically ready for the years to come.

It is extremely encouraging for us to report that the states of Haryana, Rajasthan and Gujarat are very much interested in having the NSU located in their state, and are favourably inclined towards donating land

Structure**Preamble**

A detailed analysis of the state of Indian science and higher education has led us to the conclusion that we must experiment with new ideas in order to raise qualitatively the standard of Indian higher education and, as a result, of Indian science. The following is an indicative short list of some of the serious problems with our higher-educational-scientific effort:

1. Since independence, an unmitigated horizontal expansion in the number of colleges (700–7000), universities (20–200) and enrolled students (200,000–4,500,000) has strained the available resources to the hilt, with the result that we have not been able to provide necessary library, laboratory and other facilities required for proper education. It is estimated that one-third of our universities are totally nonviable, most of the rest barely manage to exist, while a handful are heroically struggling to provide the much-needed education.

2. The Indian university, even at its best, is not structured to train the pupils to think, question, and examine and investigate critically. We do have some good scientific institutions in the country, but they, in general, do not impart undergraduate education. The efficacy of 'teaching and research under the same roof' is recognized by all scien-

tifically advanced societies, but unfortunately this has not happened in India.

3. Higher education in India has always been believed to be the responsibility of the state alone. Although the recent statement of the Prime Minister that the education budget will be raised from 3.9 to 6.0% of GNP (a figure recommended by the Kothari Commission, 1964, and adopted by the National Policy of Education, NPE, 1986) is heartening and encouraging, one must note that much of this increase would and should go to the crying social need—primary and meaningful secondary education. Even if the investment in education is increased to 7.0 or 8.0% of the GNP, the government will not be able to support higher education fully since it is very expensive. In USA the government spends 7.5% of the GNP on education but still it is very well known that almost all important and major universities raise their own resources for support. It was only initially that they were started with governmental support.

Since the major direct beneficiaries of higher education are, apart from the society in general, advanced industrial-business houses of the country (in addition to the state-owned enterprises), it is imperative that the private sector should become involved in supporting higher education in general, and scientific-technical research in particular. A close cooperation between the university research and industry is crucial for both the high-quality university system to exist and function effectively and for the industry to be more innovatively productive.

It was in the light of these and several other issues that the idea of a National Science University (NSU) as a possible vehicle for beginning the transformation towards a more responsive, dynamic, innovative and aggressively creative scientific and higher educational structure had naturally emerged. The salient aspects of the NSU concept, its scope, and its possible impact on Indian science (and Indian society, at large) have been discussed in great detail in the attached document. This paper, under separate headings, will concretize some of the 'concepts' which form the very fabric of the NSU.

Schools – Academic programmes

Ideally, the research and teaching in a great university must encompass the

entire field of thought. And if our critical experiment of creating a first-rate university devoted to basic sciences is successful, we would certainly increase the scope of the NSU. But to begin with, we intend to concentrate on basic sciences. The NSU will consist of five basic units: the departments of (1) mathematics, (2) physics–astronomy, (3) chemistry, (4) biology and (5) computer sciences, each with a balanced and vigorous theoretical and experimental research programme. These departments are expected to be individually strong and strongly interactive with one another; the growth of the entire spectrum of applied sciences is considered to be highly desirable and will be automatic. It has to be emphasized that useful, tangible and effective research in any applied area (meteorology, soil conservation, environment, patterns of river flows) requires a thorough grounding in physics, chemistry, mathematics and biology, without which it is difficult to develop a rational basis for understanding the observed phenomena and predicting the future outcome. Thus, the education and research planning at NSU will take full cognizance of its special role of providing sound basic training for all research, pure and applied.

For an overall development of the student, and also to simulate our eventual state, about 10% of the faculty will be in the humanities. In addition to covering essential and conventional subjects, the humanities faculty will specialize in epistemology and the history and sociology of science.

The broad academic programme of the university consists of two principal components, namely:

1. undergraduate studies,
2. graduate school.

1. *Undergraduate studies.* This course will consist of a 4-year intensive study programme after higher secondary (class XII) leading to a B Sc Honours degree in order to distinguish it from the normal three-year programme which leads to the conventional B Sc degree.

2. *Graduate school.* We propose a single graduate degree, the PhD (although in the process they will earn M Sc degree also after they have completed their course work since for employment in India in almost all the universities a basic M Sc degree is considered as minimum qualification) in order to avoid the waste of time and precious resources involved in subject-

ing students to a list of additional degrees, namely M Phil, etc. This tendency to indulge in issuance of such additional degrees results from the indecisive nature of our educational system. In other words, our society is unwilling to take clear-cut decisions as to what it wants to do with its youth.

Instead, the NSU will be sharply focused. A student's research-worthiness will be determined in an intense and highly interactive four-year programme. The graduate school will have its own set of criteria by which to judge a student. This means that a student who received his or her undergraduate education at another institution will be judged according to a set of universally applicable principles; lateral entry into the system will thus be possible and even encouraged.

Since the philosophy behind and the purpose of the NSU is that it should be a training ground for top-rate scientists, the educational curricula must stress and hone those aspects of the mind which are crucial to making inventions, discoveries and innovations. Thus, the development of reasoning, investigative and critically imaginative faculties is to be emphasized. Providing information and knowledge is, of course, a basic ingredient of any sensible curriculum, but doing so alone will not make a dynamic and creative scientist. The general classroom instruction will be augmented by a variety of structured as well as semistructured programmes such as homework to develop problem posing and solving abilities, group discussions between the students and faculty and between the students themselves, and student seminars. There will be continual contact with the investigations being carried out by the faculty and the graduate students. To encourage students to develop independent thinking and working habits, there will be unlimited access to well-stocked libraries and well-equipped laboratories. Moreover, for the more adventurous and inspired students, funds should be made available for pursuing their own research ideas. It is hoped that the highly successful formula 'Teaching and Research in close physical contiguity and deep intellectual relationship' will be deeply enshrined in the NSU.

Although the details of the course work, evaluation patterns and examinations will evolve with the evolution of the university itself, there are a few necessary and important guidelines

Every student admitted to the NSU must take (or qualify by examination or interview) a basic set of courses in mathematics, physics, biology and chemistry before they choose their major. In the modern era, where interaction between scientific disciplines is strong and crucial, a thorough grounding in the fundamental sciences is necessary.

The graduate school programme will consist of an year or two of advanced course work supplemented by guided research on specific topics. The time will depend on the quality and training of the graduate students the NSU gets. The Ph D program will be open to everyone with at least an undergraduate degree from any Indian university and hence, for a while, the graduate school is likely to be very heterogeneous. Individual attention and training is essential in order to bring students to acceptable degrees of trained competence. At the end of this period, a comprehensive exam will be conducted and the students who pass will be formally admitted to Ph D candidacy and will thus begin to work on their dissertations under the guidance of one or more of the faculty members. Those who fail will have one more chance (the time between the two exams will be decided later) and, if still unsuccessful, will no longer remain in the Ph D programme. After satisfying a few nominal requirements, these students will be given a terminal M Sc degree. It is again understood that the graduate student will be encouraged to be independent, inquisitive, innovative and creative. The amount of guidance will be consistent with the students' needs. An intellectually mature student with ability and drive could choose a totally independent line of enquiry and will have the blessings of the faculty. In fact, the emergence of powerful, self-propelling young minds will mean the fulfilment of the NSU's mission and its trust with the society.

All selected graduate students will be supported by the university at an adequate level (to be determined by the prevailing conditions). It will be expected that the graduate students, in addition to pursuing their primary mandate, will perform useful functions for the rest of the community: Assisting the faculty in grading homework and examinations, offering assistance in question-answer session, conducting lab sessions and other campus jobs. At no

time, however, will a graduate student be required to spend more than 10 h a week on these activities.

Faculty level, student strength, modes of selection

The NSU, with its emphasis on quality education and research, has to be of a moderate size. Yet, if it is to cover the entire gamut of basic sciences at an effective level, it cannot be too small: a 'critical mass' is essential. The size of the faculty is the single most important parameter of the entire enterprise. Among other things, it will determine the size of the student body as well as the cost of building and maintaining the NSU. We believe that an eventual faculty of 200–250 will be needed to carry out the NSU mandate, i.e. teaching, research and liaison with the industry. Given the constraint of 'excellence' and the faculty size, the size of the student body is more or less determined. Learning from the experiences of some of the great universities of our times, it is proposed that at its peak strength the NSU may have about 1500 students, whose division amongst graduate and undergraduate sections will be decided by the requirements of a healthy balance between pedagogy and direct research. This rather low student-teacher ratio will go a long way in ensuring that our best young minds are given intense and personalized training so that they may have a chance of reaching their full potential.

Faculty selection

It is a truism that a university is only as good as its faculty. Thus, acquisition of an intellectually distinguished and pedagogically inclined faculty convinced of the importance and mission of the NSU experiment is the most critical and daunting task of the NSU founders and facilitators. The recruitment of the faculty will be done in several stages:

1. Initially, a few highly reputed and distinguished people in each discipline will be chosen by a designated subset, headed by the Chief-Executive of the NSU, of the Board of trustees. The selection will be done with the active participation of and advice from the 'International Advisory Committee' constituted to advise and guide the NSU

executive and faculty on all substantive matters, particularly academic matters. The initial group will hopefully consist of an even combination of senior and established scientists and junior researchers of demonstrated potential. Needless to say, utmost care and attention has to be paid to this fundamental task because these people will not only form the core of various departments but will also be responsible for the recruitment of the rest of the faculty.

2. The core groups so selected will shoulder the primary responsibility for the choice and selection of their peers. This process is likely to be lengthy and painstaking. Although most procedural matters will be worked out at an appropriate stage, it is necessary to spell out a few desirable musts for the selection process:

(a) The university will be constantly on the look out for outstanding researchers in all age groups for induction into the faculty. It will not have fixed number of positions in any particular category. Appointments to the NSU faculty will normally be made by solicitation and invitation. However, standard advertisements will also be given in major newspapers/ journals and meritorious candidates will be given due consideration.

(b) Appropriately formed search committees will seek and invite possible contenders for the NSU faculty to come and spend a week or so interacting with the students and the faculty through seminars and group and individual discussions. This will be the so-called 'interview' consistent with the status and scholarship of the future NSU faculty. It must be stressed that the recruitment of a faculty member is a momentous occasion in the life of a university. The recruitment process has to reflect this justly. Clearly, the conventional interview, where a group of administrators with a few experts interview 10–20 candidates in a matter of hours, is ill-suited for choosing a faculty deemed to be distinguished.

(c) All 'interviews' and selections are the internal affairs of the NSU. The faculty members in each department have the primary and essential responsibility as well as the appropriate power to choose their own kind. The role of the university administration in the selection of the faculty should be minimal. The faculty may invite outside scientists-academics to help them in the

selection process, but the participation of 'external experts' depends entirely on the choices made by the faculty and is by no means mandatory.

(d) The attractive structure and exciting intellectual environments of the NSU will act as a magnet for attracting distinguished scientists from India as well as abroad, in particular, those of Indian origin. A vigorous 'visiting faculty' programme will go a long way in enriching the NSU through the reservoirs of expertise and goodwill at the command of overseas Indians and others interested in helping the Indian science grow.

(e) About 20% of faculty could spend their sabbatical or other times for research assignments or collaborations in other universities/research institutions both in India and abroad and the same number may be expected to spend their time in the NSU as visiting faculty. Suitable postdoctoral programme will be developed where foreign students will also be accepted.

Graduate students

The next rung in the research establishment is the graduate student who combines the twin roles of a student seeking knowledge and of a researcher creating knowledge. In this sense, there is a necessary period of apprenticeship in the evolution of a scientist which ends with the awarding of a Doctor of Philosophy degree, Ph D, an essential prerequisite in order to obtain the status of a professional scientist. With NSU at its full strength, we plan to have a total graduate population of around 700. Assuming that a graduate student will spend a typical period of 5 years to obtain a Ph D, about 100 students per year will be recruited. The primary admission criteria, the procedures, the rules, the graduate academic programmes, the structural relationships between the graduate students and the faculty, the additional responsibilities of the graduate students, the details of the qualifying examination, and other modes of assessment, etc., will have to be worked out by individual departments with some overall coordination. There will be a provision for admitting foreign students also in the graduate programme.

The graduate schools of the NSU will admit graduating students of other Indian or equivalent universities. It is

also expected that the graduating students of the NSU will join good graduate schools associated with institutes like the Tata Institute of Fundamental Research and the Indian Institute of Science.

At the NSU, all assessments (undergraduate and graduate), including the evaluation of the Ph D dissertation, will be internal. There will be no external examiners and external panels. The distinguished faculty members of the NSU must be willing to trust their own collective judgments of the Ph D worthiness of a dissertation.

Fortunately, there exist a variety of aids in the selection of graduate students. The NSU will make use of the entire gamut of exams, the faculty recommendations, and the interviews to select the students with the greatest research potential.

Undergraduate students

The NSU's espousal of and commitment to high-quality undergraduate education is its most distinguishing feature. We envisage a total body of 800 students, about 200 in each of the 4 undergraduate years, thus implying that 200 students will be admitted every year. It is impossible to overemphasize the care which must be exercised in the selection of this choice cadre, because it is precisely from this group and its counterparts from other universities that our future graduate students and scientists will emerge. In what follows, it is assumed that in spite of the sociological constraints driving some of our best young people away from science and research, there still exists a large pool of extremely bright people wanting to become scientists; thus, being educated in the NSU will be considered a rare privilege. Foreign students may also be admitted to this programme.

The selection of the NSU undergraduates will begin with an appropriately prepared written examination, designed to test the students' reasoning and critical faculties, which will be administered at several centres. Those who cross this hurdle at a desired level will be invited for an interview. In the early years, the interview will have to be conducted at the NSU campus, but with the passage of time, the NSU network will grow and the interview could be conducted by the NSU alumni at various places in the country. It is proposed that each faculty member devote

a full day per year towards the interviewing process. Since the number of entering students and the faculty is essentially the same, it will amount to one faculty day used to select one student. Given the conditions of our society, we consider this rather involved and time-consuming process to be essential. We not only have to pick students who are bright and capable, but we must also ascertain that there exists a good chance that these students will pursue scientific research as their career. Training a person to become a scientist is a very expensive societal undertaking, and we cannot squander our limited resources on those who are not sufficiently interested in and excited by science. Since in a free society we cannot (should not, anyway) legislate peoples' future professions, we must try to gauge their aptitudes and inclinations before opening the NSU doors for them. An extended interaction with the faculty is our best bet towards this end. In short, the student selection will be done very carefully and meticulously and will be one of the more important events in the NSU year.

Faculty members in various universities in India will also be encouraged to spot talent amongst their B Sc students and inform the NSU about them. Efforts will be made to examine and induct them into the NSU as lateral entry in B Sc programme.

It has been repeatedly stated that the NSU must be a nonbureaucratic, democratic and faculty-student-centred institute where all unnecessary and suffocating rules will be eliminated so that an exciting and vibrant research atmosphere can prevail. These values must obtain in all aspects of the NSU. For example, the principal (if not the only) criterion used to determine the faculty's salary, promotion, etc., must be their potential for and accomplishments in research and teaching. NSU's criteria will not be linked to such parameters as age. In such a place, all decisions and academic decisions in particular must be based on the criteria of merit. An institute devoted to research and towards the creation of the researcher cannot, and must not, choose its members for anything but research-worthiness. There is, therefore, no scope for any reservations or quotas of any kind in the NSU academics, neither in the selection of students and faculty nor in the faculty promotions. All societies, even the ones committed to

strong affirmative action, leave some of their premier scientific institutes to the dictates of merit.

Infrastructure, finance, salaries, fees

The NSU will be a fully residential university; all students, the faculty and the technical and administrative personnel will live on the campus. It is expected that the NSU will receive about 300–500 acres of free land from one of the state governments.

The financial needs of the NSU can be described under two broad headings: (1) the infrastructure or capital needs and (2) the recurring or operational costs.

Infrastructure – Capital needs

This entails building the campus, the offices, the classrooms, the teaching and research laboratories, the hostels, the dwellings, the guest houses, and making provision for any appropriate expansion at a later date. Anticipating that the NSU, if successful, will grow, the entire construction should be modular. Our estimates of the start-up costs, based on discussions with an architect with much experience in the building of universities in India are shown in Table 1.

Operational costs

At this stage, it is a bit difficult to give a microscopic breakdown of the operational costs, though approximate estimates can be readily aimed at. For a steady faculty of 200, visiting faculty of 40, 500 graduate students, 800 undergraduate students, 50 administrative staff, 200 technical and other employees, and with campus maintenance contracted out, we estimate that an annual budget of Rs. 40–45 crores will be able

to sustain the university at a level consistent with its exceptional mandate and responsibilities. Of this amount, a total of Rs. 7–8 crores will go to the salaries and benefits (health insurance, pension, provident funds, etc.) of the regular faculty; the salaries will range from Rs. 10,000–30,000 per month, with an average of about Rs. 20,000 per month. An equal amount will be needed for the faculty to buy and maintain quality research gear: permanent and expendable laboratory equipment, computers, etc. Also included will be the costs of attending national and international conferences. The faculty will be expected also to raise major funds for their research from organizations such as DST, CSIR and ICMR, and industry, etc. It is expected that NSU will also be supported by research grants and endowments from various sources from within and outside the country. It is important that further annual additions to the corpus fund will have to be made to maintain the level of funding and also to take care of inflation.

Financial arrangements

In order to provide Rs. 100–130 crores start-up money, and about Rs. 45 crores per annum as operational expenditures, we believe that a total amount of at least Rs. 400 crores has to be procured for the viability of the NSU; about Rs. 100 crores for infrastructural needs and Rs. 300 crores for the formation of the NSU trust. It is the income that accrues from the investment of this trust fund which will be used to run the university.

We expect half of the total money (Rs. 200 crores) to be donated by the Government of India as a one-time grant to give a jump start to the NSU enterprise. The other half will be raised from the people of India and also from NRIs. However, it has to be ensured that this one-time grant of Rs. 200 crores has to be given as a *special grant and definitely not from the UGC funds.*

Further, for enhancing the quality of higher education in science, the UGC should be provided with additional funds to upgrade and support the undergraduate science education in at least 100 colleges selected throughout the country on the basis of merit alone, and at least a dozen more good universities, including the central universities and institutes such as Indian Institute of Science, Bangalore, should be encouraged to initiate teaching of undergraduate science classes for carefully selected good students, for which, again, special funds will have to be provided.

It may be pertinent here to quote the statement of our respected President, Shanker Dayal Sharma, on the occasion of the concluding function of the Diamond Jubilee celebrations of the Indian National Science Academy on 7 January 1995. ‘The unending quest of knowledge requires sustained research. Research, in turn, needs high level of financial inputs. It was natural that in India the government should have become the major source of support in the period after independence. We have now reached a stage of development where reliance on the government must be outgrown.’

Soon after taking over the charge of the Ministry of Human Resource Development, Madhavrao Scindia has in a policy statement said on 17 February 1995 that he ‘favours greater encouragement to private initiative and voluntary efforts in the field of education’. He was, however, emphatic that this should not lead to dilution of quality, which according to him was most important. ‘Maintenance of standards has to be ensured.’

Student fees

The trust income will be the primary and major source of funds for the sustenance of NSU. However, it needs to be realized that at least a part of the immense cost of higher education, which often results in yielding manifold dividends to the recipient, must be borne by the student and his family.

It is proposed that the students will pay a tuition fee of Rs. 15,000 per annum. The suggested tuition fee is totally consistent with the recently formulated National Policy of Education, which was accepted unanimously by the Parliament. Nevertheless, several qualifying comments are in order:

(a) The amount of tuition fee charged is basically symbolic. Even in the most optimistic case, i.e. if all 800 students

Table 1.

Facility	Exp area	Exp. cost (Rs crores)
Academic buildings	400,000 sq ft	40
Library/labs/admin and misc. bldg	500,000 sq ft	30
Hostels	400,000 sq ft	24
Residences for faculty/staff	600,000 sq. ft	36
Total	1,900,000 sq. ft	130

This expenditure is likely to be spread over a period of ten years.

were able to pay the entire tuition fees, this would yield a total revenue of 1.2 crores, which is only about 5–6% of the annual teaching budget (which is half of the total budget of Rs. 40 crores). For the university to be supported by tuition alone, we would need to charge 20 times the proposed amount! (Incidentally, even this high value, Rs. 300,000 per annum, is considerably less than the prevalent rates at top-notch American universities.)

(b) The amount of financial aid provided to the student will be graduated, i.e. it will depend upon the income and resources of the student and his family. The NSU administration will work out procedures for income assessment and calculations of support to be given. Students from low-income families will be entirely exempt from tuition fees.

(c) Since there are many expenditures apart from tuition (living in the hostel, food, books, stationery), many students from poor families may still not be able to afford the NSU education. To take care of such cases, the NSU will follow an all-encompassing general policy whereby

'Once admitted, all financial needs of a student (the needs his/her family cannot meet) will be taken care of by the university. Admission to NSU will be a sure passport to NSU education.'

The financial support to the needy students will be given in a variety of ways: outright grants, work-study, interest-free loans, etc. There is absolutely no scope for selling admission by a Capitation Fee. Merit, motivation, demonstrated interest and competence will be the only indices for admission and, hence, for an assured NSU education.

The NSU will be a fully autonomous and independent entity and plans to be self-sufficient and self-sustaining. It will be completely outside the jurisdiction of the Ministry of Education or the University Grants Commission.

Expansion of research and additional revenue

Over the years, we expect that the NSU scientists will seek alternative sources of money to expand and equip their laboratories. It is expected that the NSU, with its advanced infrastructure in people and equipment, will serve as a condensation point for specialized insti-

tutes, which will be organically attached to the NSU. The marriage of the 'general' and the 'specialized' has been extremely widespread and of immense importance in the growth of both the pure and applied sciences in the West. A few notable examples are:

1. The California Institute of Technology (a great university devoted to basic sciences) manages astronomical laboratories (at Mount Palomar and Mount Wilson) as well as the Jet Propulsion Laboratory, which lies in the extended campus. Close working relationships between the university scientists pursuing 'general' basic research and the institute scientists pursuing basic and applied 'specialized' research have yielded unprecedented dividends; the Caltech-Palomar-Wilson axis can claim the lion's share of astronomical discoveries of this century and the Caltech-JPL combine is the trendsetter in all aerodynamic and space-related research.

2. Princeton University has the famous 'Plasma Physics Laboratory', a leader in the field of controlled thermonuclear fusion, as an integral constituent.

These are just two examples; the list is literally endless. These appended institutes draw heavily on the general expertise and the research ambience of the university, and in turn add to the breadth as well as depth of the university programmes. Since these institutes serve directly the needs of industries, as well as several government departments like defence and aerospace, they bring the much-needed additional revenue in addition to enriching the very environment of the university. It may be remarked that this very pattern of the synergistic development of abodes of pure and applied science constitutes a major part of Nehru's dream of Indian science.

Management structure

The President of the NSU will be the academic and executive head of the university. The incorporation part of the NSU will consist of:

(a) *Board of Trustees.* There will be a Board of Trustees, with 50 members, comprising eminent academics (10), leaders of industry/business (15), government representatives who will be nominated by name and will not be ex-

officio (5), eminent citizens representing social/political/cultural life (10), representatives of financial and banking institutions (5) and the President of the NSU along with other NSU representatives (5). In addition to being the general advisory as well as the policy-making body (on all incorporation matters, the faculty salary, etc.), the Board of Trustees will be in charge of the financial health and well-being of the university. The trust will handle creation of new sources of funds, investments, accounting, and general trouble shooting. The trust must begin functioning before the recruitment of faculty and students. The Board of Trustees will themselves elect their Chairman and will be fully autonomous.

(b) *Executive Committee.* This committee, consisting of the NSU president (Chairperson), five members nominated by the Board of Trustees and five members from the university will be the main administrative body of the university.

(c) *Academic Council.* Decisions involving academic matters (teaching and research) will, in general, be handled by individual faculty members and departments with some coordination whenever needed. Considerable flexibility and decentralization will be the hallmark of the NSU academics. The overall coordination of programmes will be taken care of by an Academic Council, comprised of the NSU President and 25 representatives from the faculty and students.

(d) *International Advisory Committee.* There will be an international advisory committee consisting of 15 eminent scholars from within the country and outside whose suggestions and advice on all academic matters will be a major and guiding input in the formation of teaching and research programmes. This committee is expected to play an important role in faculty recruitment. This committee will also be responsible for reviewing the university performance by extensive reviews every five years. The Chairperson will be appointed by the Board of Trustees in consultation with the Executive Committee and could be from India or abroad. At least one meeting of the International Advisory Committee per year will be a must.

Conclusion

The conceptualization (attached document; not reproduced here) and concrete-

tization (current paper) of the National Science University idea has emerged after years of study and analysis of the Indian science scene. It makes one wonder why, in spite of the excellent raw material (in the form of bright young students) and societal commitment, Indian science has not yet arrived on the world scene. These deliberations automatically led us to examine our 'sources of science', with the conclusion that fundamentally new approaches to higher education are needed if we plan to survive with dignity in a new increasingly cerebral knowledge-driven and competitive world order. It is true that we do have a few good institutions in the country, like the Tata Institute of Fundamental Research, Bombay, the Indian Institute of Science, Bangalore, and a handful of good universities. This, however, is a very small number to meet the requirements of a big country like India. The country needs at least another 20–25 top-grade universities where the bright and receptive minds of our young (after higher secondary) are trained and inspired by the methods, the culture and the achievements of science, through the agency of our most eminent active practitioners of science. Without a continuous input of young minds with originality and bright ideas, it would be unreasonable to expect major advancements in basic or applied research. The National Science University proposes to initiate the momentous process of making this very original, creative and productive young mind. We must stress that in the domain of higher education

today, the great need of our society is not mere education or more education but absolutely good education for those who deserve it, imparted by the best that our society can come up with in the best environment we can create. Our best scientists must not only teach undergraduate courses but must also be available for discussions, etc., to students. It is during formative years that bright young minds can either be excited and inspired to seek higher knowledge, or be relegated to the pursuit of mediocrity. The NSU aims to be what the current universities are not at this juncture.

What is envisaged is a place where:

1. The best of our scientists teach, train and inspire the next generation.
2. Our scientists can work in a free, democratic set-up, i.e. a large number of essentially equal, independent and competent professionals can compete, cooperate and collaborate with each other to create an exciting scientific environment which, in a natural fashion, will produce good, well-equipped and brilliant scientists from our youth.
3. One's scientific status is not measured by one's administrative title.
4. Scientific leadership is neither absolute nor given by appointment or by nomination but emerges in a natural fashion amongst scientists of different age groups, is only comparative, and changes with time.
5. Science, its creation, its teaching and its dissemination is the principal (if

not the only) activity; the scientists and the would-be scientists are the principal citizens and everyone else has only a supporting role.

6. There are absolute independent career ladders for scientists and administrators (administration and administrative expenses should be kept at the minimum possible): no scientist should ever feel the need to become an administrator for more money, facilities, power or prestige. From all points of view, the most desirable position should be that of a scientist-teacher.
7. All principal scientific and academic decisions are made by faculty committees consisting of working scientists; administrators must take care of only administrative matters and scientists of scientific matters. Again, the idea is not absolutism but the encouragement of the logic that those involved in the actual doing of science are repositories of wisdom which may not be available to others, peripheral to the core responsibility of the University.

With a fundamentally different guiding philosophy and with the intentions of making a nonfeudal, nonbureaucratic, internally democratic, free and exciting home for the creation, perpetuation and transmission of knowledge, we will settle for a slowly evolving new structure outside the UGC and Ministry of Education and will be in the private sector, hopefully to be followed by others.

Research Accounts

Current Science intends to start a new feature entitled 'Research Accounts'. Articles in this category are intended to be personalized reviews of research from the authors' own laboratory, based on a body of published work. The articles must provide appropriate background to the area in a concise introduction, which should also serve to place the author's work in proper perspective. A concluding section may address future trends and directions in the area. Unpublished results may be included only when absolutely essential and should be kept to a bare minimum. Articles in this category may be about 20 double-spaced typed pages, A4 size (8–10 printed pages) and should include appropriate illustrations. References to the literature should not number more than about 60. Articles should address a broad readership. While most articles in this category will be solicited by the editors, unsolicited contributions will also be considered. All articles will be reviewed by two independent referees. Authors are encouraged to suggest appropriate reviewers.

Editors