Response:

The concerns expressed by Narasimhan are a clear case of misinformation or ignorance towards facts about which I had referred to in my rejoinder. There is, therefore, no doubt why some persons have referred to the whole project as 'naive' because they have not read my articles 'The concept of the National Science University: A rejoinder' and 'National Science University: Final Report' (*Current Science*, 1995, **68**, 1190–1198) carefully. I respond to the specific questions pointwise.

1,3. I wonder from where the author has got the idea that there will be reservations for NRIs. There will be no reservations for anybody, NRIs or Indians. The only point that has been made is that 'Further, what is wrong to expect that about 20–25 (out of a faculty strength of 200–250) well-established Indian scientists working abroad should decide to return to India for good to give a boost to this university by working here' (p. 1190). This is no reservation. 'The selection will be done with the active participation of and advice from the International Advisory Committee (p. 1194)' only on merit and no other consideration. Is this reservation?

2. As already mentioned in point number 1, there will be no reservations in admissions, staff recruitments, etc. The point is very clear to us that we would rather not have the university than have a university with reservations. The financial contribution from the government is not sacrosanct. The objectives of the university will, in no case, be sacrificed.

4. The university will be established only when the trust will be formed and there is no need to have any guarantee from the NRIs. The responsibility of raising further funds will be that of the trust.

5. No contribution or donation with strings will be accepted either from Indians or from NRIs.

6. Why should IISc or IITs not approach the NRIs for financial assistance? Who has put this restriction? Who can allege that more money has not been poured in IISc and IITs as compared to the universities? When I was in Bangalore during the last Indian Institute of Science (Bangalore) Court Meeting, a number of scientists belonging to IISc questioned the money that was poured into the Jawaharlal Nehru Centre for Advanced Scientific Research, Bangalore, and stressed that if only a part of that money would have been allocated to IISc, it would have improved the Institute immensely. Why did no one raise this issue at that time?

7,8. Why should there be any guarantee for this? Is it not a fact that many graduates of the IISc, IITs, many universities such as Delhi, JNU, BHU, Hyderabad, etc., stay on in India and has the country not benefited from them? Some of them do go out for good but others return as well. If the argument of the author is carried to the other end then only those institutions should be supported whose graduates are considered unfit for selection for going abroad. However, I have always been positive and do hope that Indian colleges and universities are going to improve in future.

9. This point refers to an article published in 1986 and reprinted in *Current Science*. The views expressed in this article have no bearing on the establishment of the National Science University. The pertinent official documents in this connection prepared by the committees appointed by the Government of India are the Concept of the National Science University and the Structure of NSU, reference to which has been made in *Current Science*, 1995, **68**, 1192.

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SCIENTIFIC CORRESPONDENCE

Comments on 'What kind of a system is a human being? A cybernetic system?' [*Curr. Sci.*, 1994, 67, 936–940]

Narasimhan's account of the history of research in human cognition and his prognosis as to its future are well taken. Of concern, however, is his use of the term 'cybernetic system' without definition Neither Wiener nor, as far as we know, Ashby, ever used this expression. The word 'system' was used by Wiener only in familiar contexts such as the solar system or the nervous system, and he never thought of himself as a 'system theorist'. Indeed, the technical uses of the term 'system' in the literature make it equivocal, and there have been complaints about 'fuzzy thinking' in this field, e.g. from Kalman *et al.*[1]. It is, therefore, essential that the term 'cybernetic system' be clearly demarcated before the question 'Is a human being a cybernetic system?' is asked. Such a demarcation will, of course, depend on how one interprets the underlying concept, *cybernetics*.

Unlike the term 'machine', which Wiener defined clearly as 'a multiple-input, multiple-output transducer', he never clearly prescribed the range of the term 'cybernetics'. Narasimhan [p. 937, col. 1 para 4] mentions Wiener's use of it to mean 'the entire field of communication and control in the animal and the machine'. Since very large tracks of engineering and almost the whole of the human and biological sciences involve communication and control, this definition is woefully general. A fuller rendition of what Wiener intended appears in his 1950 book[2]:

'Since the end of World War II, I have been working on the many ramifications of the *theory of messages*. Besides the electrical engineering theory of the transmission of messages, there is a larger field which includes not only the study of language but the study of messages as a means of controlling machinery and society, the development of computing machines and other such automata, certain reflections upon psychology and the nervous system, and a tentative new theory of scientific method. This larger theory of messages is a probabilistic theory, an intrinsic part of the movement that owes its origin to Willard Gibbs.

Until recently, there was no existing word for this complex of ideas, and in order to embrace the whole field by a single term, I felt constrained to invent one.' [50j, p. 15]

These words suggest that a better approach is to treat cybernetics not as a science *per se*, but rather as a *movement within science*, which draws attention to and focuses on the stochasticity of the cosmos, and on the new concepts that stochasticity allows, such as communication, information, teleological machines, regulation, intelligence, etc. (*cf. Curr. Sci.*, 25 December 1994, pp. 919–920). Calling Leibniz 'the patron saint of cybernetics', Wiener felt that all scientific attempts to absorb mind into nature, such as studies of machine intelligence (chess-playing automata), language, and animal and human intelligence, should come under the rubric 'cybernetical'. The central concepts are 'message' and 'machine' (or monad or black box), i.e. transformer of messages; 'feedback', while important, is not quite that central.

From this perspective, the lines Narasimhan has drawn between the three approaches to human understanding, viz. the cybernetic (in a narrow sense), the artificial-intelligence, and the connectionist, appear to be too sharp. These approaches should be seen as steps in an ongoing effort, that is cybernetical in the broad sense. This effort, the ultimate aim of which must be the understanding of the entire human being, should recognize that this being is 'the most complicated object under the sun', as von Neumann put it. Today this effort is rightly focused on understanding the 'Homo sapiens–faber' part of man. However, his conspicuously active but more difficult 'peccator' part should not be entirely overlooked.

1. Kalman, R. E., Falk, P. L. and Arbib, M. A., *Topics in Mathematical Systems Theory*, McGraw Hill, New York, NY, 1969.
2. Wiener, N., *The Human Use of Human Beings*, Houghton Mifflin, Boston, MA 1950, Da Capo Series in Science, Plenum, New York, NY, 1988

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Comments on the review of the monograph *The Scientific Methodology in the Light of Cybernetics* [*Curr. Sci.*, 1994, 67, 954–956]

Narasimhan's review contains misunderstandings as to what the term 'scientific methodology' means, and unfounded charges of omission and of exaggeration on my part.

The scientific methodology (SM) is the body of principles governing the method of inquiry used by scientists both to acquire knowledge about the world and to apply it practically. It is intended to provide the practising scientist with enough principles to pursue his craft vigorously, and to offset any doubts he may entertain as to its worthiness. The SM has, first of all, to state what it is in the world that makes science possible, and to describe its classifications and its different aspects, such as experimentation, reasoning, concept formation, mathematicization, learning from the past, and the mode of discovery. Secondly, the SM must say how the notions of message, communication, intelligence, teleology, contest, etc., which until fairly recently were left out of the scientific arena, are scientifically demarcatable. Thirdly, the SM must expose instances of faulty conceptualization. Fourthly, the SM has to say how scientific knowledge is related to the knowledge of craftsmen, philosophers and religionists. Finally, the SM must comment on how science bears on human welfare. Let us from this standpoint judge the blemishes that Narasimhan finds in his review [R] of the monograph [M] in question. They fall under 14 heads, which I have labeled I, II, ... ,XIV.

I. In [R, p. 954, para 2], Narasimhan writes that the following have not been addressed in [M]:

'(i) What is science about? (ii) What is the logical structure of science? (iii) What are the distinguishing characteristics, if any, of the activities that create science? (iv) What is the difference, if any, between scientific knowledge and commonsense knowledge? (v) Are the structures of these two kinds of knowledge similar? (vi) Do these two kinds of knowledge relate to the same world? (vii) What is the relationship between the language of commonsense and the language of science?'

Of these, (vi) is nonsensical since there is only one kind of true knowledge, that of the one world in existence. Of the rest, (i) is a little too vague to be of much significance. However, an adequate answer, to wit, *science is about understanding the world around us by the method of combining logic, mathematics and observation, which came with the Pythagoreans*, is latent in the following passage:

'The purpose of the enterprise throughout has been to understand the world around us. However, what made the work of Newton possible was the methodology of combining mathematics