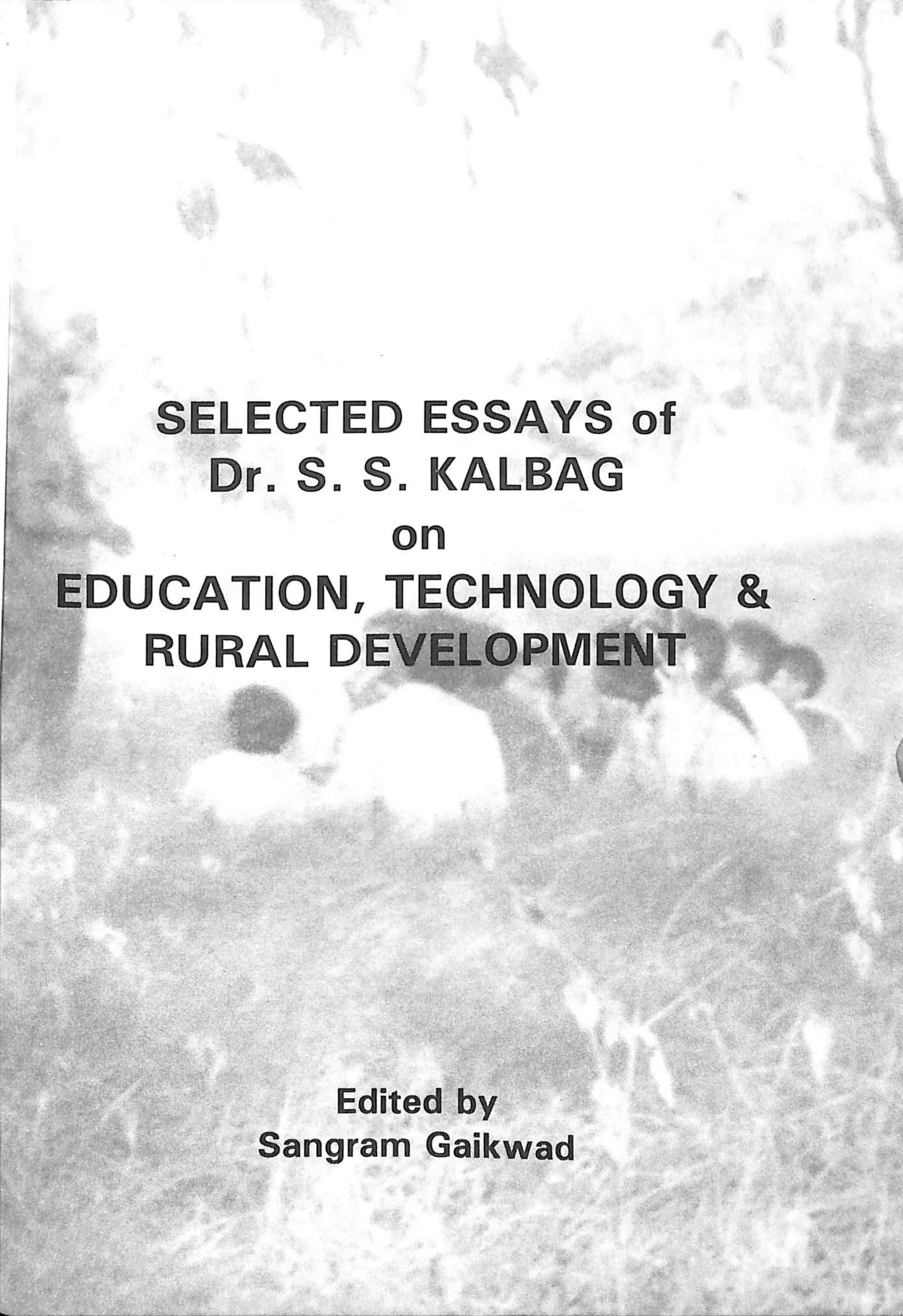
SELECTED ESSAYS of Dr. S. S. KALBAG

on

EDUCATION, TECHNOLOGY & RURAL DEVELOPMENT



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FOREWORD

Almost a quarter of a century ago, we at Kishore Bharati in Village Palia Piparia, Hoshangabad District, Madhya Pradesh, received a visitor who introduced himself as a senior scientist working with a well-known multi-national company in Mumbai. He was Dr. S.S. Kalbag. He was on a 'pilgrimage' to study and learn from our Hoshangabad Science Teaching Programme (HSTP), then functioning in all the 300 odd government middle schools of the District. Three days later, as he prepared to leave, he sat down with us to share his observations. Although impressed with the scientific philosophy and child-oriented pedagogy that guided the HSTP curriculum, there was something amiss, he frankly observed. He felt that the science curriculum evolved by us was not linked with the real life needs of the rural children and did not address the issues of development, just as the prevailing text book-based curriculum rooted in rote learning fails to do. He wanted to include in his future work all what we had done but begin where we had stopped – that is, go beyond HSTP. Having resigned from his high profile career in Mumbai a few months later, Dr. Kalbag shifted to the Village Pabal in Pune District, Maharashtra and set up his Vigyan Ashram. During the next two decades, he managed to transform Pabal into a new pilgrimage centre of education bubbling with radical ideas for 21st century India.

A superficial study of this collection of papers by Late Dr. Kalbag may lead one to falsely conclude that the aim of the Pabal experiment was to develop pre-vocational or vocational courses only. Such a conclusion would not only be unfortunate but will also amount to an unfair "reductionalism" of the theoretical foundation guiding Pabal's intervention in school curriculum. A deeper reading will bring out the basic concern that "good education has to be based on diverse experiences and, for this, real life is the best educator." While discussing the place of Piaget's theory of learning in his work-based curriculum on rural technology, Dr. Kalbag is persuaded to observe, "The process of learning cannot be expedited by receiving information from others. Where the prerequisite structures or concepts are not formed, we cannot teach anything based on these concepts. . . . . .If at this stage, we pressurize the child, it will adopt a self-defense mechanism of reproducing to us what we wish to hear, without really understanding it. This is the beginning of rote learning."

Imagine Mahatma Gandhi, the undeterred proponent of learning through productive work, visiting Pabal's experiment in late 1990s when the programme was operating in forty government schools in Maharashtra as integral part of the school curriculum. What would he have seen? He would have seen a group of girls from Class X building a 6 KVA-welding transformer, another batch of girls testing the blood groups of other students or a group of boys building two latrine blocks for the school. He would have further seen girls building a water tank and doing its plumbing. Before he is surprised, he would have found boys and girls together building a workshop shed of 900 sq. ft. (and costing it too) or making wheelbarrows and classroom benches for the school or the community. Another batch of girls would have shown Gandhiji how they made a cement slide and fabricated a steel seesaw and merry-go-round for the children of the local Balwadi. The work does not remain restricted to doing things for the school alone. Nothing would have pleased Gandhiji more than seeing senior girls doing hemoglobin estimations on primary school children and advising their parents on diet correction or examining drinking water samples for microbiological quality or even holding vaccination camps for poultry in different hamlets. The students would be visiting farmers' fields and measuring 'earth resistivity pattern' to advise where to access groundwater for irrigation. And all this going on, not as extra-curricular activity, but as integral to the main school curriculum where each experience becomes a source of knowledge, values and multi-skills.

Having seen all this, Gandhiji would be expected to exclaim with joy that this is precisely what he had said at the Wardha Conference in October 1937. He would be inclined to recall the following statement made by him 70 years ago,

". . . . . . instead of merely teaching a trade or a handicraft, we may as well educate the children entirely through them. Look at takli (spindle) itself, for instance. The lesson of this takli will be the first lesson of our students through which they would be able to learn a substantial part of the history of cotton, Lancashire and the British empire. . . . . . . How does this takli work? What is its utility? And what are the strengths that lie within it? Thus the child learns all this in the midst of play. Through this he also acquires some knowledge of mathematics. When he is asked to count the number of cotton threads on takli and he is asked to report how many did he spin, it becomes possible to acquaint him step by step with good deal of mathematical knowledge through this process. And the beauty is that none of this becomes even a slight burden on his mind. The learner does not even become aware that he is learning. While playing around and singing, he keeps on turning his takli and from this itself he learns a great deal."

- Excerpted from the address by Mahatma Gandhi
at the Wardha Education Conference, 22 October 1937

[Translated from Hindi, Hindustani Talimi Sangh, 1957, pp. vii-viii]

This historic vision of educational transformation received only lip service from the rulers of independent India. The colonial system of education was founded on dichotomy between work and knowledge. It has had an hegemonic impact on the thinking of the ruling class in post-independence India, since it reinforced the Brahminical tradition of separating manual work from learning and vice versa. This is what Gandhiji had challenged though his Basic Education programme. By 1960s, essentially all the institutions that came up soon after the Wardha Conference to promote the Gandhian conception of curriculum, gradually lost their direction and dynamism and were ultimately absorbed by the mainstream system. Herein lies the significance of the emergence of Dr. Kalbag's work during the past two decades as it explored the Gandhian idea afresh. Without claiming as much, Dr. Kalbag quietly but steadily re-interpreted the Gandhian pedagogy of linking work with knowledge in contemporary economic, technological and socio-cultural framework and demonstrated how it could become a powerful means of curricular transformation.

The papers presented here consistently underline Dr. Kalbag's deep concern for scientific philosophy and the method of science. Look at his observation, ". . . . . every measurement is an approximation; no measurement is absolute." No question of philosophical value was outside the scope of learning through work, as far as Dr. Kalbag was concerned. The discussion on text books in one of the papers leads him to raise the issue of "the usual distinction between distance and displacement" wherein distance is routinely "taught as a scaler and displacement as a vector." He builds up a logical case for maintaining that "distance is always a vector" when you look at distance in a three-dimensional space. The critical point is not whether he was right in such views but that such theoretical issues were integral to the work-based curriculum Pabal has promoted (or at least aims at promoting) for the school system of tomorrow's India.

Apart from being a scientist and educator, Dr. Kalbag was both a sensitive and intense person in the best sense of these terms. I would contend that these values of his personality were critical elements of his pedagogy that enabled him to evolve a radical vision of education. Otherwise, he would have made compromises at a much earlier stage of his work. I recall a meeting at the Indian Institute of Education at Pune when he broke down, just as a child would, in the midst of academics when some of us questioned his approach to introducing information technology in village curriculum as being premature. He explained later that the villages would be left behind if they don't get access to this technology. Time has shown that he was correct but probably ahead of his times. He contended that "we need to develop courage to act on our convictions and be willing to pay the price." His work at Pabal is a living testimony to this conviction and his early demise, probably, is the price he paid.

Had he lived, I would have liked him to pursue two additional curricular issues. One, like the scientific framework, it was important that Pabal also included framework of other disciplines, especially social science and linguistics, in developing the work-based curriculum. This would have made the curriculum holistic. Two, while learning from work and experience is invaluable at early stages of learning and it constitutes an essential entry point for the majority of our children, it can't be promoted as a substitute for learning from the accumulated human knowledge as the child advances in both the age and maturity. Often, in our over-enthusiasm we make this unintended mistake. There is plenty of evidence in Dr. Kalbag's papers that he was acutely aware of this limitation of work-based learning and, therefore, he raised philosophical issues of great importance as part of his pedagogy. However, what Pabal needs to do now is to define these limits in curricular terms and develop the path to move from experiential knowledge to theoretical knowledge.

In a recent study, NCERT's National Focus Group on "Work and Education" (September 2005) has also reinforced Dr. Kalbag's views on the pedagogic role of productive work and social action in acquiring knowledge, developing values and building generic skills in a futuristic curriculum. The Gandhian conception of education is beginning to make fresh sense again. However, the global market forces are doing their best to undo all this by reducing this vision to mere vocational education, the importance of vocational education notwithstanding. This trend is evident in Planning Commission's approach towards XI Plan which talks uncritically of the need to build a "skilled work force" for the global market. Dr. Kalbag in these papers strongly resists this "reductionalism". The character of the future discourse on education will be determined by our collective will to build up on this resistance, both in theory and in practice. The aim of education is to build a conscious citizenship for a truly democratic, egalitarian, secular and enlightened India, not a subordinate market and source of cheap skilled labour for global capital. Such reconstruction of educational agenda will be our highest tribute to both Gandhi and his indomitable disciple, Late Dr. Kalbag as well as to the unfinished task at Pabal.

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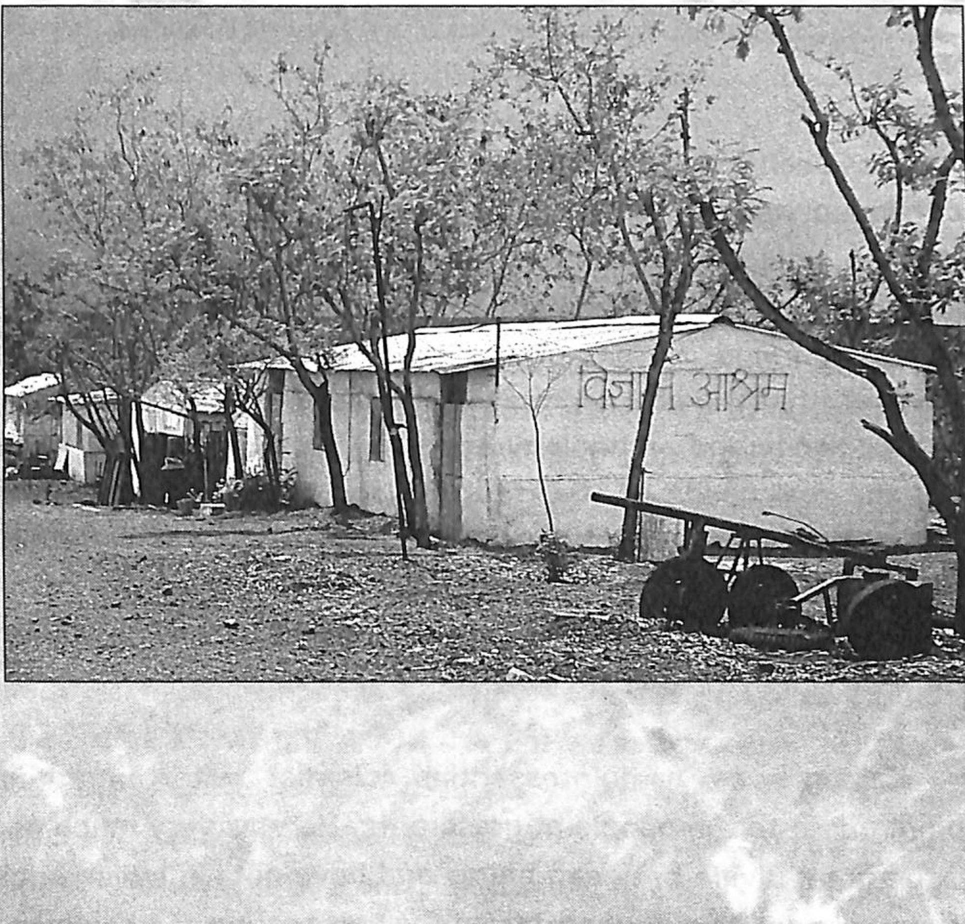
विज्ञान आश्रम

INTRODUCTION

India has seen many educational experiments as well as theories in post independence period which are based on the principles of "learning while doing" and "learning through productive work". Many of these experiments and theories have borrowed ideas from the "programme of basic education" propagated by Gandhiji. However, these experiments and theories lacked confidence in the use of science and technology and were suffering from disconnect with the real needs of the rural masses. Dr. Shrinath Sheshagiri Kalbag, a scientist turned educationist, exhibited a rare confidence and conviction about the relevance and usefulness of new technological developments in the education based on productive work.

Dr. Kalbag was a quintessential scientist with extraordinary commitment to the people at grassroots. He was very much pained by the great divide between haves and have nots in Indian society. He always tried to diagnose it from the perspective of a scientist and an educationist. His observation that the poor people in India are severely handicapped with regard to some basic intellectual skills and are therefore unable to use the available knowledge that flows past them was very accurate and original. He has further observed that all sections of the society do not receive knowledge uniformly in our knowledge distribution system, i.e. education system. Dr. Kalbag has illustrated this point by giving the example of green revolution where the fruits of new technological development couldn't reach to all the farmers due to lack of intellectual and psychological preparedness for the same. He also speaks of lack of industrial culture in agriculture and suggests a remedy of good education system for this problem. He thought of education as a knowledge distribution system or technological delivery system. He has also emphasized that education system is the only effective system to achieve delivery of technology.

Dr. Kalbag invented an education system based on the principles of "learning while doing", "multi skill training", "two-way link between school and community" and "instructor as entrepreneur". He invented this new system based on his own past experience as well experiments by him in Vigyan Ashram. He called it as his invention and termed it as "Rural development through education system". His vision was to see this invention spread all over India in all the schools.

Dr. Kalbag was born on 23 October 1928 in Mumbai. He was the youngest son of Sheshagiri N. Kalbag who had migrated to Mumbai from his native Karwar, in 1903. He did his B.Sc. from the (Royal) Institute of Science. After B.Sc. he joined the Department of Chemical Technology (UDCT) and did his B.Sc. Tech. with distinction, standing first among all the disciplines. After doing his M.Sc. Tech. in 1952 on Electrolytic oxidation of Soaps, a project he had formulated himself, he joined the food technology department in the University of Illinois, USA. Here he worked on polarographic studies of Fat Oxidation and Fatty Esters of Sugars as Emulsifying Agents.

After earning Ph D with all "A" grades, he decided to return to India in spite of offers made to him by his Professor Dr. Kummerow. This had such an impression on Prof. Kummerow that almost thirty years later, Dr. Kummerow visited Pabal to see what his ex-student was doing and offered all help. After returning to India, Dr. Kalbag joined the Central Food Technological Research Institute, a CSIR laboratory in Mysore for a brief period. In CFTRI, he showed his initiative and innovative ability, by developing a number of new designs of equipment and processes. He left CFTRI to join Hindustan Lever Ltd. in their new research unit as a research scientist in 1963 and rose to be the head of the Engineering Sciences Group.

From his work in CFTRT and Hindustan Lever, Dr. Kalbag had a large number of patents, several of which are in commercial use. While in Hindustan Lever, he took active part in professional bodies and was chairman of the Indian Institute of Chemical Engineers, Western Region. He was elected fellow of the Indian Academy of Sciences (founded by Sir C.V.Raman) in recognition of his work in the field of technology. He was also a Fellow of the Institution of Engineers (India).

At the age of 27 while finishing his PhD in USA, Dr. Kalbag decided that he will continue his "grihasthashrama" for next 27 years and then he shall enter the phase of "vanaprasthashram" and devote the rest of his life to the service of mankind. As per this resolution he took early retirement from Hindustan Lever in 1982 at the age of 54 and started working on his ideas on education.

He was planning for his future endeavor in the field of education even before quitting the job in Hindustan Lever. He had conducted a survey among the street urchins in Mumbai under the aegis of the Homi Bhabha Centre for Science Education, TIFR. The kids were smart and could manage a range of tasks efficiently, yet they did not do well in the schools they attended, because the syllabus did not match their skills. The need for the change in curriculum realized due to such experiences lead him to Dr. J P Naik and Dr. Chitra Naik of the Indian Institute of Education (IIE), Pune. In 1981, he along with his wife Meera visited the villages where the "Universalisation of Primary Education" (UPE) program was conducted by IIE. He decided to join the Indian Institute of Education, Pune after this visit and subsequent discussions. He was supposed to start his program on his own, but under the auspices of the IIE. It was agreed that he would bring his own project funds and would have complete autonomy in carrying out his program.

Later he started the search for a suitable place for starting his work. He purposefully selected Pabal, a village in Pune district, which was sufficiently away from city and was falling in drought prone area. Initially he stayed in the dalit basti of Pabal village and interacted with villagers. Later he moved to a hillock near the village, which was most suitable for his ashram like institution. He submitted a formal project to the Department of Science and Technology in 1981. Work in Vigyan Ashram commenced in January 1983. His wife Meera Kalbag was also a founder member of the Vigyan Ashram and accompanied him in his work till his death on 30th July 2003.

The roots of many of his favourite ideas and passions can be traced back to his student days. He conducted daily adult literacy classes for factory workers for nearly two years and acted as a social volunteer in his college days. During his two years stay in Chicago, he used to spend weekends at Ranches in nearby rural areas to see and study the life of rural folks, especially of the farmers there. He had scientific bent of mind even in his school days. His interest in the practice of science led him to set up, jointly with his brother, a laboratory and later also a workshop at home for his own projects. Here he prepared, as development work, tartaric acid, hippuric acid, synthetic detergents and soaps. He made a petrol gas generator, set up a jet pump, revamped septic tanks and did many such jobs. His other interests led him to spend 12 vacations, trekking in the Himalayas, camping, yachting and making home movies. These traits of deep social commitment, scientific temper and spirit of adventure were to develop beautifully in the "vanaprasthashram" phase of his life.

Dr. Kalbag documented his thoughts on "new education system, science and technology" in articles written for specific occasions, papers presented in seminars and speeches delivered at various functions. These write-ups (hereafter referred as articles) were available in typewritten forms as well as printouts from his personal computer. Dr. Kalbag left behind more than 70 such articles. Dates and references were not mentioned on many of these articles. Many of these were on identical subjects. In remaining articles certain key issues (such as "learning while doing") were repeated since the articles were written on similar subjects on different occasions. Liberty has been taken to delete such repetitions in few of the articles. Few repetitions are left untouched since these are integrally connected with the other issues elaborated in the article. At times, two or more articles are fused to form one complete article. Articles were selected to give a broad idea of the range of his thoughts and also to present the core areas of his thoughts.

Being a true technologist and a person who has thought about education as delivery or distribution system, Dr. Kalbag has also used language as a tool to transmit his thoughts in these articles. His language is as cost effective as his other inventions. It is simple, robust and to the point. His spirit of exploration can be seen in the new meanings given by him to well known terms such as knowledge, learning, etc. which need not strictly adhere to the standard meanings attached to these terms.

A man of the calibre of Dr. Kalbag lived in a drought prone village for a long period spanning over 20 years. He engaged in to a continuous dialogue with the rural people. He understood the finer elements of the rural needs and the rural situation. He tried to utilise the insights gained from this dialogue while developing his "invention" of "new education system". The general idea about his mission was very much clear to him from the beginning. He wanted to equip rural people with capacities, which will help them in exploiting the gains from the new technological developments. He had said that "India lagged behind when industrial revolution came; we are still to catch up with it. We cannot afford to miss the information technology revolution. On the contrary we should use it to catch up on the industrial revolution as well". (Ref: Chapter19, "Development opportunities")

Dr Kalbag was not a formally trained educationist. He developed the ideas springing from his own experience as a student and a practising scientist. During this process he found that his ideas based on his own experiences are supported by the theories developed by Piaget on cognition and learning. In one article named "Rural development through education system" (Ref: Chapter 2) he has explained Piaget's theory in his own language. Reference to Piaget theory also occurs in few of the other articles on education.

He says, "the Piaget Theory of learning suggests that one cannot learn in the classroom unless and until one has learnt the prerequisite 'concepts' by experience in the real life, that is, the natural way." (Ref: Chapter 3, "Learning while doing") He was convinced that "it has major implications for all education and for science education in particular." (Ref: Chapter 10, "Science through technical education")

Dr. Kalbag has also quoted Gandhiji while discussing the core principle of "learning by doing". Main purpose for quoting Gandhiji seems to draw support from the great man who has deep influence on the minds of Indian people. He has also detected mistakes in implementation of the Gandhian programme of basic education in independent India. He has narrated these mistakes in his article "Work education in schools, from concept to implementation with a specific reference to rural vocationalisation" (Ref: Chapter 7) as follows.

1) "Because of the choice of activities given in schools, the programme gave an impression to the society at large as being divorced from the direction of Science and Technology and therefore, retrogrades.
2) The ruling elite did not opt for it and created the impression that Basic Education was for the Masses and the normal 'academic' education was for the Classes.
3) We stressed the ideology and not the performance of the system.
4) We do not monitor performance indicators to judge the results of any educational experiment we do."

Interestingly, these mistakes pointed out by Dr. Kalbag also are differentiating features between his own design and the implemented version of the Gandhian programme of basic education.

Dr. Kalbag has dealt in length about variety of skills to be learned by students in school education. He was of the opinion that "varieties of skill are necessary to energise the mind just as a variety of exercises are required to tone all the body muscles". For him "the skills were means to concretise one's ideas and inventions". Many people have apprehensions that the thrust on skill learning can reduce the learning to the level of vocational education. Though such apprehensions emerge more strongly in respect of rural education, he was very clear about the role of multi skill training in his education system. He did not advocate the skill training for making the students master craftsmen but to give them enough exposure to know the skills; it's suitability to their aptitude and also to facilitate technological literacy.

Dr. Kalbag elaborates the importance of imparting attitude and skills necessary for entrepreneurship through education in many of the articles. He says, "Entrepreneurship is not just self-employment. It implies innovation and uncovering new opportunities". (Ref: Chapter 20, "Self-employment and agriculture, random experiences and thoughts") The unique concept of "instructor as entrepreneur" developed by him was influenced by this thought. He also tried to address problems of unemployed dropouts through this concept, which was also one of the characteristic and adventurous features of his programme. He says, "We have a large population of dropouts who need to be usefully employed. There are no salaried jobs to give them. But there are many jobs to be done for the community as also reconstruction jobs, which can be made by small enterprises... We appoint a trained 'drop-out' as an instructor in the school. He operates his business with the school facilities and gives hands-on training to students. He gets the surplus from the operation, the community gets service at a modest cost and students get a good education". (Ref: Chapter 7, "work education in schools.... vocationalisation")

One of the crucial features of Dr. Kalbag's education system is the organic link between the school and the community. He always spoke about the school surrounded by community and not a school in isolation. He envisaged a vibrant and symbiotic relationship between school and community. School would provide various kinds of services to the community and students would get an opportunity to exercise their skills in real life situation thereby learning the practical and economical skills attached to the skills. He thought about community services as an economic transaction between school and community necessary to make the community a stakeholder in the proper functioning of school and to make the school little independent financially.

This feature of school and community link is also the one, which is difficult to implement through state machinery. Various developmental schemes by government having specific degree of community participation as an important condition for its implementation have failed miserably. There are varieties of reasons for this phenomenon, which need not be discussed here. However, Dr. Kalbag was confident that such link could be established since the niche of rural service sector has remained untouched by the commercial forces, which are now targeting rural markets. He was of the opinion that the schools should use this service opportunity for providing paid services to the rural community which will cement the link with the community and will also allow to cover a portion of cost of education.

It is a well-known fact that the schools run by state machinery are in a pathetic state everywhere. There is no dearth of reports, studies and analysis proving this fact. Various schemes and programmes including those for education by welfare state are never seen as means to achieve certain goals. These are treated as end in themselves. The schemes and programmes are actually perceived as big bread and everybody including the power elites in village community want to have a larger bite of it. A strange kind of dependency on the state for almost everything in public sphere is developed in people over the period. The local initiative has almost come to an end in post independence period. In spite of such a depressing scenario, fact remains that the vast population in rural areas has no other option than the state run schools. Dr. Kalbag wanted to implement his education system through state run schools because of this reality. He designed his courses keeping in mind the constraints of funds and collective initiative.

He employed the discipline and methodology of a scientist while designing the educational course. He collected feedbacks on the performance of the courses developed by him such as "Introduction to Basic Technology" (IBT) and "Diploma in Basic Rural Technology" (DBRT) regularly. Feedbacks were in the form of hard data as well as critical analysis. The comparative data in respect of few schools about marks scored by the students opting for IBT and other students was gathered for a long period. The data proved that the overall performance of the students opting for IBT course was better than those students who have not opted for IBT. While analysing the performance of instructors he says, "One of the major problems was that the instructors, who were a product of the educational system we want to drastically change, could not be changed through just a one-year practical course. It is much easier to impart the technical training than to give a new outlook. What is hoped, and it is only a hope (there has been no study to check it), that the practical, real life work will bring them to use their natural logical method of thinking and that this will happen, with some persistent persuasion, not only in their technical work but also in their everyday life." (Ref: Chapter 2, "Rural development through education system") He relentlessly used such feedbacks to improve the educational system, which he was devising. The process was similar to that of designing of a prototype usually employed by scientists. He says, "I feel like an inventor. My invention is the education system that integrates education and development, one that is close to everyday life and which costs so little to implement. My vision is that one day I will see this invention spread all over India in all schools". (Ref: Chapter 1, "Perspective plan for Vigyan ashram")

Though the education system developed by Dr. Kalbag at Vigyan ashram is specifically devised for secondary education, he has also discussed guidelines for school education from lower primary to higher secondary level. (Ref: Chapter 7, "work education in schools.... vocationalisation") He has also written about "information referral system" which will form a vertical connection from the field through school, community polytechnic upto highest technological institutes such as IITs. Dr. Kalbag was national chairman of the committee on community polytechnic scheme formed in 1987. This committee had recommended the steps to be taken to form a nationwide "information referral system". As per this system, the students in the village schools would collect data about local problems and local needs. Such data would be transmitted upwards to the higher technical institutions such as IITs, through community polytechnic. Community Polytechnic would function as a trainer for the school and would also work on the data gathered from school. Wherever needed the higher technical institutions would utilise their human resource to work on such problems, which could not be solved at lower levels. Thus a system was envisaged, in which creative energies of all the people in the chain would get employed for solution of local problems.

The idea of providing upward connection to the rural areas by using information technology is hot nowadays. But Dr. Kalbag had spoken about it way back in 1987 in a more comprehensive manner. He had sensed the role of information technology in establishing vertical connection from rural areas to higher institutions very early.

He has written at length about the revolutionary role of information technology in education. (Ref: Chapter 6, "Information technology can make a breakthrough in education") He thought Information Technology would be useful in speeding up communication and imparting training at lesser costs. He has elaborated on the ways of tackling the main concerns such as quality, finance and coverage while using information technology in education. He suggests connecting all the schools with Internet and to use multimedia computers and computer based lessons on a regular basis.

Since he was not happy with the existing methodology of preparing computer lessons he entered into the business of making computer lessons way back in 1997, by following his own principle of "learning by doing". He said, "Many of the computer lessons I have seen in USA, UK and India are nothing but normal text lessons put on the computer screen with some colour, pictures, and sound, (music or reading the text). This is followed by the usual questions. This is not our idea of a computer lesson. We have to make use of the computer potential, to implement those ideas in education, which were not practical till now". (Ref: Chapter 6, "Information technology can make a breakthrough in education") The thoughts expressed by him under the topic "New pedagogy in computer lessons" in the above referred article, are not only original but also provide important guidelines for developing interactive computer lessons.

He was using computer (spectrum) in Vigyan Ashram since it's inception. He had also started using Internet through dial up connection in year 1995 in which it became available in India. The need to explore use of internet in education as well as for rural development lead him to search for alternative solution to the dial up internet connectivity. In Dec 2001, he collaborated with a company incubated by IIT Chennai tenet group providing Internet connectivity using Wireless in local loop technology. It was a commercial venture undertaken by Vigyan ashram. It had not only solved the connectivity problems of Vigyan ashram but 60 villages in remote areas of Rajgurunagar also got their first telephones and the Rajgurunagar taluka got internet connectivity for the first time.

Dr. Kalbag found quite a few people sharing his thoughts on significance of most advanced technologies for least developed areas. Neil Gershenfeld, Director of Centre of Bits and Atoms of Massachusetts Institute of Technology, (MIT), USA was one amongst them. Neil Gershenfeld speaks about road beyond digital revolution and transition from personal computer to personal fabricator, which would not just make mechanical structures, but fully functioning systems including sensing, logic, actuation, and displays. Out of the six fabrication laboratories (FABLAB) installed by the Center of Bits and Atoms of MIT all over the world, one is in Vigyan ashram. FABLAB, an idea developed by Neil Gershenfeld, is basically a collection of set of computerized high-tech tools, which can be used to fabricate instruments of any utility and configuration. Neil Gershenfeld admits that the concept of FABLAB was partly inspired by the thoughts of Dr. Kalbag and the experiment of Vigyan ashram.

The articles written by Dr. Kalbag on science and technology are also very significant for two reasons. Firstly, they demonstrate a very different and rare point of view towards the role of science and technology in rural development. Secondly, they provide useful insights to understand his idea of education.

He was utterly unhappy about the technological divide existing between "India" and "Bharat". He felt this divide on two levels. First one was in respect of capacities of rural people and other was in respect of energies of research in science and technology being utilised for betterment of the life of rural people. As far as the first is concerned, in one of his article he has noted skill deficiencies of rural youth educated from the existing schools. These are as follows

1. Language: Apart from not knowing the sophisticated concepts and terms even in their own language, many have difficulty in understanding a chain of instructions. They can absorb only one or two at a time. (They need low flux density).
2. Lack of ability to measure common units of length, area, volume, weight, temperature, time etc. Manipulation of these numbers involving simple arithmetic calculations (viz. conversion of units, direct and inverse proportions, calculation of rate, concentrations etc.).
3. Inability to keep any records.
4. Non-familiarity with many operations that need minimum effort for training.

Such observations have shaped Dr. Kalbag's experiments on education in which he tried to develop processes and sub processes to overcome such deficiencies. This aspect is elaborated in his articles such as "Skill development as base for education" (Ref: Chapter 9), "Technology delivery through the education system"

(Ref: Chapter 8) and "Developing scientific temper" (Ref: Chapter 13). He starts from skill deficiencies and finishes with the need for development of scientific temper. He says that the process of rational thinking is natural to all human beings and is based on the experiences of the individual. He further calls scientific temper as refinement of this process which can be brought about by catering adequate experiences to the students through education based on the principle of learning by doing.

As far as utilisation of energies of research in science and technology for the betterment of rural life is concerned, Dr. Kalbag's thoughts were very positive, full of conviction and ahead of his time . He says, "When we say rural development, there is a connotation about low-level technology, voluntary agencies and "sacrifice". The term rural development connotes many things but not science or modern technology." (Ref: Chapter 14, Rural areas: Goldmine of opportunities for creative scientists") He was of the firm opinion that rural development in the true sense has been a largely unexplored field for scientists and technologists where they can apply simplest of science and get good results. He further identifies the attitude due to which such feelings are not shared by scientists and technologists when he says, "We commonly start with techniques invented by others and then look for a problem to apply them. There must be an equal thrill in taking up a problem from real life and then inventing a technique to tackle it. But we do not do much of this in our laboratories." (Ref: Chapter 14, Rural areas: Goldmine of opportunities for creative scientists")

He had identified various fields such as energy and transport, workshop services, animal husbandry, agriculture, home and health, food preservation, water and construction in rural areas. He thought there is ample scope for adventurous and creative mind to apply science and technology in these fields. The excitement of a creative scientist is almost palpable if we lend an ear to his loud thinking about typical rural problems, which have remained unattended for centuries. While discussing about the age-old bullock cart he says, "The bullock cart is not an efficient system. If we get rid of the bullocks we will have more fodder for the milch cattle. But today the bullock cart is essential. A pair of wheels for the bullock cart cost Rs. 2000 and more. But the axles are not standardized. Steel wheels of identical size cost half the price, but they are not widely available and the skill of making a wheel is not as common as the wheel itself. The pneumatic wheeled cart is at par in cost with the conventional, but air and tube services are not common. Mechanisation of the "bullock" cart is possible and viable but workshop services need to spread fast." (Ref: Chapter 14, Rural areas: Goldmine of opportunities for creative scientists")

Dr. Kalbag wanted school education to develop the orientation for problem solving and to encourage the spirit of invention and exploration amongst the students. He knew that "there are needs of rural areas that are distinctly different from urban needs. These needs could be met by inventions and formulations for local needs". (Ref: Chapter 17, "Science and technology project for rural areas") He was convinced that "even the dullest, can indulge in problem solving and make little inventions". (Ref: Chapter 4, "Problem solving orientation in education") Dr. Kalbag has spoken about "invention" in many of the articles. At many places it actually means innovation. He has used the terms "discovery" and "invention" in an exploratory manner in his writings. His thoughts about invention and innovation are also reflected in his design of courses at Vigyan Ashram. He developed a concept of "idea prize" in Vigyan Ashram. Any student who gets any kind of new idea, which can be useful in solving any kind of problems is supposed to submit his idea in his own language. Such ideas are rated according to the innovation and problem solving abilities involved and the student gets a cash prize for the ideas as per the rating. Many of the students of Vigyan ashram developed indigenous innovations catering to the local needs. An affordable and portable ERM machine, a multipurpose minitractor called mechbull and geodesic dome (Discussed in detail in Chapter 23, "Low cost housing-vigyan ashram approach") are few examples of such innovations.

Dr. Kalbag has extensively used terms such as "productivity" and "cost reduction" while discussing the projects for rural development. It is interesting to see the use of these terms, otherwise used exclusively in corporate domain, in the discussions on rural projects. Somehow the rural development is always treated as a holy cow by welfare state where the concepts such as "productivity", "cost reduction", "capital intensive technology" connected to so called unholy ideas such as "profit making" and "luxury" are not given an entry. Dr. Kalbag thought of productivity as an ability to increase the assets with the given resources. He spoke about productivity of simple operations like digging wells, building a bund, making pits and even sweeping and cleaning (Ref: Chapter 17, "Science & technology projects for rural areas") He saw cost reduction as a means to achieve wider availability of existing service or product.

Dr. Kalbag was completely convinced that the new developments in science and technology hold the keys for the problems of rural development. As a true technocrat, he does not discuss the sociological or historical impediments in rural development. Occasionally, he mentions few benevolent features of Indian culture in support to his arguments. The thoughts such as viability of the present model of capitalist economy for a country with vast population like India are innocently absent in his writings. Since the articles were written with an utilitarian intent of putting forward his core ideas, such thoughts might not have found any mention in the articles.

Dr. Kalbag rarely takes the luxury of reflecting on philosophical issues. In one of the articles titled "Why India needs Vipassyana" (Ref: Chapter 27) he submits his thoughts on real causes of misery and the significance of vipassyana in a distilled form. In another article he reflects about the journey beyond eradication of poverty. He says, "Assuming this eradicates poverty, brings prosperity, shall we be happy and peaceful? No. Already we see that the world cannot support spending of its resources in the way the present prosperous society is spending. It is not just a question of the environment. Are the people actually happy? Do they have the peace of mind? Neither the rich, nor the poor are happy. Neither the 'materialist' west nor the 'spiritual' India /east are happy. It is not the Western Model or the Eastern. We have all, by and large, lost the Art of Living. We are confused about what the quality of life means. We do not know how to progress in S and T and yet live a frugal and happy life". (Ref: Chapter 12, "Vigyan Ashram, where do we go from here") This shows the inner Indianness of the man who constantly spoke about science, technology and development. Interestingly, he himself has demonstrated a way of leading such happy and frugal life at Vigyan Ashram.

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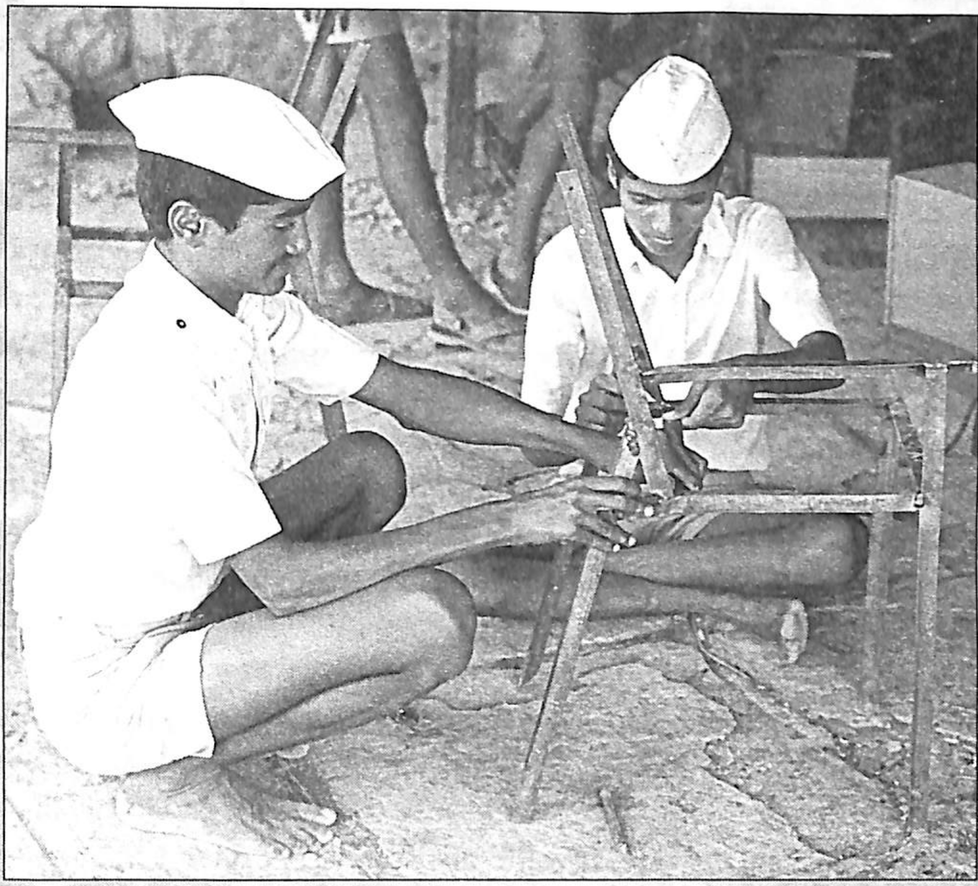


I feel like an inventor. My invention is the educational system that integrates education and development.

PERSPECTIVE PLAN FOR VIGYAN ASHRAM

My Vision

I would like to see India prosper and be a pathfinder to the rest of the world. This will happen only when everyone can reach his or her own full potential. Hence, raise the lowest.

My stress is therefore on the education of the rural people. I believe intelligence is developed and not inherited. Activity based thinking is the source of intelligence.

Good education has to be based on diverse experiences and for this, real life is the best educator.

In our society, we need to develop courage to act on our convictions and be willing to pay the price. Many of us do not act on our own beliefs and we seem to be "stage acting" for all the time. We believe only in symbolic acts not acts for results.

I feel like an inventor. My invention is the educational system that integrates education and development, one that is close to the real everyday life and which costs so little to implement.

I feel like an inventor. My invention is the educational system that integrates education and development

My vision is that, one day, I will see this invention spread all over India in all the schools.

My vision is that, every village will have the equipment and the skills that are the basis of all modern industry. My industry, my invention will achieve this at a very low cost.
My vision is that, youth coming out of this system, in villages all over, will be handymen, who are at home with a variety of skills and can concretize their ideas. They are inventors at their level.

My vision is that, a majority of the rural section will thus get access to most modern techniques and this will spur development from the grass-roots and ultimately, propel India into the new age. My vision is that India will, one day, be at the forefront of a new civilization. Now I have put my vision in black and white, as clearly as I can. But it is not possible to describe a vision in words. I hope I can show a glimpse of it in my own action.

The Objective.
Rural Development through Educational System.

Strategy
Organize infrastructure and equipment with community involvement and impart relevant skills at the grass-roots level. This will give the local youth the capability to perceive their own problems and act to solve them; this will be true sustainable development, brought about by education.

Short Range Plan (Up to 5 years)

a. Formulate a syllabus and a teaching and implementing system to give skills to students and services to the community through the students. This will give necessary on-the-job experience to the students and services at modest cost to the community. This has been achieved for both the formal and non-formal modes.

b. Introduce flexibility in the curriculum so that it can be adapted to local needs and changing times, without losing the advantage of a common general effect. This has been done by introducing the Project system in the final stage of the syllabus.

c. Investigate scale-up problems, by replicating in more situations. This has been done through Rural Technology through Education System (RTES) funded by CAPART and MHRD jointly from 1988-92 in three schools.

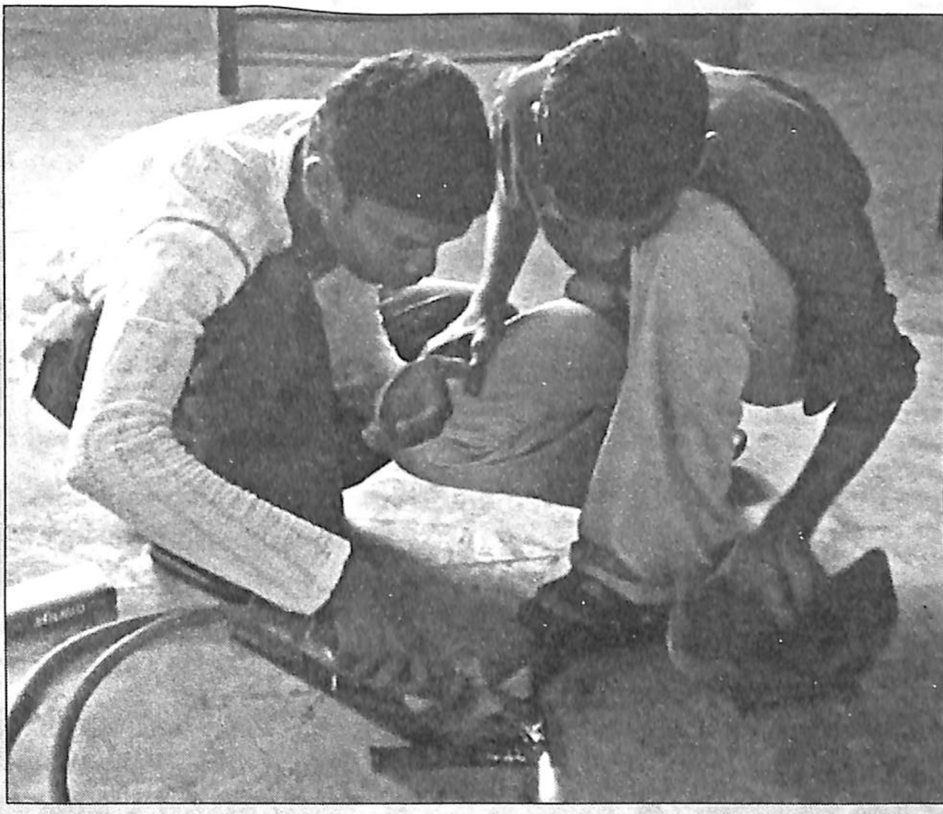
d. Convince Education Departments, Central and State, about the benefits of such a program and adopting it formally. This has been done partially. The NCERT and MHRD have accepted the principles and also instituted the Prevocational Scheme of funding that accommodates this. The Maharashtra State CERT put forth a proposal to start schools on the Vigyan Ashram model in 30 districts on an experimental basis. If successful, this will be extended to all secondary schools in the state. After waiting for the Central prevocational scheme, the State government announced their intention to do this and the Education Department has decided to implement the program in 100 schools in the current 5 year plan from 1995 June and use 1994-95 for preparation, selection and training of teachers and instructors etc.

e. Network the Community Polytechnic (CP) Scheme and the Prevocational scheme, both of MHRD so that, the former trains the instructors and becomes a resource group for the latter. Such networking is provided for in the CP scheme, as recommended by the Kalbag Committee report given in 1987 (of which CAPART was a member). These recommendations have also been accepted by the Govt. of India. The Program of Action of MHRD, as presented to the Parliament and approved, includes this.

f. Set up a computerized information and referral system covering the whole nation. This will allow easy retrieval of economic, demographic, and technical information and thus facilitate solution of these problems. It will also link the rural education system and youth to the national S and T establishments through a referral system.
g. Propagate formation of a funding consortium for the above. This will be linked through coordination committees at State and National level. This is provided for in the above CP report and is being pushed through the MHRD, via the vocational program. (Joint Council of Vocational Education)
h. Ensure technical back-up for the above, by exploring the technical feasibility and economic viability of acquiring suitable computer hardware for rural conditions and training rural youth to install and operate the same for rural economic activity including education and development, with minimum government finds. A computer has been set up at Vigyan Ashram through CAPART funds and used through CAPART funding for training rural youth in its operation. Also a PC/AT computer has been assembled to operate on battery supply and do the necessary maintenance through local youth in the Ashram.
i. Promote development of designs and technologies to suit the school level equipment facilities and skill level. Document these after testing in application; make these available to all schools so that the Schools become a channel for introducing new technologies in the rural area. A network of polytechnics and engineering colleges and some Its can be used to generate new designs so that a library of designs is available for all schools to implement for rural use. This has already been started. A list of projects for such colleges is available and DST has also agreed to fund these as separate proposals.

Long Range Plan (5-20 Years)

a. Extend the system with variants all over India.
b. Link CP scheme to education to form a single national level coordination setup.
c. Institutionalize the information and referral system, from the village/grass-root level to the S and T establishments and funding agencies at the national level.
d. The Institutionalizing of the various aspects of this perspective plan must be so done that, Vigyan Ashram should be superfluous and the program should go on without the Vigyan Ashram initiatives. It should become a national program.
e. Develop a system so that the grass-root workers document their work in a scientific spirit, and in their own language and style. This should include validation by other peer groups and then publication in a scientific journal specifically run for and perhaps by the "barefoot" scientists and technologists.
f. Make a compendium of rural needs, grid problems, which will be continuously updated, as a part of the information system. This can be used as a source for selecting research and development problems by the engineering, agricultural and other educational institutions to bring the existing urban students nearer to reality.
g. Adapt the above so that the principles of education that are contained therein, are extended to urban areas also and link the urban and rural weaker sections thus helping to reverse the migration pattern.



The provision of community services not only brings realism to education, but also links education to rural life and the community.

RURAL DEVELOPMENT THROUGH EDUCATION

Abstract

Based on the belief that learning in real life situations stimulates the intellect, a system of multi- skill education for in-school and out-of-school youth has been developed.

Such a system has been implemented on an experimental basis in 4 schools for over 5 years. It integrates education with rural development by giving services through the school to the community at modest charges.

Part I states the philosophical base and the scheme. Part II deals with the problems faced in implementing and the evaluation so far. Part III outlines the plan for future extension to more schools.

The Great Divide

The people of India, under the leadership of Pundit Jawaharlal Nehru, have given a high priority to Science and Technology. In the over forty-five years since Independence, we have made considerable progress in agriculture as well as industry and also in the

The provision of community services not only brings realism to education, but also links education to rural life and the community.

development of our own technology. But we must admit that the world has been moving faster and the gap between the developed countries and us is, if at all, is becoming even wider, And worse still, the main problem of poverty is still looming large. The divide among the haves and have-nots has increased. Every step forward we take in science and technology seems to widen this divide even more. The Green Revolution, which has undoubtedly helped the nation to be self-reliant in food, is also being accused of being responsible for widening the gulf between the rich and the poor. There is something seriously wrong in our approach, if a great step forward like agricultural research is also widening the gulf rather than narrowing it.

Let us understand this great divide, the divide between the rich and the poor, the educated and the illiterate, the organized labour and the landless, the successful small entrepreneur and the unsuccessful unemployed, the urban and the rural. How did this divide arise and what adds to it? How can we bridge it?

If we accept that true knowledge is wealth, we must look at how knowledge is percolating from its fountains to the needy. Knowledge, like all wealth, grows exponentially. That is the law of nature and we cannot change it. Any flaws in the distribution of this knowledge will therefore have a much more visible effect on the growth of knowledge and therefore all wealth. My perception is that a large section of our society is severely handicapped with regard to some intellectual skills and is therefore unable to use the available knowledge that flows past them. They therefore, remain poor while the knowledge enriches those who receive it. All sections of the society do not receive knowledge uniformly, because of the flaws in our knowledge distribution, i.e. education system. To make matters worse, those who are responsible for the distribution of this knowledge, the educated in general, and the educationists in particular, do not appreciate the quantitative significance of this handicap. They are therefore, equating the rise in educational standards and increase of the syllabus content with increasing literacy. These effects are likely to be self-defeating, as the enlarged syllabus makes it even more difficult for the educationally handicapped to cope with the changes. Similarly, every disillusioned literate can be a disincentive for the neo-literate. What are these handicaps and what can we do to remove the hindrances in the flow of knowledge?

Before we go into the solution of this problem, we should clarify our objectives.

What are the characteristics of good education? What kind of development do we want?

Education should be an enjoyable experience. After learning something new, one should be eager to use that learning in real life and get the satisfaction of having learnt it. We see this in children. A child is eager to learn to walk and to talk. It is a pleasure and it keeps trying and practicing. A child learning to ride a bicycle enjoys the learning process and will find every excuse to take the bicycle out and use it in everyday life and gather experience. If we can achieve this, even to a limited extent, everybody will have true knowledge born out of practical experience and therefore usable. Moreover, they would be able to use it. All development springs from human knowledge, and the endeavor to learn more and more. In such a society, development will be a direct consequence of an effective education system. Such true development will be a constant effort to improve one's own life. A development that is the result of proper education will be a true sustainable development.

Piaget Theory

Jean Piaget was a biologist who drifted into the psychology of learning and worked for 40 years to develop a cognitive theory that is now widely accepted. This theory has great relevance to India's problems.

This, in brief, is the theory. A child is born with the human biochemistry and a few instincts - among them the ability to grasp with the thumb and fingers and to suck. With this inherited nervous system and brain as the "hardware" the new born child interacts with the environment and gradually builds up a picture of the "reality" outside, by creating a mental structure in its own brain. It continues to learn through this interaction with its environment and builds up a "model", by a process of assimilation and accommodation. It continues this learning process throughout its life and uses this model to anticipate the results of its actions in the real world.

This natural process of learning is analogous to, and is perhaps, the origin of the scientific approach consisting of observation, recording and study, making a hypothesis and verification by further experiments/observation. It is worth noting that, this natural method of learning is never completely lost or given up. Everyone continues to learn by this method throughout life, experiencing the pleasure of learning as well as the keenness and satisfaction of finding a use for it. The human child or the adult, however, may not use this method in its formal and conscious learning stage.

This is where our problem starts. This process of learning cannot be expedited by receiving information from others. Where the prerequisite structures or concepts are not formed, we cannot teach anything based on these concepts. Thus for example, a child of 3-4 years who does not have the concept that a volume of a liquid remains constant, even as we pour it from one vessel to another, cannot understand properly the methods of measuring volume in a measuring cylinder. If at this stage, we pressurize the child, it will adopt a self-defense mechanism of reproducing to us what we wish to hear, without really understanding it. This is the beginning of rote learning. If this pressure teaching continues long enough, the child (and then the adolescent and adult) adopts this unthinking "learning" as the standard method of formal learning. This is what we have achieved in our learning system. The same child however continues to learn by the natural and scientific method in its real life outside the classroom. One can see this approach in the solving of simple problems such as untying a knot, or repairing small gadgets or devices. Here one always uses one's own observation and previous experience and makes a hypothesis about what has gone wrong and what needs to be done.

Let us come back to our problem of children who have abandoned the natural method of learning. Can we correct the ill effects of education, by improving the learning environment so that a child learns without tension and wants to use that acquired knowledge in its everyday life?

We have experimented with a course designed for rural areas with the above objectives.

The course is called as Rural Technology course.* This will be learnt as a separate subject from 8th to 10th standard. The course will be an integrated part of the overall syllabus.

The basic Principles of the Rural Technology (RT) system

1. Multi-skill training.
2. Using the acquired skills in real life conditions, by giving services to the community.

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*Presently this course is clled as Introduction to Basic Technology (IBT)

3. The community paying for these services on cost plus basis.
4. Using the surplus as an incentive to staff and students.

1. Multi-skill training

Multi-skill training not only broadens the horizon of experiences of the growing child, but also gives it the capability to act. It acquires some commonly required skills so that it can concretize its ideas by solving its own problems. The child becomes a handyman. Also the rural problems, and often all problems at the ground level need a multidisciplinary approach to understand and think of a solution. Thus, it is always a generalist who refers the given case to a specialist for a solution.

The multi-skill training programme also reduces the cost of education, because, at any given time, the batch of students is working with different pieces of equipment in different sections. This reduces the number of equipment required to give hands-on experience to all students. For the same reason, the school equipment has greater utilization. Also being trained in a variety of jobs, the school is better equipped to meet its own requirements for equipment as also services. The school can therefore be better equipped by its own efforts.

2. Using the Acquired skills in real life

This is done by giving services to the community. The provision of services not only brings realism to education, but also links education to rural life and the community. It establishes relevance, gives ample opportunities for interaction of the staff and students with the community. It encourages them to understand the needs of the community and use their skills for meeting these. This is development at the base level. It also gives confidence to the student to later start on his own if he wishes. This step is necessary to encourage both invention and enterprise. Everyone is not inclined to do that, but given the right environment, the seeds of invention and enterprise can germinate.

Multi-skill training broadens the horizon of experiences of the growing child.

3. The community pays for these services

This economic transaction is necessary. It brings the criterion of economic viability in what the teacher teaches and the students learn. It also reduces the cost for both the user and the giver. For the school, part of the equipment cost and most of the material cost is borne by the community who uses these services. Also, it is an evaluation and quality control mechanism by the community. If these services are not used, it indicates that they are either not relevant or not up to the mark. We have found this as the lowest cost solution for providing services to the rural area. By providing services through the educational system, the demand for these services increases until they become commercially viable; thus it lays the foundation for creating new job opportunities.

By providing essential services through schools, even in areas where such services are not commercially viable because of low demand levels, the community benefits. It can therefore be induced to pay the cost of the equipment and other infrastructure facilities for starting such a programme for the school. By thus involving the community, the financial burden on the government is reduced, thereby making it economically feasible to consider such a system for more secondary schools. This also makes it possible for the community to demand the services from the staff and the school as they have invested in it. The community now has a stake in the proper functioning of the school.

4. Using the surplus as an incentive

The distribution of the surplus allows the staff to be given a core salary for the time they spend on actual instruction. The remaining time is then available for giving services to the community, on a cost plus basis. The earnings of the staff are linked to the level of services. At the same time, the students have an opportunity to get hands-on experience. The community gets the services it needs. All are benefitted. There is also a healthy working relationship between the parties concerned.

The Experience

This type of system has been under trial through Vigyan Ashram, Pabal since 1983. The Vigyan Ashram was set up in Jan. 1983. It submitted a proposed syllabus to the State Education Board, which was accepted from June 1985, with due formalities and procedures. From 1988, the programme was extended to three more schools in the region. Thus, the extendibility was studied by providing trained teachers to these schools, without direct involvement of Vigyan Ashram.

The important conclusions from the past 10 years experience are as follows:

1. There is better academic performance by students, in spite of diversion of 20% time to this "pre-vocational" training.
2. Where the co-operation of the school is not forthcoming, this can become a farce; some benefits still accrue and the students do feel the interest.
3. The school and the community have immense potential for benefiting and the latter is willing to collect funds for it.
4. Community services can rise up to Rs. 30,000-50,000 per quarter or be as low as Rs. 200-300, depending on the initiative taken by the staff and Headmaster.
5. It has an indirect effect on the community. It reduces superstition, brings a modern outlook etc.

6. It provides for non-formal training of school dropouts in the same system, and the two complement each other.

Services provided through School

- Workshop Fabrication and Repairs
- Blood and Urine Medical Test
- Electrical Wiring and Repairs
- Agricultural Products tests
- Water Prospecting, Electrical Method
- Soil Analysis
- Hand Pump Repairs
- Pest Management
- Construction Work
- Poultry and Dairy Products sale
- IC Engines and Tyre service
- Drinking water tests and Treatment
- Plumbing and Sanitation
- Sewing and Knitting

PART II

FORMULATING THE SYLLABUS

The Beginning

Starting with the idea that we should have a multi-skilled course that would train students and give services at the same time, we began with a large number of short courses in the technical field as also arts subjects. But it was impossible to get teachers for any of them. We therefore had to give up that idea and then decided to have a common set that would be useful everywhere in India.

I depended on my own needs in the village to decide the topics to include in the syllabus. The list included Water Resource Development, Construction, Workshop Technology, Energy and Environment, Agriculture, Animal Husbandry, Home and Health and finally Engineering Drawing. These topics were of immediate relevance to us in Pabal and I thought they should be relevant everywhere.

Even though these topics would be common for all, there was a need for flexibility, to suit local needs. The project system solved this problem. The projects to be selected in the final year could be anything related to the above topics and that would be a good exercise of total planning and review. Also, even in the practical of the earlier stages, we did not aim at graded exercises but included some useful articles to be made. This change made the objectives clear to the students and also produced articles that could be tested in use and perhaps save money for the school.

Thus, the syllabus was drawn up, based on the perceived needs of the rural community and services that could result from them. The actual development of exercises was similarly dictated by the local needs, as also what was possible.

Most of the exercises were therefore simple. What the students could do easily and was also needed by the community, stayed, while what was difficult and/or was not useful as service to the community, was dropped. Perhaps, there are still a few which do not fit in the above description. But this seems a good guideline for drafting the syllabus.

THE COURSE

The following is a description of the practical work done by the students

Engineering

- Measurement of Length, weight, force, pressure, rain; use of vernier scales.
- Making one of the following articles of Ferro cement construction: sheet, water tank or wash basin
- Making 3m RCC columns
- Welding, soldering practice; making articles like chains, hitch hooks, stools, chairs, chappal stand etc. fixing hangers; adhesive and veneer bonds.

Agriculture

- Growing one crop- tilling, sowing, irrigation, pest management, harvest, and sale
- This includes study of pest control equipment
- Growing one batch of poultry broilers
- Dairy and AI centre visit

Energy and Environment

- Preparing a map, using plane table survey (farm, percolation tank, dam site etc.)
- Hand pump repairs.
- Simple electrical circuits; connect one lamp and switch; staircase wiring with two-way switch, two- room house wiring
- Fuse wire; load protection, fuse selection, etc. connecting 3-phase motor; reverse direction of motor
- Diesel engine; starting and stopping; names and functions of parts; care
- Biogas plant, smokeless chullah, solar cooker/water Heater, use and care.

Home and Health

- Sewing and knitting
- This covers different kinds of hand stitches; simple repairs and alterations; buttons and hooks, Velcro etc. simple patterns and cutting
- Knitting needles, simple pattern

The following are at present done by some groups as part of the project. It is now proposed to put these in the practicals for all students test for water quality.

- MPN
- Measuring Haemoglobin in blood to detect anaemia.
- Making simple preserved food products; lemon squash, tomato sauce, pickles, jam/jellies etc.
- Agriculture product analysis; moisture content; fat and lactometer tests
- Soil analysis; sampling, pH and N, P, K.

Projects

Each student does four projects:

The projects are intended to:

i. Give the concepts of planning, report writing, drawing conclusions, referring to earlier work.

ii. More practice in using the acquired skills.

iii. Produce assets for the school or the community.

iv. Some idea about the cost, market price and potential demand.

The following are examples of projects to illustrate possibilities. These have already been carried out by the students.

Engineering

- Drinking water system including water tank, piping and waste water disposal for home or school.
- Setting up a WC block.
- Part construction of a house or sanitary system.
- Fabrications of simple workshop equipment such as bench or pipe vice, drill stand, power hacksaw.
- Fabrication of useful transport aids-wheel barrow, trolley, cycle trailer etc.
- Fabrication of simple furniture for home or school — racks, cots, chairs, school desks, writing table, blackboard and stand etc.
- Fabrication of simple implements such as harrow, weeding tools, seed drill etc.
- Services such as repairs, sharpening etc. up to a predefined value.

Agriculture

- Growing a complete grain or cash crop in 10 gunthas.
- Setting up drip irrigation for some five trees.
- Pest control service to five crops.
- Making silage.

- Making and selling plants, nursery for fruit trees or for social forestry.
- Raising and selling 25 broiler birds.
- Dairy-operation for 3 months; including milk tests, records, profit calculations.
- Attachments to a village AI center for 3 months.

Energy and Environment

- Wiring of households or school premises.
- Complete installation of a water pump, electric motor or diesel engine.
- Watershed survey and planning.
- Survey of a site for percolation tank.
- Location of sites for wells; VES tests.
- Pump Head survey and selection of a pump.
- Setting up or maintenance of Biogas plant or smokeless chullahs.
- Maintenance of hand pumps.
- Building of small bunds and water harvesting channels.
- Maintenance of diesel engine; including measuring efficiency.

Home and Health

- Making complete simple garment.
- Developing and testing simple menus for low cost, solar cooker use etc, time saving or better nutrition etc.
- Health survey of children.
- Survey of an anaemia patient in risk groups - small children, pregnant women etc.
- More diagnostic tests; blood sugar; blood grouping, jaundice test etc.
- Drinking water quality of village sources.
- Methods of purification of drinking water and their effectiveness by MPN test.
- Making and selling Milk products like khoa, pedhas, paneer etc.

- Making and selling food preserves.
- Soil analysis or moisture content of agricultural products as service.

Text Books

While the practical lessons did not raise any controversies, some of our textbook lessons did. They raised certain fundamental questions on the methods of teaching. It is therefore perhaps appropriate to raise them here.

In our textbooks, (as also practicals) we start with measurement.

In the lesson on measurement, we started with units and gave a table to illustrate the different things we measure and their units. The first item was weight, for which we gave kilogram and gram as the units. Some science teachers raised an objection, saying that weight is a force and the unit should be Newton and not gram or kilogram. I only remarked whether they would ask their grocer to sell them one Newton of Wheat! They were insistent that though we may use wrong terminology in everyday life, we should teach the correct concepts, particularly in a physics lesson. I would not want to create a schism between the classroom and everyday life. We certainly teach them the difference between weight and mass later, but we would not avoid the use of the word weight in the sense in which it is used in everyday life. They were not convinced even when we showed them a chemistry instruction book, asking for weighing out so many grams of a reagent!

Another controversy was our statement that every measurement is an approximation; no measurement is absolute. Also that even so-called subjective properties such as taste and colour can be measured to different levels of accuracies, and that such measurement is necessary. Thus, we wished to convey to the students that every measurement consists of two parts, choosing a unit and then a comparison of the item to be measured with the chosen unit. The teachers were of the conviction that measurement is absolute and any error is due to the observer. Also subjective things cannot be "measured."

Yet another controversy, probably with more justification, was our refusal to accept the usual distinction between distance and displacement; distance is taught as a scaler and displacement as a vector. We thought this was a wrong way of teaching when a distance between two cities becomes distance or displacement according to whether we wish to call it a scalar or a vector quantity. We had discarded convention, and said that a distance is always a vector. But we do not always need all the information; sometimes, it is enough to know its absolute value only. We explained that the reason why we needed to call distance a vector was that space was the only parameter that had three dimensions. So if we used only two of its dimensions, we needed to know which two, therefore we have to give the direction as well. Therefore, it becomes a vector. But when we use all three dimensions, as in volume, then there is no ambiguity as all dimensions of the space are used. Thus, length and areas are vector but volume is not.

There were several such points of dispute and therefore we never got the textbook agreed upon.

The Teaching Method -

No matter how it is organised, the teaching method is finally determined by who actually teaches. We had stressed practical work. But somehow our instructors always preferred to dictate notes and be in the classroom rather than have a practical demonstration. The former dropouts-turned-teachers always enjoyed being called "Sir" by the students. So a lot of our teachers still stuck to the dictation/rote-learning mode of education.

It was difficult for me to do away with their dictation, because it was necessary that the students have something in their notebooks. The students have neither the habit nor the ability to make their own notes after hearing a lecture. We tried to provide charts giving the main points of the practicals or lectures. We wanted the students to elaborate these points in their own words and make their own notes. But the charts remained charts, and both the students and the instructors seemed more at ease with dictation. We now intend to try the practicals handbook.

Another problem in teaching Rural Technology was the difficulty the students have even with simple arithmetic. A large proportion of the rural students, including many who had passed the12th std. and even several "graduates" cannot do simple proportions (much less inverse proportions). Many cannot even do multiplication or division by 10 or multiples of ten. Teaching the number system and how to do these operations with multiples of ten, was tried but forgotten soon thereafter. Only after repeated use are they able to understand this method.

One of the major problems was that the instructors, who were a product of the educational system we want to drastically change, could not be changed through just a one-year practical course. It is much easier to impart the technical training than to give a new outlook. What is hoped, and it is only a hope (there has been no study to check it), that the practical, real life work will bring them to use their natural logical method of thinking and that this will happen, with some persistent persuasion, not only in their technical work but also in their everyday life.

Brief evaluation

1. The programme was implemented in 5 schools for varying periods; one school from 1985, three schools from 1988 and in

one school the programme was run from Oct 1989 to Dec 1992 and terminated.

2. The programme has faced no major problem in terms of the subject matter to be taught. It is neither too heavy nor too difficult to understand.

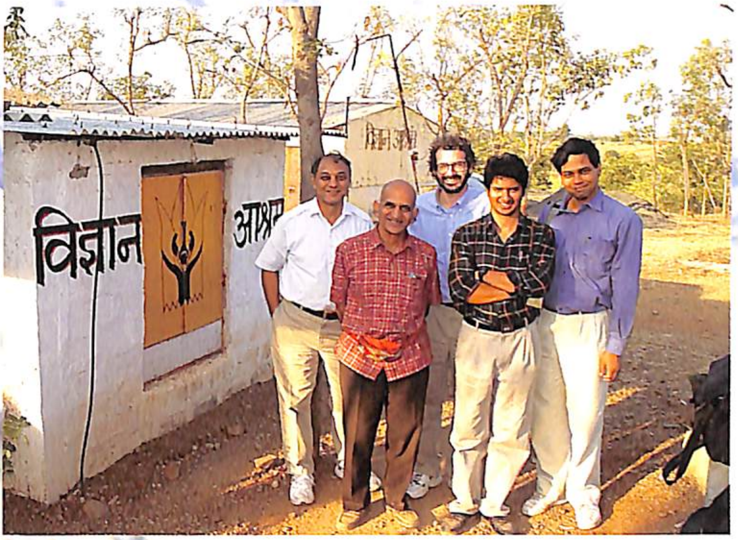
3. The cost is Rs. 287 per student per year. This was the budget cost and it has not exceeded till 1992. The capital cost per student intake is Rs. 667 as per budget, but an ABC analysis indicates that it could be halved to about Rs. 350 or less.
4. The three schools, which were a special project for replicability study, had a total expenditure of Rs. 7, 87,874 during the four-year period. During the same period they gave total community services of the value of Rs. 3, 45,539 or 44% of the total recurring expenditure.
5. Staff and students separately rendered services or sometimes both worked together. In each case it has certain advantages; but in every case the community has received the benefits and has paid for them.
6. It has helped the students in better performance all round, in spite of 20% time diverted to this course from the conventional academic course.
7. It has encouraged a section of the students to use the acquired knowledge outside the classroom in their everyday life.
8. It has given an opportunity to out-of-school youth to acquire some useful skill training from the school system.
9. It has influenced the community in general, in thinking about new ways of doing things and to that extent, reduced dependence on superstition.
10. It has delivered services, which were otherwise not viable commercially and helped to nurture demand for these.
11. The staff has a tendency to be complacent and even arrogant towards the community they serve, because of the technical

skills they have acquired. They need to have an incentive system and some community control.

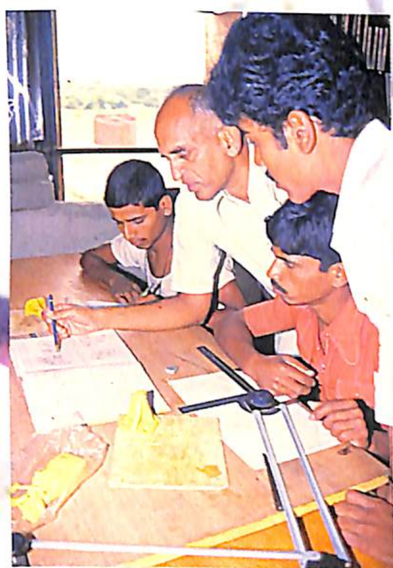
12. They need a resource group for discussing their technical problems and consultation in giving services; otherwise they stop at even minor hurdles.
13. There should be a good information system and communication channel by which two-way information between the resource group/supervision bodies and the school staff and management is facilitated and documented. A computerised system is recommended.
14. The Khamgaon school where the programme was run for a little over three years (the scheduled period for which grant was available) was a failure. The main reason was non co-operation by the school principal who created hurdles and lack of a resource group for guidance. However, they could still show that the students enjoy the training and that some services have a scope in any community.

Dr. S. S. Kalbag
1928 - 2003

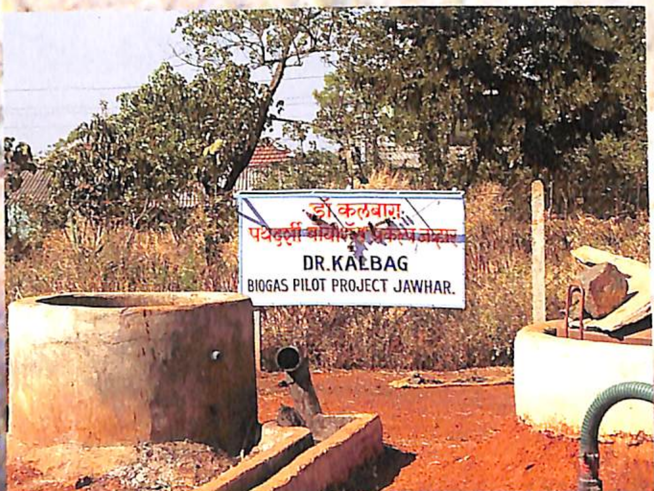
Meera (Amma) and Dr. Kalbag



Dr. Kalbag sir with
Bishnu Pradhan
Dr. Neil Greenfield,
(Director - CBA,
MIT, USA)
Anil Babhman
Dr. Debu Goswami
at Vigyan Ashram



Kalbag sir teaching and
working with students



Power generation using
non edible oil cake
biogas plant at
Pragati Pratishthan, Jawhar

In the presence of Dr. Anil Sadgopal Vigyan Ashram team decided its mission statement

Dr. Yogesh Kulkarni, Ex. Dir. Vigyan Aahram, receiving GKN award of £100000 at London, Sept. 2009

Vigyan Aahram hosted 'Fab5' international conference on digital fabrication.
Fab labbers around the world at Pable.

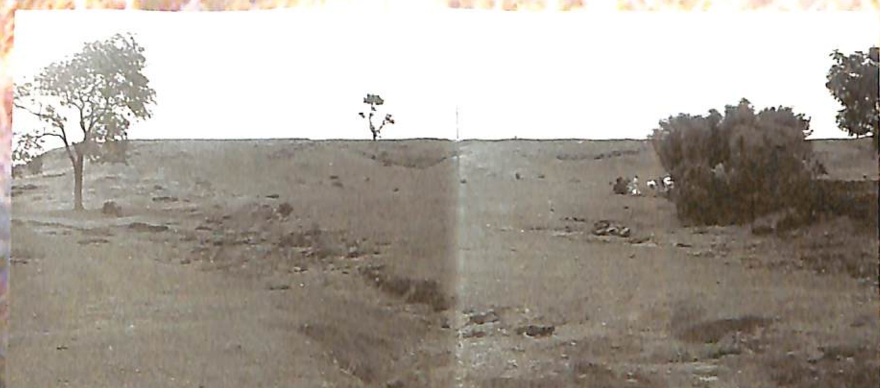
IBT Students doing plain table survey

Every year 30 th July
"Open house Exhibition"
is being organised to celebrate
the death anniversary of Kalbag sir.

School children from nearby
villages visiting 'open house
exhibition'

Vigyan Ashram students
displaying their products at
'open house exhibition'

Vigyan Ashram
hills
in Jan. 1983.



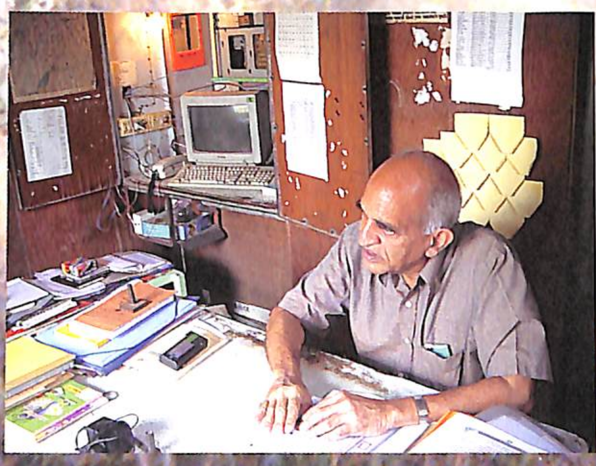
Wireless in local loop (WLL) center at Vigyan Ashram

IBT school under 'plan 100' project

Garbage trolly designed and made at Vigyan Ashram for Gram Panchayat.

Community service -
students doing threading of pipe

VA PAC commite member
Dr. Waghmare, Mr. Ashok Kalbag,
Mr. Anil Bahuman, Dr. Gowarikar,
Mr. Vijay Kumar,
Ms. Sunanda Mane and
Dr. Yogesh Kulkarni



Kalbag sir in his office

Pabal dome
constructed in
earthquake
rehabilitated village

Fablab at
Vigyan Ashram
established
in collobration with
MIT, USA

Kalbag sir showing 'Mech Bull - I'
to the Director - CBA, MIT, USA

PART III

The Future: How Do We Scale Up This Educational System ?

The Proposal

The Maharashtra State Council of Educational Research and Training put forward a proposal some time back, to extend this system to 30 schools in as many districts. The Ministry of Human Resource Development, New Delhi now has a scheme, which can fund such programmes in the States. The proposal is now being considered by the State Government. Meanwhile, preparations are going on to get ready for the programme.

It is time for a wider debate on the philosophy and contents of this Rural Technology system. Input from professional scientists and educationists could make valuable contributions.

The Need

Granting that such a system is to be implemented in a much larger number of schools, where are the teachers to come from? They will have to be trained. Who will train them and how? Which schools will be selected and on what basis?

The following is the scheme now under consideration.

1. The schools will be selected on the following criteria:

a) The school should be located in a village with a population of less than 10,000. Taluka and district headquarters should be avoided. The school will have less than 200 students preferably, in 9th and 10th standards.

b) The community must come forward to pay for the cost of the equipment, (approx. Rs. 40,000) and where this is done, the government will provide teachers.

c) The teachers will be paid a fixed salary for a part time job; the remaining time they will provide services to the community from the school facility and will get a share of the income earned from this. The services will be as described earlier.

Services Provided Through School:

Workshop Fabrication and Repairs — Blood and Urine Medical Tests
Electrical Wiring and Repairs —Agricultural Product tests
Water Prospecting, electrical method — Soil Analysis
Hand pump Repairs — Pest Management
Construction Work — Poultry and Dairy Products sale
IC Engines and Tyre service — Drinking water Tests and Treatment
Plumbing and Sanitation — Sewing and Knitting

Initially, some publicity will have to be given, perhaps through video and print material about the kind of services given by schools where such programmes are running. Such video cassettes are already available. This may help in persuading some communities to collect Rs. 40,000 for starting a school in their village, with the clear expectation that they will then get the above-mentioned services in their village at affordable costs.

d) Where the school is able to raise resources, the school will be selected, subject, of course, to the constraints on the total number of schools planned and their geographical distribution.

e) Community Polytechnics will be involved in this scheme as a resource group for the village school. The idea of community polytechnics it's role in the scheme is discussed in detail in the next Chapter.

We therefore need an information system that starts with the needs and facts of the rural scene, and poses technical questions that need to be solved.

COMMUNITY POLYTECHNICS AND INFORMATION REFERRAL SYSTEM

The Ministry of HRD started a scheme called "Community Polytechnics" in 1978 with the idea of utilizing the technical expertise, the equipment and student resources for rural development. They designated some selected polytechnics as "Community Polytechnics" and gave them funds for this work. In a review of the scheme in 1987, it was found that while most of them had established a base in the village society, their work had involved neither the staff, nor the students and certainly it had little to do with the normal educational programme of the polytechnic.

The review suggested a way of linking the technical education programme to the rural development.

1. First, the staff and students will select projects for the final year students, (as required by the syllabus) which relate to real life conditions and which are also good for practical experience for the students. Projects which are of relevance to the real life problems of the rural areas can be selected. These could relate to cost reduction or increase in productivity of existing operations or design of new processes for existing needs. This is thus normal development work and not "rural development"

in currently implied meaning. Examples of projects completed, in hand or in the wait list are shown elsewhere.

We therefore need an information system that starts with the needs and facts of the rural scene, and poses technical questions that need to be solved.

2. The second important activity is to develop training material, both text and teaching aids. We understand best when we try to simplify and teach someone else. The students should try to (a) identify what the applications of their learning are, in a different real life situation, (b) explain the concept and application method in a simple language without using technical jargon, (c) and demonstrate either the application or the principle, by doing. This will reinforce their own learning and at the same time also generate new methods of teaching for lower levels of the same subject.
3. The technical staff/students should also serve as an easily accessible, low cost, technical consultancy group for the rural area. This does happen already in some cases, but is to be formalised and encouraged. This will have a particularly significant role in the use and applications of computers and generally in the conversion of a felt need into a technical project.
4. With the above activities implemented, the staff of the Community Polytechnics set apart for the rural development work, will act as the transfer agents or facilitators for the link between the above three activities and the work in the rural areas, particularly the school instruction and services through the school. Their role will be in arranging the training of multi-skilled instructors for the school, overseeing the linkages created, acting as a channel of information and a resource group.

The Information and Referral System

There is another role for the Polytechnics, namely, carrying Information Technology to the rural area. This has also been recommended in the 1987 review of the Community Polytechnic Scheme and has been included in the Programme of Action of the Education Policy in 1992.

A computerised system is not effective unless it goes to the whole system. If a part is computerised, the manual part then becomes the bottleneck and the whole system is not fully utilised. But what will the role of computers be? Who will install them and at what cost? Who will do the maintenance and training functions? The Polytechnics can be trained for these functions. But how can the Information Technology fit into the rural area? Obviously, the information about the existing situation that we want to change has to be measured and sent. From the rural area we need trained people who can measure, record, do preliminary processing and then send it through the system.

We talk of the Information Technology revolution now in the offing, but are not clear exactly how we can exploit it for fighting our backward economy. The general trend is for its use in the further development of the already developed section of our society. There is nothing wrong with this; but a nation cannot progress fast if only 5% of its population can contribute to the core activity and the rest are only providing passive labour. We therefore need an information system that starts with the needs and facts of the rural scene, and poses technical questions that need to be solved. These technical problems will be sent through the technical wing of the school, upwards to the Polytechnic, Engineering colleges, or the IITs and National Laboratories. In this way, the problems are posed to that group where they match the talents of the technical group. Also, sometimes a recurring problem indicates a deeper malaise, and often such problems can be good material for fundamental research. This is how research into cholera or malaria started. The linkage between the research group and the field where it will be applied must be good for that research to be effective in application. The information system will be used for feedback on programme implementation, current economic indices, local surpluses and deficits and perceived needs and problems.

We need an information system that can list and document such problems that need technical solution and for which an economic value can be assigned. We also need agencies that are waiting to fund projects of this nature. With these, I do not see why the existing science and technology and education institutions will not be able to solve most of the problems and make the application of such development work almost automatic.

If the above proposed two-way linkage between the rural needs and the technical expertise for solving the country's problems is established, the population at large will reap the benefits of science and technology and will willingly supply more funds for research and development activity. They will then see modern technology in not only distant space applications but also in their immediate environment. This does not have to be hi-tech; in most cases it will be the imaginative application of what is already known and used elsewhere.

Such a system will improve our education by linking it to real life situations and it will produce development by using the education system as the channel for delivery of technology. What has been said for rural areas is equally valid for the whole country.

21 Aug 83
Palsal

My dear Mira,
This last week has been rather eventful — in a way. When I returned to Palsal on 18th the rivers were in spate and I travelled via Khed. August 8, 15 & 16 recorded a total of 49 & 79 mm. highest in the season, bringing the total to near 450 mm. The rain was well spread and absorbed in the ground with little of floods. The ground water has now risen very high all wells are risen and Palsal can stand a year of drought — without problem. Our own well, aided by the bund has water to within 3 feet from top — can you believe it? Our pump is installed, pipeline erected & we can pump water to the top - though not to the tank for another day. Cement sheets (our panels) are being fixed on the 1st house & regularly produced even if rather slowly. This week the walls of the 1st unit will be ready & I hope the roof will be on by about 10th Sept.

Palsal is a beautiful place now, all streams have running clear water — like Kodaikanal. The sound of water is music to my ears. Even our plot has a little nice stream of clean water. I don't know how long it will last.

On the "moral" level also, I have had some success. Both my young engineers wanted to go to Bombay. I felt they were not telling the truth. By my persuasive talks & moral pressure, one of them came out clean to say he was sorry he had told me lies, he was going for an interview in Bombay & now he has decided not to go. I knew they were not telling the truth

One cannot learn in the classroom unless and until, one has learnt the prerequisite 'concepts' by experience in the real life.

LEARNING WHILE DOING - THE NATURAL SYSTEM

There is a school in Pabal, our village, where a new course called Rural Technology is being offered to students from the 8th-10th std. This is a novel course in two respects, what it gets done through students, and also what it can do to the village.

This year a group of girls from the 10th std. built a 6 KVA-welding transformer. When it was completed, they invited the Headmaster and the girls did some welding job in his presence, using their own machine. The Headmaster narrated this proudly to other Headmasters of vocational schools visiting Pabal, especially to see this programme.

Earlier, another batch of girls did the blood grouping of about 60 students of the school. The boys built and erected double and single bars in the school grounds. Last year, two groups of boys built two WC blocks for the school, at a total cost of about Rs. 2,500 each. These included porcelain WC pans, cement brick walls, cement sheet roof, septic tank etc. The girls built a water tank and did the plumbing. If these projects surprise you, read what other kinds of jobs they have done earlier. A batch of girls, from an earlier year built a cement slide, and also fabricated a steel seesaw and merry-go-round for the children of the local Balwadi. The boys and girls together built a workshop shed of 900 sq.ft. for Rs. 27,000 in 1987. They have built wheelbarrows, classroom benches and a host of other things of use to the school or the community. The girls have done hemoglobin estimations on primary school children and advised their parents for diet correction, where necessary. They have examined village drinking water samples for microbiological quality and also tested various methods for purifying these water samples. They have held vaccination camps for poultry in different hamlets.

one cannot learn in the classroom unless and until, one has learnt the prerequisite 'concepts' by experience in the real life.

School students doing these? As part of their SSC syllabus? Incredible but TRUE. This is now possible for any school that opts for the Rural Technology for its SSC technical stream.

This is part of an innovative effort by Vigyan Ashram to bring modern science benefits to the rural areas, through Education. The motto is Rural Development through Education System.

Introduction:

We learn in two important ways: the natural way and the classroom way. The newborn child starts learning (from the moment of birth), to see, to recognise faces, to speak, to walk and so many other skills we take for granted. This is the natural method of learning, so easy that we do not even consider it as learning.

The child going to school gets classroom lessons and begins to learn reading, writing and arithmetic – then other subjects all the way to the university. This classroom method, whether given as formal or informal, is so widely accepted, that we consider it as the only possible method of learning. Let us compare the two methods.

Comparison of the two systems:

Natural System	Classroom System
Deals with a concrete situation.	Generally abstract, through words.
Application, relevance is clear.	Application is also abstract.
Feedback on learning progress:	
Instant	Slow, After the Test!
No pass or fail - just learns	Examination "Sword" over the head.
Can often give some benefit/income	Generally, with some cost incurred.
It is considered for only skills.	It is considered for all higher "learning".

The comparison raises doubts about the efficacy of the classroom method. It is widely accepted, but is it satisfactory?

After learning one language in the natural mode, during the first two years of life, we find it difficult to teach another in the next 10 years of schooling! After going through the present classroom system, the child lacks self-confidence, is generally lacking in any additional skills that can help it to stand on its own legs. Some are so weak, intellectually, that they lose out in the competition that is life and need all sorts of 'protection'.

On the other hand, going to school, does not end the natural learning mode. Outside the school, they learn to cycle, swim and so many other things. But in the classroom, it is only the classroom method.
Surprisingly, the natural method is also widespread, particularly among the people we consider, not educated! When one goes to a

garage / workshop, the mechanic there probably has not gone to school for learning his 'engineering' skills.

The house we live in has probably been built by masons, who did not have "vocational" classes. We find that all over in India, we probably get more services through people who learnt by working with another craftsman: they learnt while doing the job.

This natural system then, is capable of teaching, even those whom the classroom has rejected. It is teaching them to a level, where they are the backbone of our labour force. Does it have something that we can adopt in our formal classroom system in order to improve it? Is this natural system of learning capable of being 'grafted' on to our classroom system, to produce better results?

Interestingly, there is one profession where the elements of the natural system are still preserved. Medical education is never given, without a real life hospital attached to the college and the prospective doctors learn while working with a practicing doctor in a hospital. Can we consider making it obligatory for a productive workshop to be put alongside an engineering college? Why not have an auto-engineering course linked to a regular service and repair garage?

Going to the fundamentals, the Piaget Theory of learning suggests that one cannot learn in the classroom unless and until, one has learnt the prerequisite 'concepts' by experience in the real life, that is, the natural way. We suggest therefore a way of combining the two. Give the relevant experience on the basis of real life, through a practical exercise, that is, actually doing a job, even if empirically. Then raise the curiosity of the learner, through questions and explain the pertaining theory, if necessary in the classroom. This is our recommendation.

Objectives

Our objective in general school education is to let the child realise its full potential. With a good education, the child must feel confident to face the world, and must be even eager to do something on its own. Earning to make a living is incidental. The real life achievement is "our own contribution" for community progress. On these criteria, our education system has failed miserably. So we should talk about how to make general education meet these criteria. We are not talking of how to give 'vocational' education to some, so that they get some earning. We are talking of giving basic skills as an integral part of general education.

The major faults of the school systems are:

1. It is too abstract and dull for most of the learners, from the primary stage.

2. If they miss out on the early stages, it becomes even more difficult to catch up later and they are doomed to "fail'.
3. Even if they do succeed, the returns of this education are uncertain for the majority.

The correction we seek for the classroom system is through the following:

1. At every stage, the teaching must start with concrete action. 'practical" must come before the "theory".
2. Every skill must be learnt through its application, use it and then understand the why of it.
3. Skills must be internalised by constant application, inside and outside the classroom.
4. The system must provide for different pace of learning for different students. We should not force the pace, at least not in the primary stage of education.

5. While a "syllabus" is necessary for present day education system, it should allow for flexibility in detail. The student should have a choice in doing things that he wants, even if the skill to learn is fixed in the syllabus.

We should distinguish between information and knowledge. Knowledge comes only from information that has been **experienced.** So unless information is put to use, we do not get knowledge. Knowledge is a tool; it is software, a 'program' in the computer jargon. We should not rush through education, until we give the child the joy of learning a new skill. It must enjoy using the aquired skills wherever it wishes. This way it will internalise them and then it can go on to the next.

We should concentrate on giving the skills and leave the child to choose the material on which to use it. Thus, reading is a skill, writing is a skill. Mathematics is a skill in handling markers, e.g. how to use a railway timetable or a library catalogue. We need to have skills that can help us shape the world around us-the clay, the soil, the wood and in the modern world, steel, energy sources like the sun, fuel wood, electricity, diesel, kerosene and petrol. We need to have the skills that will make our living easier, that can help to concretise our ideas, our inventions.
In modern education, it is not enough to be able to think; we must have the capability to act and this, our general education does not even try to give.

How to do this kind of education?

1. The balance between the concrete and the abstract is maintained by giving a practical exercise for the student to do. These practical exercises will comprise of skills that are relevant in modern society. Thus, the learner sees the relevance. And he learns while trying to

make something useful for himself or society. Having understood what he is trying to master, some shoptalk tells him more about it - the theory part.

2. We also give an opportunity to practice these skills by giving services to the society. This serves a dual purpose. The learner can internalise the acquired skills and also get the satisfaction of doing a socially needed job. This increases his self-respect as also his self-confidence.

If we are going to do something ambitious, something very much different, we have to change many things, and the foremost among them, is our mindset. If we do this then the new system of education developed at Vigyan Ashram, which has been proven on an experimental basis in many schools, is capable of making social education effective. The decision is now for the society to take.

we need in our country today,
millions of little inventors
rather than a few great thinkers.

PROBLEM-SOLVING ORIENTATION IN EDUCATION

This paper puts forward the case for problem solving orientation in education, particularly school education. After describing what problem solving means, it discusses why problem- solving orientation is necessary. And then it suggests how this could be introduced in school education.

What is problem solving?

It is common in most schools to give "problems" in mathematics to students for drilling the skills. This is not the problem solving we have in mind. Nor does problem solving include the "brain teasers" or quizzes that are published in popular magazines, with the answers given overleaf.

All of us get involved in some activity. While we can go through most of it without consciously thinking of it, there are occasions when things go wrong and our thinking process is called into action. The housewife has to prepare tea for a visiting friend. She can go through the acts of boiling the water, taking out the tea leaves, laying the table etc. on "auto pilot", while she is busy chatting with her friend. When she goes to the tea packet and if she finds it empty, her mind is suddenly called into action and she has to think what she should do next. Should she make coffee instead or should she use the tea bags a salesman had left three days ago? This is a trivial example of problem solving. Even the laziest among us solves problems, often by bypassing them.

we need in our country today, millions of little inventors rather than a few great thinkers.

Every problem is a challenge we face. Most of them we solve easily. The more difficult ones, we tend to postpone or bypass. But rarely do we consciously face a problem as a challenge or an opportunity. If we do, and if we succeed in solving such a problem, we feel we have made a breakthrough and get a sense of achievement. This experience gets etched in our mind, perhaps forever. This is the kind of problem solving we want to introduce. In this, there is a consciousness of the nature of the problem and it evokes a feeling of challenge. When the problem is partially or completely solved, there is a sense of achievement (a "Eureka" feeling). After the problem is solved, the individual is distinctly wiser and more experienced than before.

At present, our education system ignores this kind of problem solving. It assumes that when the required background information is available, it will be applied and the problem will be solved. When faced with a problem, most of the students bring the activity to a halt and wait for further instructions, while some bypass the problem without solving it. This is often at the cost of quality. The few, who take up such problems and follow them through, have the stuff of which inventors are made. This is the orientation we want to give: everyone making little inventions or big inventions, as the problems turn up. The problems that great thinkers grapple with, lead to discoveries. The problems that everyday life throws up, lead to inventions. Without belittling the importance of great thinkers, what we need in our country today, are millions of little inventors rather than a few great thinkers.

Everyone, even the dullest, can indulge in problem solving and make little inventions. Many of them may not be even worthy of notice from others, but to the individual, they do immense good. Today, we need to train students to be such little inventors. Our progress will depend on how many of them we can turn out.

Why problem-solving orientation?

Problem solving turns information into knowledge. Information is stored in books, libraries and in our memory. When we put information to use, it gets converted into knowledge. Thus, knowledge is that information which has been stored in the memory after testing it in action.

When we are given a formula, say, $E = MC^2$, where E is energy. M is the mass of matter being converted into energy and c is the velocity of light; one cannot be expected to be able to use such an equation straightaway, even if one is good in arithmetic. One must be able to choose the appropriate units that are compatible with the formula. Only after one has used the formula a few times, does one feel sufficiently at home with it. The information about the formula becomes knowledge after its use. In problem solving, design, construction, assembly and other such activities are very effective in converting information into knowledge.

When we read instructions on the use of a product, e.g. an adhesive, we have information. When we have used it a few times, we have knowledge about the product, i.e. the adhesive and its use. When we use this adhesive as part of our problem solving, (say, to make a prototype), we get an insight into what the adhesive can do, and equally important, what it cannot. Both are important pieces of knowledge. Problem solving always produces knowledge that is much more useful and valuable than the information on which it is based. The difference is the expertise. Problem solving generates this know-how.

Many students come to a halt in their practical projects, because they do not know how to calculate a certain parameter. In real life situations, there are many things we cannot calculate and predict; yet there is an empirical method available. One must know when to use the empirical method and when to use calculations and design.

Calculations and design formulae are themselves based on empirical data as on the scientific knowledge. Often, empirical knowledge leads to new technology and scientific understanding follows later. Problem solving gives a proper balance between an empirical approach and a scientific approach.

Problem solving teaches us patience, judgment between alternatives, self-evaluation and all those qualities that are invaluable in real life. This is because when problem solving is made part of the curriculum; we are putting up a real life situation, chosen for its shorter duration.

By our definition, problem solving gives a sense of achievement (a "Eureka" feeling) when a job is successfully completed. This joy has its own effect on increasing motivation and should lead the students to take up more challenges. Thus, in a way, it induces the pursuit of excellence. Civilisation has been built on this - each one sharpening his own skills, putting in his best. Problem solving exercises provide an outlet for creativity and thus encourage it.

How to orient for problem solving

The weakness of 'exercises or 'problems' given in the classroom at present is that they have an answer which the teacher knows and anything else is considered wrong. Also it does not involve physical activity and gives little scope for creativity.

On the other hand, our problem solving involves physical activities, secondly, there are many possible approaches and no one knows the final answer. This is more like a real life situation and gives the advantages we discussed earlier. We can consider these as open-ended exercises.

Example: We need to cut a large number of triangular panels with the three sides of the triangle being 1.2m., 1.23m. and 1.23m. The steel sheets, from which these panels are proposed to be cut, come in widths of 3 ft. or 4 ft. and lengths of 6 ft. or 8 ft. What size sheets should we buy and how should we cut the triangles? This is a real life problem. If we adapt it for the classroom, we will be defining everything and therefore, reduce the number of possible approaches and consequently, opportunities for creativity. It will then be only an exercise in arithmetic. When a problem like this is posed, one could come back with a variety of answers, such as finding a good value for the scrap produced or finding a source that gives a more suitable size of sheet, thus enabling a least-cost solution to the problem. Thus, in problem solving, we remove boundaries, not only of the approaches but also the input data. The information given is considered only a guideline and neither complete nor sacrosanct. The whole point is to reach the target, in this case, the reduced cost.

Another approach for generating exercises for problem solving orientation is to try and find new applications for an existing product or technique. E.g. we know how to make square nets. What are all the applications where this skill may be put to use? Some of the answers could be; volleyball nets, baskets, hammocks, sheep enclosures etc. There could be many more answers depending on the experience and creativity of the students.

It is true that such exercises are likely to involve higher costs as they include materials etc. But they can also produce physical assets and could be used to offset part of the cost. The cost of such exercises can be reduced by making models in place of the prototype objects. This however reduces the realism but does not limit alternate approaches and therefore creativity.

Physical activity, however, has a stimulating effect on generating new ideas. Once the activity starts, many new ideas for problem solving exercises will suggest themselves.

To facilitate selection of such exercises for this programme, all programmes selected and the different solutions tried, should be recorded along with their shortcomings and strengths. Such recording not only consolidates the knowledge but also brings out the scope for new improvements in the problems to be given.
Problem solving orientation is relevant to all students, but is most essential (and at present, conspicuous by its absence) in technical education. It may be worthwhile to make a beginning in technical school education, in order to give a problem solving orientation to education. Other schools could give a problem-solving slant in their work experience and social service classes.

Some suggested projects for schools

1. To make a "football" that forms as near a sphere as possible.
2. To make a rope ladder for descending into a well. (Light, compact and safe).
3. Make a wheel - hub + rim from straight components, bent into shape. (accuracy, cost, strength)

4. Make a folding 'knife' using spent shaving blades. (Safety, elegance).
5. Make a folding easy chair or scale model. (weight, cost)
6. A "post office" balance for weighing letters up to 100g. (cost, ease)
7. Make a device for weighing a cow. (ease of operation, cost)

Such examples could be multiplied. Initially, the teachers and students will find the problems very difficult. But this is no cause for despair; it is a part of education. They should start, notwithstanding a high rate of "failures". These are not failures. They are necessary learning stages. Even while they progress, the students could think of new projects. These projects could be taken group wise or individually depending on the ease of getting materials, the cost etc. The time allowed may also be adjusted but should not be too long; a month may be a good interval to start with. If it is too long, the students do not give serious attention until the time limit comes close.

We expect that once started, problem-solving exercises will be fun and enjoyed by all.

In India, we probably get more services through people who learnt by working with another craftsman.

SERVICE-PRODUCTION CENTRE RELEVANCE IN EDUCATION

Introduction:
It is almost axiomatic to say that education in real life situation is most effective. This is the basis of the old system of vocational education where an apprentice worked with a craftsman to learn a trade.

As the complexities of the subject increased, engineering education tried, first "practical" then industrial /factory training and post education apprenticeship. While all these have helped to different extents, none of them have been entirely satisfactory

Objective: Education or Profits?
Good education is the primary objective. But if the school unit is not economically viable, can it give good education? If our objective is to promote entrepreneurship then the answer to this question is "No!" A school that cannot run its workshop profitably, cannot create confidence among the students that they can run a profitable enterprise,

The objective of making profits and giving good education are congruent. In fact, in vocational education, good education means teaching how to make profits from the vocation. Having said this, we must accept that there are constraints when educational institution operates as a commercial unit. We must therefore evolve the concept of "Semi commercial" operation.

A school that cannot run its workshop profitably cannot create confidence among the students.

The Constraints:

1. The business environment is lacking. The objective of the real situation is, in fact, to create the business environment.
2. The location is chosen for education not profitability: This is a valid reason. We should therefore consider the profitability as an index and not the volume of profits.
3. Work culture: An educational institution works for much shorter periods than an industrial concern. This should change. A vocational institute should work like an industry. This is the leaning of real life situation.
4. Overheads of education cannot be borne by the school production centre. The salary of teachers should not be charged and the depreciation of equipment may be charged only in the proportion that it is used. This is the concept of semi commercial operation.
5. Management system will not be as well honed as when production becomes the main activity, As against this, the educational institution has greater opportunity to experiment and innovate and not charge it to costs. Only when the technique becomes "proven" it can be included in the commercial operation.

Semi commercial Operation:

The concept of semi commercial operation has been proposed to mitigate the constraints of an educational institution in conducting a commercial operation.

The costs may be calculated on the following basis:
All direct costs of materials should be charged. Direct labour should be charged on notional basis; the time cost may be decided on the basis of local rates. Time used figures from optimum, to be achieved after practice.

Depreciation should be charged where the equipment is specifically for that purpose. Where the equipment is used for production for a short period only, proportionate depreciation may be charged if the usage is 50% or more.

In other cases, calculate the depreciation in a project proposal and charge the same rate per item.

Overheads; where overheads cannot be easily determined, use a figure of 10% on materials consumed.

We consider that after the costs as calculated above are recovered, one may add a margin of about 15% if there is a profit distribution scheme. We do not charge the margin on items of an experimental nature.

Our Experience
Over the last 10 years or more, we are convinced that a semi commercial operation is feasible. It brings realism to the work; staff remains alert and up to date and it constantly brings new opportunities to light. Most importantly, it encourages entrepreneurship. Many of our staff members have left to start their own enterprises, because their stay with us has given them the confidence. We have found that the position on our staff has become a route to self-employment. Many of the workshops in this region have been started by our ex-students.
Two of the staff members from the other schools where this program

was introduced, have also started their own enterprises and all these are prospering.

While the above situation is very encouraging, the disquieting feature is that all the enterprise is restricted to fabrication workshops. The other areas are not showing the same entrepreneurial success. Refer to the following notes.

Our Poultry Broiler operation is perhaps the best example of a successful semi-commercial operation. For almost 9 years now we have been operating a broiler farm, where the students invest and after completion of the course, get a share of the profits, in proportion to their investment. We have been distributing profits regularly to the students passing out. Many of them start their own poultry and at least two of them are successful poultry farmers. But unlike the workshop, the poultry has not been popular with the other schools, though they have shown they can operate profitably. The need for day and night presence and the kind of work does not make poultry very attractive. But among our students, more poultries have been started (by our ex-students) than workshops.

Agriculture should have been the simplest to operate as a semi-commercial operation, but there is very little interest and a lot of negligence. This makes it difficult to operate successfully as a commercial operation.

But some areas of this, particularly the fodder crops, have been consistently making good profits.

Dairy is also an operation that can be run as a semi-commercial operation with a steady turnover. Like agriculture, it is not glamorous and does not attract students. The AI service for goats is another regular though low-volume semi commercial operation.

I would now like to focus on some novel products and services. Water prospecting by the Vertical Electrical Sounding method has been one of the most popular and unique services, of a strategic value to the rural area. Added to this, we have been making and selling the electronic instrument for this also on a low profit basis. The total value of the tests done till now is in the order of 17 lakh rupees (1700 tests that cost commercially about Rs. 1000 per test now.) Two of our staff members set up their own enterprise, in the neighborhood.

The Rural Lab, giving medical diagnostic service has been operating on no-profit no- loss basis for about 6-7 years and has a net collection of about Rs. 390 p.m. This is not a large sum but the service is most appreciated and very strategic. This is a good example of a semi-commercial service that is very important but not very good as income generating. It has a regular stream of girls coming for training.

There is scope for novel products of rural significance. I can give example of electronic products, (beside the ERM) and also engineering designs. The geodesic dome was a good operation until we set up one of the boys to do it as a commercial operation, which it is to this day. We now have the MechBull, which is likely to repeat the story. In the construction, there is consistent demand for boys to build geodesic domes, but we are not doing it on our own. We pass the orders on to our ex-students who have become contractors. As the service requires staying outside for extended periods, we find it difficult to organise. But it has tremendous potential, perhaps in tens of lakhs per year

The Magnitude of the Community Services:

We shall now consider the magnitude of the services provided from the schools. Vigyan Ashram is an educational and a development

unit combined. There has to be a difference between an ordinary school and Vigyan Ashram. We shall therefore first look at the quantum of services given by the three schools at Loni, Dhamari and Mukhai. These technical sections were run by instructors trained at Vigyan Ashram, but were operating on their own, with only one monthly coordination meetings.
The following table shows the rupee value of services given by the three schools, quarter-wise from Jan. 1989

Table IV
Value in Rs.: Community Services.

Quarter/school	Loni	Dhamari	Mukhai
1	476	16611	692
2	372	840	156
3	1766	5678	72
4	1214	1909	6540
5	9352	13736	13204
6	14636	5438	52362
7	23594	3771	3613
8	16503	5612	3616
9	3738	1863	8366
10	6786	12995	19410
11	12802	8737	1619
12	3614	9651	6109
13	12093	3497	11412
14	3365	10991	2662
Total Rs.	1,10,311	86,329	1,48,899

The above table shows that the schools have given substantial services to the community for which the community has paid. Such amounts have been accounted for by the schools in separate bank accounts.

A glance at the figures, quarter wise, shows that the services, by value have varied a lot from quarter to quarter and school to school. This is because, when prodded, the services increased; and otherwise there was a tendency to take it easy. This shows the potential that the school technical group has and also the need for an incentive system and community control on the services, to do the prodding.

Another way of looking at these is to consider the services as a % of the Grants received. The non-grant expenditure is what is paid for by the community. We have been able to reach a level where roughly 1/4 to 1/2 of our total expenditure comes from locally generated funds, through community services. In other words, we are spending that much more than our funds provide for.

The figures for some years are given below,

Table III: Expenditure from Grants and Non Grant sources.

Institution	Period	Grant (in Rs.)	Non Grant
Vigyan Ashram	Jan 1987-Nov89	10,43,785	7,09,999
Vigyan Ashram	Oct1991-Mar 93	9,40,900	3,85,403
Loni School	1988-91	2,56,000	77,961
Dhamari School	1988-91	1,56,000	51,782
Mukhai School	1988-91	1,56,006l,	16,309

Vigyan Ashram's the non grant expenditure per year has remained around Rs. 2.5 lakhs, but the grant expenditure has increased substantially for new projects.

Nature of Services:

We have already seen the different types of services provided by Vigyan Ashram. In the schools, however, the services were predominantly workshop services. Electrical services, water prospecting and agriculture were rather low. This was more due to the apathy of the instructors. Under pressure, they have shown that they can rear poultry and run poultry courses. This adds substantially to the monthly service figure. For example 50 birds per month add more than Rs. 1500 to the service quota, but it involves attention outside the working hours, and so poultry was never popular among the instructors. However, boys from the village would come to us for poultry training.

Over the years, the quantum of services from Vigyan Ashram has remained fairly constant, but the nature has changed. The following figures illustrate this.

Year (Period)	**Amount in Rs. of services.**
1992	2,76,702
1993	2,67,637
1994 Jan-July, 7 months	2,05,989

Subject-wise breakup is as follows:

Dairy:	21,381	Fees: 5,512
Poultry eggs:	2,500	Interest 502
Broilers:	18,721	ERM instrument 1,348
Goats:	600	Workshop 6,427
Farm:	17,972	Water Resource 1,000
Agri. Products	4,784	Rural Lab 1,987
Miscellaneous:	4,005	MechBull 14,107
Energy:	4,595	Publications 3,555
Electronics:	240	
Rural Business Centre	25,000	
Total for April -July 4 months Rs. 134,510		

Lessons for the Future:

1. A service-production-training centre is a feasible programme for the rural area, including the smaller villages of less than 10,000 populations.
2. We can expect these training centres to complement the vocational education and facilitate the economic development of the region.
3. The facility could be attractive enough for the community to induce them to invest in the infrastructure for the centre.
4. The success of such a centre will depend on the "work culture" of the institution. If they want to work as a commercial unit, they must work like one. The 10.30 am to 5pm, 200 days in year system will have to go.
5. The staff should have an incentive system by which they get a core salary and the balance is linked to their productivity.
6. It is to be expected, that if the centre is successful, many of the staff would leave to start their own enterprises and new staff will have to be trained. This should be an on-going process.
7. This could be a selection process for attracting towards the vocational school, candidates with an entrepreneurial spirit and ambitions. This would be good for the education.
8. Agriculture and animal husbandry are well situated for production with a view to supplementing the income of the institution or reducing the dependence on government support. However, suitable top-level management will be necessary.
9. Engineering subjects are suited for the service industry and may not contribute much to resource generation. However, they will nurture demand for engineering products and help in creating new employment opportunities.
10. As a policy such Service-Production Centres should not compete with small engineering industry in the rural area but act as pathfinders.
11. A successful Production Centre will be an ideal method for demonstrating the need for change in our work culture and related values.

The computer lesson brings the best of teachers to every student.

INFORMATION TECHNOLOGY : A BREAKTHROUGH IN EDUCATION

If India is to meet the challenges of the new millennium, we shall have to overhaul our education system, starting with vocational education and also covering school education from primary to high school. We have to increase several folds, the effectiveness in imparting skills, as also the size of the student population covered in a given time frame. We shall also have to change our work culture. To do this, we have no choice but to turn to the new Information Technology (IT). The main concerns to tackle will be: Quality, Finance and Coverage.

We shall first see in what form the IT can help us in our task. We shall also see what else will be required to make our vocational education effective. The IT will be used in two ways: a) Speed up communication, b) give training.

Speed up communication

It stands to reason that, if we have to have interaction between different schools on the one hand and the supporting groups (resource groups, administrative group, etc.) on the other, we must have fast and clear communication. The present postal system (snail-mail, as it is called, when e-mail becomes common) is too slow

The computer lesson brings the best of teachers to every student

and expensive. Whereas, the postal service costs Rs.3 per packet and takes about 5-10 days and has no acknowledgment, the e-mail costs only one local call (Rs. 1.25) and takes less than 2 minutes to reach anywhere in the world. If not delivered, intimation comes within 20 minutes. Very soon, this will be accompanied by Internet Telephony. For such a vast improvement in service, the cost of a telephone and a computer for the school is the price we shall have to pay. More on this later.

The e-mail and the Internet will be used not only to replace postal mail, but also for on-line accounts checking, feedback, and approval of funds etc. Obviously, hardware alone cannot improve matters, unless the people in the school and the government bodies change their methods too. The Internet will also be used for group interactions between schools, not for occasional conferences, but almost continuous audio-visual exchanges and chats.

Training/Lessons

If the communication use of IT will expedite interaction several fold and at a lower cost, the use of the multi-media features of a computer, coupled with Internet or Compact Discs (CDs) can expedite training at a lower cost and with better quality and will be faster in replication.

The multi-media for the first time makes possible a new pedagogy to be used for classroom training. The ideal training sessions have a small student to teacher ratio, personal attention to every student's progress, and they allow a student to learn at his own pace. The computer CD lessons make economically feasible a ratio of between one-three students to one tutor. Because of the multimedia feature, the computer lessons use audio and video with student interaction for tuition. The computer is the tutor and the human is a facilitator. Besides, it can keep a record of his rate of progress and final status and can make examinations superfluous. In the privacy of the computer tuition, the students are relaxed and enjoy attempting quizzes. The concentration of the students on the lesson is markedly greater.

The computer lesson brings the best of teachers to every student and makes an optimum combination of text, sound and visuals including sketches, photographs and videos and animations. What is more, they take a shorter time than a classroom lecture, without audio/video.

Let us now answer most of the common doubts.

Can we afford computers?

The cost of a student hour on a multimedia computer (5-year amortisation on RS. 25,000) is less than Re. 1 per day, with less than 2 children learning at one time. The Primary School teacher with Rs 50,000 per year, costs more than a Rs. 2 per student hour, assuming 200 work days, 3 class hours per day (5 periods) and 40 students per class.

Who will maintain the computers in the rural schools?

The computer hardware is simpler to maintain than a diesel engine. We already have many of our rural youth trained to even assemble computers. Last May, we had a 3-week course when 15 representatives of rural schools learnt how to use the computer and assembled their own computers, took them home and set them up. Many of them are using computers to give us a monthly feedback; (by post because the telephone lines are not connected yet). We are also producing CD lessons on how to assemble multi-media computers, partition and format hard discs, load the software, do fault finding, etc. all through CDs. The lessons will be in 3 languages, Marathi, Hindi, and English.

CD lessons bridge the language gaps

Not only are the lessons now available in different languages but also the student can, at his choice, go from one language to another at the flick of a button. The rich and the poor, the rural and the urban, the common and the elite will have the same lessons, a kind of equality that we cannot imagine with the present teaching system.

The student can take his lesson at his own convenience, from morning 6 am to 10 pm, as he likes. To start with, we feel, one hour per week for the students of the 9th and 10th standards will be enough to prove the benefits of the system. The results of the examinations as also the self-confidence of the students will be the criterion.

The CD lessons are replicable and fast

Once the effectiveness of a lesson is proven in actual use in some schools, it is easy to replicate it in thousands of schools. And coupled to the telephone through modem and Internet, any doubts could be solved expeditiously.

They remove the gap between the formal and non-formal

The use of CD lessons, not in a classroom but in small groups at prescheduled times, removes any distinction between formal and non-formal. Thus, even youth working during the daytime, could take computer lessons to understand the theory and take the final exam if desired.

"How to do" on a CD

The vocational and practical classes of science subjects have a special advantage in using CDs for pre-practical instructions. We have a CD lesson on electrical wiring, where the student logs on to the lesson and then drags lamp holders and switches to arrange them on the screen, then chooses tools, the wire guage and colour and then does all the wiring from terminal to terminal, using the computer mouse. After completing the wiring, he fits in lamps of any desired wattage. After switching on, the lamps will light up as expected by the circuit used by him. What is more, he can pick up a voltmeter and/or an ammeter and connect it at any point in the circuit, any number of them at the same time and measure the voltage and /or current. He can use this for studying Ohms law, calculating voltages, or currents in series and parallel, play with resistances in series and parallel and see how they affect the current or wattage. And all this is done on the computer screen, with no risk of damage or electric shocks or short circuits. We also have a program where one can prepare a solution of a given % strength. We plan to extend this to standard solutions of desired normality and do titration in the computer "chemical" laboratory. These are not to substitute real shop floor experience, but to prepare for it better.

Teaching complex concepts is easy on a CD

Students find it difficult to understand abstract ideas. Computers make it easy by using animation. For example, students, who are learning blood group determination, cannot visualize how the "foreign cells" are recognised by the blood and which groups are (and why?) Universal Acceptors and Universal Donors. Why are the groups A, B, and AB or O? Our animated computer lesson show the template concept and how the white blood cells recognise the 'foreign' cells and ask for antibodies to be generated. With frequent quizzes before even the lesson is over, the students are able to predict in each quiz whether the blood cell will be accepted or rejected.

Finally, the lesson shows by visuals how the blood sample is taken and reagents are added and how the slide looks where there is coagulation and when there is not. To cap it, the lesson ends with a video showing the whole sequence in real life, including the coagulation of the blood drop with Anti-A reagent in close up view. Such a lesson convinces anyone about the value of these computer lessons.

Let us build the software

We are already in the computer lessons making business. We have 2 CDs under test in 15 schools and two more under preparation. Each CD has a number of lessons. The interesting point about making CD lessons is that, where no concept teaching is involved, even our SSC failed students of Rural Technology have made lessons. Such, for example, are lessons describing preparation of food products etc. Trying to make the lessons (in Power Point) is, in itself, very educative. We have therefore, invited the students of our network schools also to make lessons, which we can show on the Internet. But where the teaching of concepts is involved, a creative effort is needed. People who understand the subject and also the computer programmes can optimally use the potential of this new technique.

The new pedagogy in computer lessons

Many of the computer lessons I have seen in USA, UK and India are nothing but normal text lessons put on the computer screen with some colour, pictures, and sound, (music or reading the text). This is followed by the usual questions. This is not our idea of a computer lesson. We have to make use of the computer potential, to implement those ideas in education, which were not practical till now.

1. Learners should construct their own knowledge. Given the proper environment, the learner must exert his observation and thinking skills and build up his knowledge about the subject. For example, in the computer assembly lessons, we present

the learner with many parts and ask him to 'guess' which one is a 'floppy drive' for example. He has to learn to observe and remember the distinctive features of the item and identify it in various configurations. This challenging situation, not only holds the learners' attention, but also makes it more satisfying for him. In our Basic Electrical Lab lesson, the child can play with the fittings and find out the rules of wiring by himself; connecting in all different ways and finding when the lamp lights. This is constructing own knowledge; "Learning through Discovery".

2. Learners should know not only what is right, but also what is wrong. When presenting choices to the learner, we ask him not only to identify the right choice among many, but also sometimes the wrong one among many correct choices. This reinforces the concepts from the negative side as also the positive side.
3. When the student makes a wrong choice, we do not say "wrong". But we say try again. Thus, we help to reinforce the student's self-confidence.
4. We present a standard route for the lesson. If the student is very bright, he can skip and go faster. If he is a slow learner, we can give him a still more elaborately explained route. So the learner can chose the route matching his abilities.
5. The learning process is a continuous series of quizzes (choices to be made) by the learner, with some explanation screens in between. The session therefore, provides continuous opportunity for the computer to store the "learning curve" of the individual student, session by session. The teacher can later open the student's file in the computer and see how the student is progressing. There is no need for a separate examination, unless one wants it for other reasons.

6. We can combine games with the learning process. We can even give rewards for every success. The potential is unlimited. We have not explored this area fully yet.

The Costs

I have already mentioned that computers are cheaper than a primary school teacher. I have also indicated that IT will not only make communication much faster but also cheaper through use of Internet.

Our computer lessons on CDs can be available for as low as Rs.500 to 750 each. Considering that this will have 5-10 lessons of moderate complexity, this is much less than the training costs of trainers. Thus, the IT will not only boost our education progress, but also save money and time. What is holding us back is only the fear of the new. But interestingly, children are not only more attracted but also pick up faster.

Conclusion

1. We have very little time to catch up with the rest of the world. If we miss the bus we shall forever remain a backward country. If we want to catch up, we need to increase our tempo of progress and that means Education.
2. We shall have to adopt the IT in two main directions:
   a. Connect all schools with Internet for faster communication and interaction.
   b. Use multi-media computers and produce computer-based lessons. These lessons will not be used in the normal classroom, but students will book their own timings on the computer for taking their session.
3. We shall have to concentrate on making lessons that fully exploit the potential of the multi-media computers.

4. Wide scale adoption of IT by education system will give a boost to our IT industry and could make things much cheaper.
5. We cannot afford not to use IT in our schools starting immediately. Tomorrow may be too late.

"Under Basic Education of my conception,
children will learn while playing."
–Harijan Sevak
17.3.1946
Mahatma Gandhi

WORK EDUCATION IN SCHOOLS

FROM CONCEPT TO IMPLEMENTATION WITH A SPECIFIC REFERENCE TO RURAL VOCATIONALISATION

Abstract

The concept of education through work is deeply ingrained in the Indian Philosophy and Gandhiji's vision of education. Work has been introduced as a component of education through different schemes - Work Experience, SUPW, earn while you learn and so on. Skills are a desirable part of education. Also the activity of work needs to be done in a value-based method since values are essential for the survival of the human race. But values cannot be taught by preaching. The work environment needs to be conducive for the formation of values. The teacher has a key role to play in activity-centred education. The implementation of activity-centred education has not been upto the mark so far. We should therefore learn from the past experiences and try to give the scheme a second chance. Use of information technology can go a long way in reducing the cost and improving the chances of success. The present paper discusses the thinking process and what constitutes learning, the role of work activity in education, the role of teachers in the Basic Education System and finally some implementation strategies.

The Vision

Gandhiji's vision of education:

'(not only) ....a fine healthy body but also a sound, vigorous intellect that is not merely academic but is firmly rooted in and is tested from day to day experience.'- Harijan, 8 May 1937

"Under Basic Education of my conception, children will learn while playing." –Harijan Sevak 17.3.1946 (Hindi)

"An intelligent use of the bodily organs in a child provides the best and the quickest way of developing his intellect." Harijan, 8 May 1937, p 104.

"All education to be true must be self-supporting, that is to say, in the end it will pay its expenses, excepting the capital which will remain intact." - Harijan, 2.11.1947

"Under Basic Education of my conception, children will learn while playing." –Harijan Sevak 17.3.1946 Mahatma Gandhi

Introduction

For more than a century now, many commissions and committees have recommended work as a component of education at the school level. We have accepted these recommendations and made efforts to implement them.

Many educationists like Gijubhai Badheka have preached activity as the basis of education. We have incorporated it at the Balwadi level. But at the Primary level, we seem not to implement it as a core part of education. Work components were introduced under different schemes: work experience, socially useful productive work, earn while you learn and so on.

But we have not succeeded in integrating education with work/activity. Scientifically planned studies to pinpoint the failures and rectify them are not easily available.

But one feature stands out. Most of the programmes for implementation have put as their objectives, 'dignity of labour, life related skills, preparation for life, self-reliance and such other goals'.

The idea of work being an integral part of education or in fact its base has not been incorporated as the primary objective, not even as one of the objectives. But the vision of Mahatma Gandhi clearly had this in mind as shown by some of the quotations above.

It is not surprising therefore, that the role of work in the implementation of the programmes was entirely different from what it should have been. The reduced importance given to this in relation to the academic studies led to its failure. There were supplementary causes also, as will be pointed out later, but they also arose from the wrong understanding of the role of activity (work).

In this paper, we shall look closely at the thinking process and what constitutes learning and also see the role of work activity in education. We shall also consider the non-acceptance of the Basic Education System (as propounded by Gandhiji) by the general public and see what lessons it has for us.

Nature of Learning

All our information reaches us through our five senses, viz. sight, hearing, touch, taste and smell. This information travelling as electrochemical signals, produces synapses or linkages between the neurons. Each neuron can have 1000-10,000 such synapses and there are about 10^{10} (10 billion) neurons. So the number of items of information can be 10^{14}.

Whatever is the source of information, signals coming from the senses produce patterns/microcircuits in the brain. This is somewhat like rain drops falling on sand. Next time a similar stimulus comes through, the old pattern is recalled. With some repetition, the pattern gets 'fixed' and the stimuli get responses that we call 'learning'. Thus learning is caused by the outside signals coming through the senses.

Mind is a self-organizing system. It can combine patterns and make new combinations. This is how past experience is used repeatedly.

Nature of Thought

In thought, we reproduce an activity in our mind. The old pattern is recalled and we 'feel' the old activity in our mind. Human society has evolved over a few million years. We have replaced groups of patterns by symbols that we call words. This is the need for language, which thus further speeds up thoughts. Thus, when we say 'tree', the mental patterns, relating to the tree are recalled. The thinking process is thus recreating in the mind the activity patterns, without actually going through the activity. We think in languages. This produces savings in time and effort and has made for faster progress. But we cannot forget that new patterns or new combinations must be produced by activity, before they can be recreated in the mind. In other words, we cannot think of something of which we have no patterns, because we have never done it. Activity /work is thus the base on which all thinking and learning is set up.

Let us consider some examples:

Example: 1

Case 1: A child has not seen a chair. The teacher describes a chair in the class. The only pattern the child can get is of the sound produced by the teacher. It can reproduce that perhaps; this is like rote learning. It has no value as far as the chair is concerned.

Case 2: The child has seen a chair and has a visual imprint of the chair in its mind. When the teacher says 'chair' this mental picture is recalled.

Case 3: The child has used a chair, perhaps has built one or worked with it in some way. The word "chair" brings back all these experiences and the child can use the new information from the teacher usefully.

Thus, the same teaching by the teacher is more useful if the child has a variety of patterns related to the topic.

Example: 2

A child of say 1-2 years is playing with water on the roadside. He is completely absorbed by its 'study' (learning while playing). He tries to catch the water, squeezes it between his fingers, lifts it on its palms, feels the cold when the water has flown away and the wet arm is exposed to the wind. He sees how the water runs away in different directions when the hand is turned differently. Children play like this again and again until the novelty wears off and the experience is fully internalized. The child has now 'learnt' the properties of water, how it is different from a solid. Later, he will see some other liquids, maybe milk, and learn that milk also behaves like water. So gradually he gets the concept of a 'liquid'.

He has thus learnt the properties of liquids and knows many liquids, but he does not have the words to describe the experience. But he has constructed his own knowledge, based on his activities.

Years later, a teacher teaches what liquids are. The child recalls his earlier learning. What the teacher says makes sense to the child. He will absorb it.

The teacher thinks he has taught the properties of a liquid to the child. But what he taught was really only the articulation of experience the child already had. If he describes what happens when milk is spilt and you wash it with water, maybe the child has learnt something new. But again it depends on his past experiences of activity.

Observation, logic and creativity

We all agree that these skills are a desirable part of education. But let us see how these are also related to activity.

A scientist goes into the laboratory near a table and observes. He comes out. A child is seeing this. What it observes is that he bent over something, peeped in and then came out. The scientist searches for his glasses. The child says he has left them on the table in the room.

Who has greater observation? The scientist who took the reading on the instrument or the child who saw the activity of the scientist and noticed that the glasses were left on the table. Both have observation. But it was focused differently. Depending on their past experiences, both the scientist and the child focused their mind on different areas of the same room. Thus, observation is just an ability to focus our mind on some part of the visual signals coming in, based on our past experiences.

Logic also is recall of past patterns. If we never had felt the heat of fire, we can never conclude that fire heats up. Thus, logic is the ability to link many past experiences in terms of cause-effect relationship.

When we have a new situation, we can link the cause-effect learning from another situation and use it in a new circumstance. This is creativity. After doing it a few times, we learn which experiences can be used where. Creativity is this ability to take different patterns and link them to make a 'new' pattern. Maybe we need to test this new pattern. This is achieved after some experience and we learn which patterns are useful and which are not. Thus, not only thought, but also qualities such as observation, logic and creativity are dependent on activity/work and formation of mental patterns or microcircuits.

Value System

It is well known that a mountaineering team that has gone through a traumatic experience together, forms lifelong bonds. Similarly, army

Jawans who have fought battles side-by-side form deep bonds. Growing up together is a way of forming these bonds. Working together to grow together is the dream of any well-organized company. Consider any trader who cheats. Will he succeed and prosper? Maybe when there is no alternative, he will continue to get customers. But if he has an honest trader to compete with, where will customers go? So in an open market, only those who are honest will attract customers.

Why should anyone speak the truth? Is it because a religion says so? What will happen if our senses, say the eyes and the ears give us false messages? We shall stumble and get into problems all over. What if a company has many employees who give routinely false information? This company will not prosper. Thus, a nation that lives on falsehood cannot prosper. Maybe any organization can tolerate a level of untruth, but beyond that it will decline. That is why truth and honesty are needs for survival. All values are built up from the needs of human society. And anyone who works will soon find the need for these values from his own experience. Then why does a society, for example India now, feel it has gone down in values? The values of the human race are a permanent need for survival. They will temporarily fluctuate, and so will prosperity along with it. The society will soon find for itself that they have to have better values if they want to prosper as a nation. That is why- 'Satyameva Jayate'.

The point is, there is no value formation without feeling the need for it in the world of work. Classroom teaching will never inculcate values. It may even be counter productive, if the teacher is not a model for the values he preaches. Work environment is essential for formation of values. Stories of great men can help but it is not a substitute for testing the values in a real life work environment.

How the activity effects can be multiplied

If we were to depend on activity for learning everything we have to

Truth and honesty are needs for survival. All values are built up from the needs of human society.

learn, it would be a very inefficient system. In fact, the early civilization progress was slow for this very reason. But our brain is not just any computer, but a self-learning computer. This means that, with the given information we can increase the useful output by many permutations and combinations. Let us suppose, we have learnt from our work that the mango tree flowers better after a period of drought. If we have this experience, the human brain has the capacity to extrapolate this information to other flowering trees and test the conclusion. This is the basis of scientific research. It is in-built in the human brain to extrapolate and test earlier results. In all activity, we try to anticipate results and then consolidate or modify our 'hypothesis' depending on how it stands the test. The major importance of this ability is that the rate of acquisition of new knowledge becomes related to the amount of knowledge already present. This is exactly the situation (as a mathematical equation) that gives exponential increase of knowledge. In common language it means that, like compound interest, the knowledge grows explosively. Thus, keeping up with work activity, the knowledge growth keeps increasing. And therefore we cannot rest and say we have enough mental patterns and we shall keep playing with the same old patterns. This is what we do now in our school education, we keep playing with a small stock of experience.

The implication of exponential growth (as against linear growth) is two fold:

A : Even if we go slow in the primary school, but make sure the learning is proper, the acquired knowledge will grow fast later. On the other hand, if our learning is not proper at the primary level, it will not give exponential growth and later growth will be slow. So give a firm foundation to the primary school education.

B : Any differences between students at the primary stage should be removed by paying more attention to slow learners. If this is not done the differences between the slow and the normal will enlarge and result in permanent inequality of opportunity in the different sections of society. Therefore, attention to slow learners in the primary schools will be the main route to reduce social imbalance, more effective perhaps than all the subsidies and reservations we think of now.

Role of Teachers in Activity Centred Education

- Analysing the kind of learning that takes place through activity and giving complementary support to the children. Selecting new activities for the children to reinforce their learning.
- Supplementing activity learning with skills in articulation.
- Widening the horizon of activity, arranging for materials, helping in skill development etc.
- He should be a guide, friend and philosopher.

In the primary section, this activity will be only learning oriented. In the secondary school it should be production oriented, in addition to the learning goals. This will involve handling purchases, keeping accounts etc., which will also be the role of the teacher-coordinator.

The teacher's role here should be only as a facilitator. He will sometimes find the students ahead of him in certain skills and he should openly learn from them. This will help to raise his image among the students and also to form values.

Where did we go wrong in the Basic Education Experiment of the Fifties?

The Basic Education system propounded by Gandhiji, seems identical to what has been suggested now. To understand him, we have to read between the lines of the many writings by Gandhiji on Education. Unfortunately, those who implemented the programme went more by the apparent form rather than the deep thinking behind it.

- The programme gave the impression to the society at large as being divorced from the direction of Science and Technology and therefore, retrograde. This was mainly because of the choice of activities to be given in schools.
- The second effect was that the ruling elite did not opt for it and created the impression that Basic Education was for the Masses and the normal 'academic' education was for the Classes.
- The third mistake was that we stressed the ideology and not the performance of the system. If we had data to show that Basic Education could produce better results than the normal education for the common man, we could have gradually got acceptance for the system.
- Lastly, we do not monitor performance indicators to judge the results of any educational experiment we do.

We should now take precautions not to repeat these mistakes if we give these ideas a second chance.

Guidelines for the new system:

1 Lower Primary school will use the education methods advocated by such stalwarts as Gijubhai Badheka, Tarabai Modak, Anutai Wagh in India and Madame Montessori in Europe. These methods are now universally accepted for children's education. (Children will learn while playing- Gandhiji)

2 The middle and upper Primary will have more activity (use of body organs to develop intelligence-Gandhi) to impart work orientation. The MHRD already has the 'work experience' syllabus under the MLL program. This should be taken up for implementation.

3 The Lower Secondary School should implement the 'Prevocational Scheme' earlier announced by MHRD (1995) with some changes to reduce costs and bring in community

involvement. The principle that work brings earnings starts here as also keeping accounts.

4 The Higher Secondary School should start the vocational stream, keeping in mind the Gandhian vision that they must move towards self-financing.

5 Feedback systems are an essential part of all life and also industry. The curriculum is like a road map; the vehicle using this road map still needs the steering mechanism and the driver. Our education system must have a modern and fast feed-back system, using the new Information Technology, to save time and money.

Curriculum

The National Curriculum Framework for School Education prepared by NCERT will be the basis, but will be modified to meet the guidelines given above, particularly for improving quality.

Based on above, the following topics will be covered by all students.

- Home-Health-Society
- Agriculture-Animal husbandry (Plant and Animal Kingdom)
- Engineering-all materials
- Energy-Environment and other systems

These four themes will cover all topics given in the NCERT document.

Vocational Course at + 2 Stage

The major attention here has to be on the following areas:

- The teachers must practice a vocation, if they are preaching it. They must earn part (50%?) of the salary through their vocation - Production-Service Centre.
- The students must get hands-on experience in this Production-service centre.
- Technology is not the only thing in a business. Identifying opportunities in the local scenario is the most important skill, followed by where and how to get this information and use it.

- The school could also undertake development work for the local self -government, jobs such as building sanitary blocks, houses, watershed development surveys, contours etc.
- The course consists of a generic course on learning to spot opportunities and collecting information and an elective that is the specific vocation chosen by the learner. He does it as a project and submits a critical analysis and also recommendations.
- The Administrative structure is essentially the same as today. But all the State staff is trained for intensive use of computers and Internet.
- The staff will have the vocational schools and a number of new enterprises as their performance indicators.

System of Implementation

This is where four major innovations have been introduced.

1. Community Services for Hands-on Training

The last decade has seen an explosive growth of the Rural Market. Most big commercial houses in Consumer Products and Consumables are exploiting this growth. But there is one niche of this market they cannot touch. This is the rural service sector. Our vocational schools should use this service opportunity for providing paid services to the rural community, which will cover a substantial part of the cost of material and a part of the instructor's salary.

In our prevocational schools, the schools give up to Rs 70,000-80,000 worth of paid services, which covers all the cost of materials, gives hands-on experience and supplements the salary of the instructor. The two major benefits are the hands-on training to improve quality of education and the modest cost services available to rural communities. For example, small villages, where commercial services are not yet available, the school gives services of fabrication and repairs, electrical wiring, water prospecting, agricultural services and even blood and urine testing and simple pathological testing. This is what we mean by Education through Reconstruction and Reconstruction through Education.

The second effect of this is that the technical school base becomes a good delivery channel for introducing any new technology. They know the language of technology.

Because of the benefit to the community, community funding in all our schools provides the infrastructure and equipment.
Thus, the community involvement not only makes the school a real community development centre, but also reduces the cost of vocational education by around 50-75%, improving quality at the same time.

2. Trainee Entrepreneur Scheme
This is an interesting idea that meets the needs of 2/3 sections of society and reduces the cost of education markedly.

We have a large population of dropouts who need to be usefully employed. There are no salaried jobs to give them. But there are many jobs to be done for the community as also reconstruction jobs, which can be made by small enterprises. In order to start such enterprises the dropout needs the following.

- Motivation: given by seeing another person from the same class doing a business and earning well. 'If he can, why not me?'
- Training: we can provide the skill/training in the same school giving vocational training to formal students.
- Capital and infrastructure: we appoint a trained 'drop-out' as an instructor in the school. He operates his business with the school facilities and gives hands-on training to students. He gets the surplus from the operation, the community gets service at a modest cost and students get a good education. Our schools have such production cum service centres for each of the four subjects. (Examples: making cots and racks, rewinding electric

motors, growing and selling poultry and vegetables, making and selling food products, doing blood group tests etc.)

- During the learning period, he gets a stipend for training the students, which gives him some sustenance. He also earns through the services he provides. This varies from 100-200 to some earning beyond 1000 p.m. in addition to the stipend.
- When the instructor has enough experience of his business, he leaves the instructor job and we help him to get a bank loan and start his own enterprise.
- A new instructor takes his place.
- The school is thus not only giving skill training to school students, but also giving enterprise training to out-of-school youth and helping them to start own enterprises.

This is our Trainee Entrepreneur Scheme.

3. 'Virtual Visit' and Feed back system.

- The feed back system is as important to a project as eyes are to a human being. It increases speed of progress and avoids errors before they become too expensive. It is also useful in distant training and for inspection to see the truth.
- We visualise 'roving monitors' with a handheld computer, a web cam and a mobile phone, linked to each other and the Internet. This combination can take interviews, visit work places, have question-answer sessions; virtually anything one can do during a field visit. A roving monitor will visit the designated place and the expert will have a dialogue from his office, through the Internet. Any other school can also watch if they are interested.
- We have not been able to test this system, because we do not have the connectivity to Internet from our village yet. But we are ready to start and have got rough estimates and the cost of the set up will be approx. Rs 50,000.
- We expect that such a roving monitor could be an independent vocation, financed by banks to people with journalistic qualities. They will carry out visits to schools for a fee. Other times, they

could be free-lance journalists, reaching an accident spot on a motor bike and sending reports to news services, within minutes of an event.

- We expect we shall need one roving monitor for say 25-50 schools, within a range of 100-200 km.

4. Computer Based Lessons

We have already started producing Computer Based Lessons (CBL). They will be a boon for the education system. They have many advantages.

Financial Aspects

- The computer is much cheaper than a teacher on per hour basis.
- On the basis of the recommended staff pattern for vocational topics and the current salaries, the cost of vocational education will be approx. Rs 3000- 5000 per year per student.
- Our costs with the Trainee Entrepreneur scheme for Prevocational stage are less than Rs. 2000 for a 3-year course per student, with hands-on training.
- Our submission is that the state has obligation for Primary Education. It should bear 100 % cost of the Vocationalisation of Primary education. (Estimated at less than Rs 5000 per school of 400 students for capital facility, nil for recurring).
- For the Prevocational and Vocational (+ 2) stage, the State should give a grant of RS. 1000 per year per student and let the school charge the balance as fees from students. The school will then have to 'sell' the vocational course to students on the basis of the benefits of the package. The student also, having paid fees, will take the study more seriously.
- This grant should be reduced to nil over 5 years after a 10 year period for building up infrastructure and experience.
- The monitors will cost nothing to the state; they will be self-employed.
- The planning system has to allocate funds provided the schools meet the performance indicators. Compare the marketing of a product. The company expands production facility only with an

expanding, profit making market. The State should invest only when the schools are coming forward voluntarily to take up the course on stipulated conditions. The State bodies will have to 'market' the course and give the benefits.

The Ten-Year Perspective.

This ten-year period will be divided into 3 parts.

1 Zero time phase-the prerequisites should be in place at the start.

2 Three (3) year phase -First lot being implemented. Going through fine-tuning.

3 The seven 7 year phase when the programme is growing exponentially.

The Zero Phase

- Work experience course is introduced in the primary schools, in a phased manner.
- All schools have electricity and telephone connections.
- All schools have Internet connectivity with local call rates.
- Recommended monitoring and feed-back system is in place.
- Local self-government looks at technical schools for doing their technical work, having higher technical units as resource group.
- New schools are enrolled only through their agreeing to raise the finance for the infrastructure. This number is a performance indicator.
- The programme is ready for introduction in those schools that volunteer to pay for the infrastructure.

Three-Year Phase.

- The prevocational course will be introduced in 100 schools in each of 6 selected states.
- The vocational programme in the new form is started in schools after the 3rd year, when pass-outs from the prevocational programme are coming out. The number will be decided by the demand.

Seven-Year Phase

In this phase, the number of institutions for each level will grow at

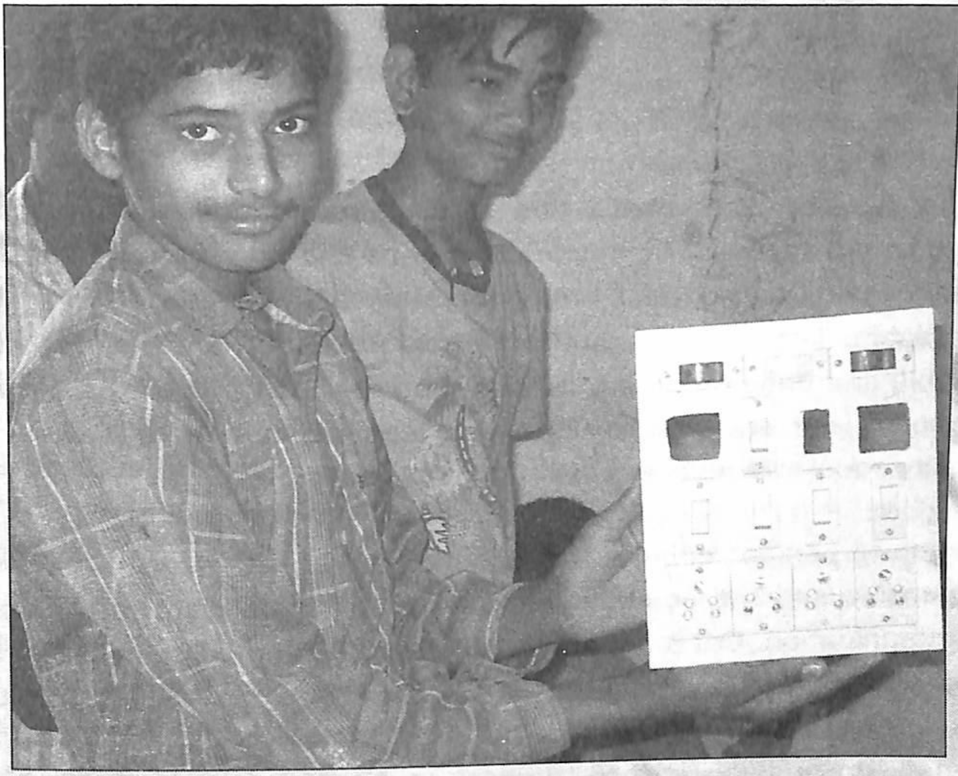
the rate of the market growth. We expect it should grow exponentially.
At this stage, a decision should be taken whether the state should continue funding or the community would take over. If the benefits are perceived as substantial, the parents may be willing to pay the costs.

Summary
A scheme based on 18 years experience of the Prevocational Programme is presented, for giving work-oriented education at different levels of schooling.

The Primary will have Work Experience syllabus as detailed.
The Lower Secondary will have a generic, prevocational multi- skill course that gives a variety of relevant services to the community, through students. There is also a Trainee Entrepreneur scheme that brings in ex- dropouts as instructors after proper training and develops them as small enterprise men. This combination reduces the cost to Rs 2000 per student, for the complete 3-year course. The package has several benefits to the student that should make the student willing to pay for the entire cost. (Compare costs of computer courses in the large number now proliferating)

The Vocational Course has a generic part: stressing on spotting economic opportunities and collecting and analysing information. The specific vocation will be an elective part. All training will be through hands-on experience in a production-service centre that links with the community for its market. It also does development work for the local government.

Overall the cost of training will be substantially less than the present estimated Rs. 5000 per student year to less than Rs.1000 per student year. Even this will be ultimately passed on to the clients.



The technology must also be flexible enough to overcome small disturbances in the economic environment.

TECHNOLOGY DELIVERY THROUGH THE EDUCATIONAL SYSTEM

Generally, the print media and person-to-person communication have an advantage. They depend on print and non-printed material (audio-video tapes), which are constant and can be referred to again and again. There is therefore nil or minimal distortion. But it is not flexible and once recorded, it cannot be changed to suit the target group. These are suitable for mass communication, but do not ensure equal effectiveness in all sections of society.

Person-to-person communication on the other hand is slow, expensive and the communication is likely to be distorted during communication. But it has the advantage of being adjustable to the needs every of individual person.

Today, in India, we use both the above modes in different proportions. The organised sector uses printed technology transfer documents (text and drawings) and person-to-person communication is used to supplement the document. The audio-visual communication is through person-to-person contacts.

Let us now look at the hurdles in these technology communications reaching our target group – the below poverty line and other weaker

The technology must also be flexible enough to overcome small disturbances in the economic environment.

sections of the rural society. For this, we should first define our target group and its capabilities and weaknesses.

Our target group is mainly the BPL (below poverty line) section of the society and other weaker sections. The members of this group are generally illiterate or neo-literate, and are not comfortable with the printed matter. Their familiarity with numbers does not go beyond simple additions. Decimals and calculations involving direct proportions are beyond most of them. They have an aversion or fear of writing down any information or instructions. They cannot retain a chain of instructions given orally – nor are they inclined to write or read them. They generally do not understand symbolic diagrams as against actual pictures. They are poorly trained in all measurements and have only a limited access to tools of measurement.

It is obvious from the above description that, printed matter cannot be the ultimate technology carrier for the BPL sections of the society – which is our target group. Even the recorded audio-visual communication meets a barrier except in the simplest of communications. Thus, the technology that produced the Green Revolution requires the farmer to use a certain rate of seeds per unit area, apply a definite proportion of fertilisers or pesticides and also make some other simple calculations for deciding on irrigation or calculating profitability. The majority of our target group cannot do any of the above operations and therefore, the Green revolution has passed them by – in spite of the loan subsidy and other government schemes.

The lack of simple language and arithmetic skills in our target group leaves only the person-to-person communication as the ultimate delivery system for our target group. But if we plan to organise training and demonstration camps for them, numbering hundreds of millions (nearly 50% of the population) for various technologies – the cost will be prohibitive and the progress will be slow and uncertain. The teachers/ organisers have to be paid and supervised, the participants have to be compensated for attending training camps and the cost of materials used in the demonstrations must be borne. Also in such training camps, the participant is at best doing a "technology" along with others in a location away from his home for a finite time. There is high probability that after going home, where he tries to reproduce the same results, he is unable to do so – and then he has nobody to refer to and forgets about the training.

Thus, the training camps apart from being expensive and slow are far from satisfactory in delivering the technology that can have a long-term effect.

The Transmitter – Receiver Concept:

We have a large number of radio and TV broadcasting stations. These communicate all over the world by using electromagnetic waves. But only those suitably equipped with "receivers" can tune into them. Different technologies are constantly being "broadcast" in various modes. Only those who are suitably equipped (with prerequisite knowledge/skills) can receive them. So our ultimate goal should be to raise the mental skills level of our target population such that, they can receive and have access to the technologies they need. This is what education really means. But this will take a long time. In the immediate future, can we set up a "receiver" in every village and hamlet who receives audio visual messages, masters them and then gives them by person-to-person contact to the BPL sections in the village?

The organisations that reach into every village are -

1) The Gram Sevak and the Gram Panchayat in the BDO-Zilla Parishad Chain.

2) The Patwari/ Talathi in the Revenue Departments hierarchy.
3) The village school in the Educational system.
4) The commercial trade and retail distribution network.

In the past we have tried the Gram Sevak as a motivating channel and also as a Technology Delivery System (TDS). Even under ideal conditions, there is a limit to the number and variety of technologies that could be delivered through one individual. The patwari route is not available because the Revenue role takes precedence. The commercial – trade network is good for delivering goods but not knowledge. This leaves the Education system as the only option worth exploring.

In a sense, education is itself a "technology" delivery operation, so there is a commonality and nearness between the two operations that has yet to be exploited. The Education – Development link has always been recognised. Teachers have, at various times, been given "additional" assignments, considered to be of national importance e.g. motivation for family planning etc. The students also are supposed to be involved in social service, socially useful productive work (SUPW) or work experience, social forestry etc. But their role in converting Education as a TDS is entirely different.

What is envisaged is a 3-tier system for technical education in schools in the rural areas. The three levels will be at the +2 level (11 and 12 std.) at block level, at the secondary school level 8th – 10 std. (at least 2-3 per block) and work experience sections in other schools, also at 8-10 std. level, but in all secondary schools. These schools will be equipped with Agro-engineering facilities of differing levels. These schools will have trained instructors who will give practical instruction to students, who in turn, will provide service as part of the curriculum and take part in field trials/ demonstrations of new technologies – teaming up with farmers/ villagers who can use the new technologies.

The proposed curriculum for Secondary and Higher Secondary schools covers water resource development, construction, workshop technology, energy and environment, agriculture, animal husbandry and home and health.

The skills taught in the school work experience classes will be those that need minimal equipment facilities. Starting from simple measurement, calculations and recording, conducting surveys and collecting information, they can cover electrical wiring, biogas maintenance, bicycle and two-wheelers servicing and repairs, tyre-tube vulcanising service, fertiliser and pest control services, low cost construction and petty repairs, etc. The pre-vocational education will give more substantial and wider range of skills than work experience and prepare a wider base of experience after which the students can specialise in any one of the vocations learnt in the 2 stages.

The school-villager transfer takes place at person-to-person level. This will be more effective than a training camp because –

1. There will be one to one student-villager team testing out and learning a new technology/skill.
2. The difficulties of the villagers (computations/ reading/ measuring etc.) will be made up by students and vice versa. The staff members of the school will be constantly available for reference and help if problems arise.
3. Any problem not solvable at school level could be referred to the institution of higher experience, like engineering or agriculture colleges etc.
4. There will be cross utilisation of experience within the village groups.
5. No extra costs of training camps etc. are incurred.
6. The training period extends until the technology is fully internalised in real life situation.

Now we shall consider the question of how the staff in the school can be trained and fed new skills or technologies. After a basic course in rural technologies, the multiskilled instructors are quick in learning –even self-learning of new skills in very short training periods or from audio-video and printed material. They need some time to practice these skills to reinforce what they have learnt and they are ready to give their service to others. We have shown this when our staff learnt many skills like vulcanising of tubes, two-wheeler repairs, diesel repairs, motorised prayer repair, motor rewinding, poultry, artificial insemination of goats, etc. without outside teachers. This is a tremendous advantage. Apart from reducing the cost substantially, growth is also possible. This in fact will be the take-off stage for the individual, because he grows by himself thereafter.

The multiskilled instructor at the secondary and higher secondary level can be initially trained through the Community Polytechnics scheme, Krishi Vigyan Kendras and Health Extension Services. Each instructor can handle 20 students in the practical lessons and can handle six batches per week, each for six hours. That is, he can give instruction for120 student-days per week. The equipment costs per school at different levels are given later in this note. A system like this, integrating education, development and community service and acting as a technology delivery system has the following advantages and potential pitfalls.

Advantages:

1. The system can reach every village at minimum cost.
2. It can handle villagers with different levels of skills/ development.
3. The system not only delivers the technology, but also follows it up. This will be a great advantage.
4. The technology carrier is a local resident and is therefore always available for consultation. This inspires confidence.

5. The technology is taught in the place and environment where the recipient is going to practice it.

Possible Hurdles:

1. The multiskilled instructors have to be taught through Community Polytechnics, voluntary agencies, Krishi Vigyan Kendras etc. Co-ordination will be slow.
2. The schools need to be given initial equipment – a capital investment. The estimate to cover the whole country is as follows:
   5,000 higher secondary schools @ Rs.2.5 lakhs each 12.5 X 10 or 125 crores.
   10,000 secondary schools @ Rs.1 lakh each 10 X 10 or 100 crores.
   40,000 other schools for work experience @ Rs. 20, 000 each 80 crores.

Total requirement will be of 305 crores for covering the entire country.

This is a relatively small sum to invest; a one-time investment, technology delivery system that does rural development at the same time. Besides, it will generate more assets located in rural areas and operated by rural youth. None of the structures will be huge concrete buildings built by urban contractors.

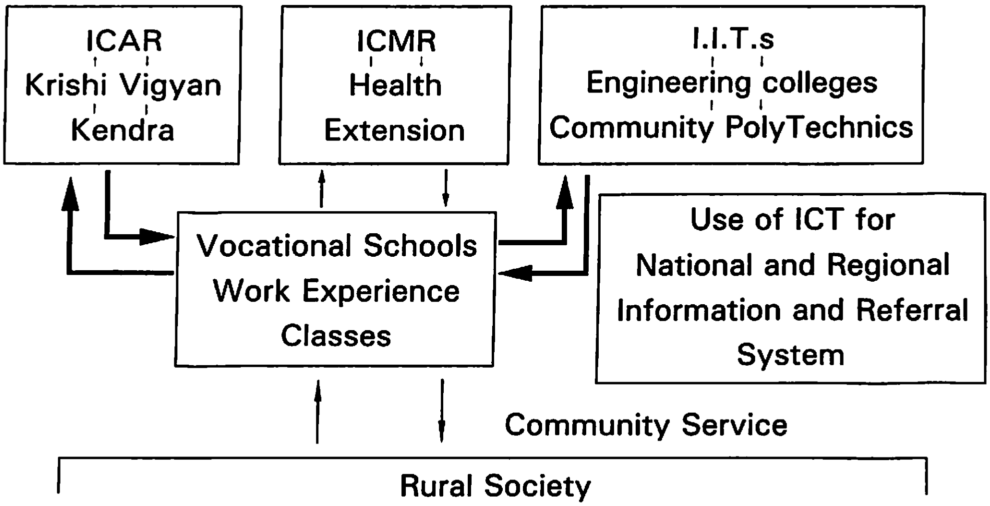
3. The recurring costs of these will be about 150 crores per year going into rural areas. This may ultimately be reduced if the community that gets the benefits agrees to bear part of the costs.

4. A possible objection can be that "so many schools do not even have a blackboard or a teacher, how can they be delivering technology?"
   a) It is secondary and higher secondary schools that will be the TDS not primary.

b) Even the secondary schools are far from satisfactory. But if we give them up for a lost cause, can India have any future? We cannot write off the education system as a whole. On the other hand, this scheme giving a relevant technical education is actually designed to stimulate the intellect and will do wonders to the educational system, if it is worked as planned. This will be a greater gain from this scheme than merely the technology it delivers.

c) The school workshop is ideally suited to build the classroom building, the blackboard and sanitary facilities etc. at less than any contractor's costs. In fact, this should be the first technology delivery assignment to this system. It will boost the morale of all teachers.

Net work Diagram for Education as a system for technological delivery.



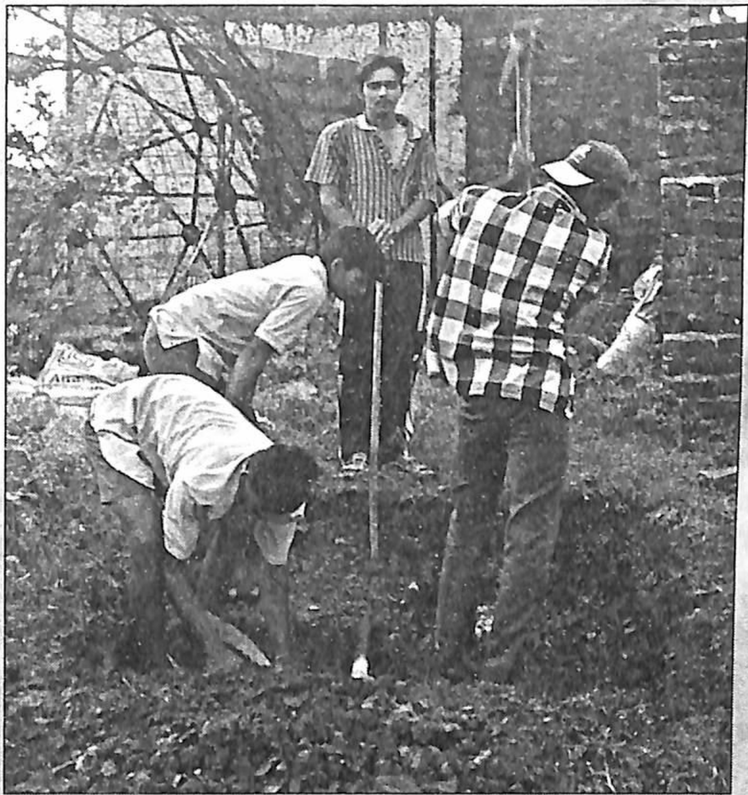
A Technology Delivery System will not function for a long term unless it is also linked to the information system that feeds grass-root information (technical, economic and social) into the Research and Development Wing. That is, it must receive, as well as transmit information.

For this purpose again the rural youth, the students, the Nehru Yuvak Kendras and the Jana Shikahan Nilayams and all village youth groups should be involved and trained to discuss their problems, collect relevant data, quantify it, identify the problems, spot opportunities, and then use the referral system for their solution. In the referral system, the problems and the relevant information travels in the direction of increasing expertise and the problem is referred to the group where the challenge of the problem matches the talents of the research group. Such a scheme has been elaborated for the Ministry of HRD during the appraisal of the Community Polytechnic Scheme in 1987.

The proposal for the Technology Delivery System through schools, described here, really involves only networking of the various schemes already included in the programmes of the various Ministries viz.

1. Community Polytechnics Scheme.
2. Vocationalisation of Education
3. Jana Shikshan Nilayams and Nehru Yuvak Kendras all from Ministry of HRD
4. Krishi Vigyan Kendras from Ministry of Agriculture.
5. Health Extension Programs from Ministry of Health and Family Welfare.

Additional funds will be required only if the coverage is to be extended beyond present plans. But the networking of these schemes will increase the benefits beyond those of the individual schemes. And then Education will really lead to development.



If learning of a variety of skills is an integral part of
education and is made the basis of learning,
many who succeed in the former,
that is physical and manipulative skills,
will feel encouraged and emboldened to master the latter,
the mental skills.

SKILL DEVELOPMENT AS A BASE FOR EDUCATION

1. "Small is important"

For want of a nail, the horseshoe was lost.... and so onto the loss of the Kingdom. In everyday life, we have to do so many little things. Generally, those who are successful in life are the ones who can get a large number of little things done better than others. Even big things, say setting up a new factory, is made up of little things, like laying of bricks neatly, the machines to be laid out thoughtfully and all electrical joints made properly. Why do some people do these little things better than others? In my opinion, the two important parameters are skills and pride. One must have the skill and the talent to do that and one must have the pride in that work. Even an intelligent person is not born with all the skills - his rate of learning may be faster but he has to learn it and develop it. The exceptions may learn by themselves, by good observation and adoption. In general, one has to be taught these skills. The pride comes from a realization that what one is doing is important and doing it better will earn appreciation.

So, if we want the big projects to be successful, our masses, from the lowest unskilled jobber to the highest skilled experts must do little things even better. This is possible only if, from their childhood, we give them a variety of skills and develop the pride in doing these little jobs better.

If a variety of skills are taught in the educational system, each one will have ample opportunity to succeed in one or the other and will get a boost to his morale.

Very often, the pride comes when a certain skill is acquired. The child, who learns to read, likes to show off the new skill.

If we teach skills and give importance to even little things being done properly, we will, in a few years, have masses that have better skills and more pride.

2. "Success breeds Success"
"Nothing succeeds like Success"

We have a problem that a large number of children drop out from schools. Even from families with a tradition of learning, many are looked upon as "duds". Boys and girls, who in normal life are smart or at least average, do poorly in classrooms. These boys and girls either drop out or manage to scrape through because of pressure from parents.

There are many cases each one of us would know; where someone who was a failure or second rate in school; shines in his profession. Why is this so? It is because real life needs many more skills and qualities than required for school success. Yet, boys with potential talent in other areas are branded a "failure" and tend to drop out.

If a variety of skills are taught in the educational system, each one will have ample opportunity to succeed in one or the other and will get a boost to his morale. This will encourage him to persist in others. At least he can go through school with a greater measure of pride and self-respect. I suspect that in many cases, the 'failure' in book learning is due to lack of concentration and interest, arising out of non-relevance to real life situation. If learning of a variety of skills is an integral part of education and is made the basis of learning, many who succeed in the former, that is physical and manipulative skills, will feel encouraged and emboldened to master the latter, the mental skills.

3. Education is the Condensed Experience of the Past

Obviously we cannot absorb the total experience of all who have gone before us. To help absorb the maximum, the experience of many individuals is generalized into knowledge stated in the form of laws, theories and facts. Thus arise the disciplines of science, engineering, medicine, mathematics, geography, history and even grammar, language and literature.

If we are going to condense all the knowledge harvested in the past and pass it on to the children as education, there are two ways in which this could be done. One approach is to list all the essential items to be conveyed and teach them through the books. The other approach is to list the key items and contrive a situation where the children or students rediscover or find out for themselves the main concepts intended to be conveyed. The first approach of giving this through books is what is currently practiced. This has led to unsatisfactory results and everyone agrees on the need to change the latter approach.

It is not possible to learn all ideas from the past by "rediscovering" them under controlled conditions. Only a finite number of laboratory or field experiments / demonstrations can be arranged as part of education because of limited resources and time. While simple experiments can illustrate or demonstrate ideas, they do not necessarily show their relevance. Relevance is brought about, by referring to real life situations. At present, it is tacitly assumed that, the real life situations are common to all students. In fact, they are widely varying and therefore, even when relevance is indicated by reference to real life situations, many students do not understand the relevance because they have never experienced the real life situation referred to.

Let us take some examples:
City bred boys do not need to burn wood as a fuel; they rarely watch the stars in the sky and could hardly recognize the varieties of trees or birds around them. The village bred boy who would feel at home with trees and birds, could perhaps build a fire for cooking, but would not know about electric trains or television or cold, pasteurized milk sold in bottles.

Would it not be a good idea to teach skills in doing things in the garden, in the home, handling tools, using materials - skills that everyone will find useful in everyday life? In doing these things as part of education for all, we build a common base of experience. And to illustrate new concepts or ideas we can refer to this base of experience.

This common base will not only make things relevant to all students, but will also help to integrate all students irrespective of social background.

4. Relevance of Education will be judged by the self-reliance and confidence of the so -called educated

The primary role of education is to prepare an individual to face the challenges of life. In the under-developed countries, the main challenges of life relate to earning a decent livelihood. In developed countries, where a reasonable living standard is assured, education aims at a "fuller" life.

If the above premise is accepted, teaching of skills becomes the primary functions of education. Why teach science at all?

Traditionally, craftsmen passed on their skills to their own children and also perhaps apprentices. These in turn became self-reliant craftsmen. Is this what we want to do now? The craftsmen passed on to their wards strictly limited skills. With a sort of inbreeding of knowledge within separate crafts and guilds, there was no progress, only stagnation. Without the why and how, there was only limited innovation. Lastly, the choice of skills was limited to those relating to a particular trade only and so utilization of knowledge from other skills did not take place.

What we should now aim at is to teach skills used in an endless variety of acts. The intention is not mainly to teach crafts but primarily to develop physical, manipulative and mental faculties. The selected crafts will serve as carriers for these skills. A skilled carpenter with a steady hand, an ability to visualize, having a good judgement, could easily be trained as a welder or a plumber or a mason. Given the intellectual capacity, he would be perhaps a better experimental scientist than if he had not developed his craft skills.

As explained earlier, the teaching of skills, through a variety of jobs done, will give a wide enough base of experience, on which the science subjects could be taught so that, the learner has an insight into what he has been practicing and knows the whys and hows. He would therefore be encouraged to develop further on his own and make his contribution howsoever small to the fund of human knowledge.

The teaching of skills and science will thus complement each other and produce the desired self-reliance and confidence.

5. Life is one Continuous Education

The primary role of education is to prepare an individual to face the challenges of life.

Education should not be merely the imparting of knowledge. It should be so done, that the student imbibes the spirit of enquiry and discovery, so that whatever one does, one is slowly learning and life becomes one continuous education.

This principle is generally accepted but it is difficult to implement. Different teaching techniques will afford more or less opportunities in doing this. Even the printed matter can arouse the curiosity and encourage the reader to think, wonder and find out for himself. The printed matter can do this, most successfully only for people who have this quality. The book only focuses attention on a new area to investigate. The very young who are just introduced to reading have to struggle to get meaning out of the book and cannot pick up the subtle thoughts.

Modern methods of teaching science include a demonstration or an experiment and then induce the student to arrive at the principle and then wonder why and how. These are a big improvement but have only limited success. The enterprising students read ahead of their class and somewhere the principle is already stated and so he does not "arrive" at it. It is like a brainteaser in a magazine. If you know the answers are given on Page 124, you have limited patience and if you cannot solve it, you are tempted to look up the answer. Also, the teacher knows the answer and his behaviour will be acting a part and never searching for an answer. In real life, the search goes on for months, years and may be for life. These experiments cannot teach the quality of persistence in the search.

The subject matter of the experiment itself introduces some limitations. If the school experiment deals with the behaviour of gases or say the effects of a magnetic field, the students tend to think of experimentation only in the four walls of a laboratory. Even long practicing scientists do not necessarily practice the same philosophy in real life.

On the other hand, let us say, the student is learning to lift heavy loads, uses a rope for climbing up a tree or just planting a seed - the answers are not stated, at least not fully in any book. The teacher can only show one way to do it and not necessarily the best and it is easier to let the student find out for himself.

Teaching skills that are used in everyday life provide a better medium to induce the spirit of experimentation as well as the methods of drawing conclusions where results cannot be quantified so easily.

Knowledge becomes education when it is fully adsorbed and becomes part of the system.

What is it that one remembers? One remembers what is strikingly different. One remembers things through association. One often remembers what we experienced in childhood. There is a good chance that an experiment with an unusual result will be well remembered.

But there are other things like the fall of objects under gravity which are part of the system and do not have to be remembered. If one has learnt swimming or cycling in childhood, we never lose it.

The things that are practical soon become part of us and are never forgotten. If science education is imparted by demonstrating the why and how of the skills being practiced, the chances are these effects will remain as long as the skills are retained, perhaps longer.

Education must have a multiplier effect

With a very large and growing population, any system we choose must have the potential for exponential growth. The possible constraints on any such system are (a) Trained teachers (b) Material facilities (c) Demand.

Demand is the most important constraint. If the education is seen as more beneficial compared to other systems of education or no education, there will be a demand. If the skills to be imparted are properly chosen, it is natural to expect that these will help the learners in earning a living.

The current well-educated section may tend to look at this as "education for the masses and not for the classes". This should not be so. The traditional learners will be better educated with the acquisition of skills.

What is true of students is true of teachers. Teachers are made of the same stuff as students, only one generation ahead. One major difference is the age. Teachers will have to be given different skills and more important, they will have to be selected on a different basis. There is also a possibility that, after acquiring certain skills, the teachers may get better earning by practicing these skills than by being teachers in a primary school. While this may hinder the spread of the education for a while, it is to be considered a good indication that the education is seen as relevant and produces self-reliance. This will certainly stimulate the demand and also more will volunteer for teacher training.

The resources like the building, the land, the equipment, are all essential. There is a possibility that since various skills are taught and practiced by the students, a small fraction may be capable of bringing in some return. It is necessary to keep this income under watch; it should not smother the system and at the same time not be allowed to die off. That would be a sign of growing irrelevance. The maintenance and acquisition of new equipment should be coming out of the system itself.

In the primary classes, basic skills will be imparted. These will be-
Maintenance: Skills required in everyday life. These are ones which children can be called upon to do with or without assistance. Some of these will not be recognized as something that needs instruction. But there are better ways of doing even little things.

Use of Tools and Devices: Tools are what distinguish the human race from animals. One should have familiarity with the use of as many hand tools as possible. The specialization will come later. A rope is not merely a tool but it is used in all walks of life and has multiple uses.

Use of Materials: Tools are used to shape materials. One must also get a feel in the working of different materials. This can go along with use of tools.

Physical: The use of tools and materials depends on certain physical abilities like strength, aim, agility, nimbleness of fingers, flexibility of body and limbs, stamina, courage and endurance. Whether these are called skills or abilities, they can be developed by training and exercise. Sharpening of all senses is equally important.
Nature: We have to learn to understand, recognize and interpret the nature around us. The things around us are not to be seen as information – they must be seen as skills to be practiced. To some extent, these are the skills which the uneducated have and the educated have lost.

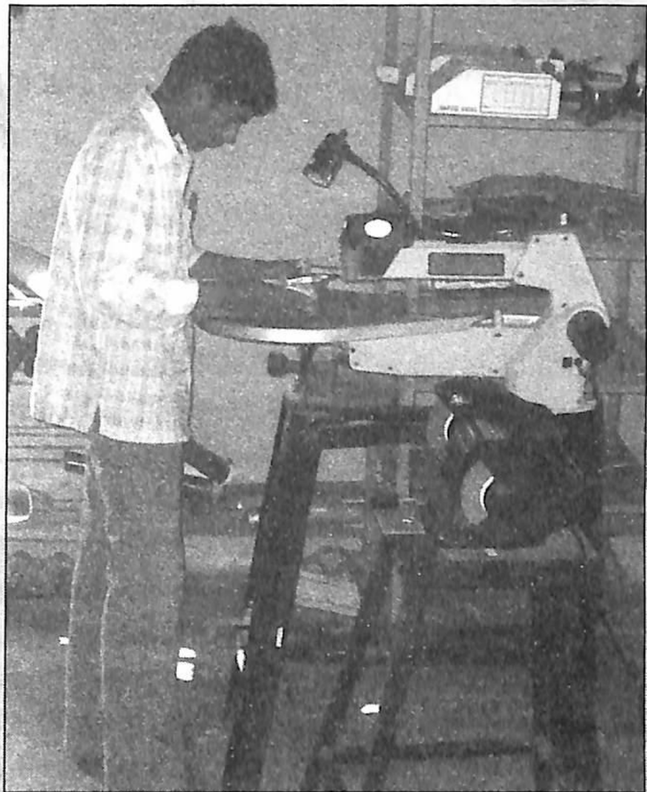
What skills should be taught?

Compulsory:

Maintenance	Use of Tools & Devices	Familiarity with materials of Construction	Physical	Nature
Cleaning,	Scissor	Clay	Walking	Skills in
Sweeping	Penknife	Wood	Running	recognizing
Winnowing	Kitchen tools	Paper	Swimming	& interpreting
Laundry	Axe	Plastics	Cycling	Rocks
Mending	Screw driver	Metal	Jumping	Soil
garments	Saw (wood)	Glass	Climbing	Sand
Rafoo/darning	Pliers	Plants	Games	Air/Wind
Oiling	Crowbar	Cotton/Wool/	First-aid	Sky
Watering of	Shovel	other fibres	Endurance	Clouds
plants	Pick-axe	(silk, jute etc.)	Hygiene	Stars
Serving food	Sickle	Leather	Sanitation	Plants
Making a bed	Rope	Bricks	Music &	Animals
(home)	Grinding	Cement	other arts	Birds
Adhesives	Screening	Wax		Insects
Packing	Wire	Plaster of		Colour
Sharpening	Nails	Paris		Sound
Lifting	Hammer	Asphalt		
Carrying load	Flame			
Lighting a flame				
Cooking				
Paint/white-wash				
Leveling earth/				
ground				
Drawing st. lines				
Drawing circles				
Digging trenches				
Repairing shelters				

Specialisation:

Agriculture	Masonry	Welding	Weaving
Poultry	Carpentry	Sheet metal working	Dyeing
Apiary	Plumbing	Smithy	Tailoring
Horticulture	Wiring	Road construction	Plastic
Sericulture	Painting	Irrigation	Fabrication
First aid		Maintenance	Art-Music
Health Services		Bricks manufacture	Painting
		Kilns/lime burning	Sculpture



when we talk of teaching science we actually want to teach the methodology and concepts of science rather than a package of information.

SCIENCE THROUGH TECHNICAL EDUCATION

1. WHAT IS SCIENCE?

Why do we want to teach science to school students and if possible, to every one? Science is a body of knowledge obtained through the use of the scientific methodology; and it is this methodology that we want to teach, so that people can use it to solve problems in everyday life and gain more knowledge on their own.

So, when we talk of teaching science, we actually want to teach the methodology and concepts of science rather than a package of information.

This methodology involves observation, measurement, recording, classification, comparison, and recognising patterns, making a hypothesis, and then testing the hypothesis by experiment. This methodology has proved to be very fruitful because it depends on deriving information from action in the real life world. This is different from other methods, which depend on "truths" stated by an authority and accepted blindly by subordinates. Very often, these truths relate to situations where the veracity is difficult to test.

In this paper, I want to make the following points:

1. The above scientific methodology is very similar to the learning

mechanism of the mind and every human is capable of using it.

2. The learning process for the basic scientific concepts has to be based on activity.
3. It is advantageous to use technical education to give skills and then practice their application in everyday life and give actual experience of the scientific concepts involved; this is different from the current practice of using contrived "experiments" to demonstrate the concepts and "tell" about their application in life situations.

when we talk of teaching science, we actually want to teach the methodology and concepts of science rather than a package of information.

2. NATURE OF LEARNING PROCESS

Here, I am depending heavily on the Piaget theory, because it best fits my own experience. The learning method of the mind as propounded by Piaget is akin to the scientific method of making a hypothesis and an experiment to test it. Some of the concepts the mind learns by experience are as follows:

i) Class membership and inclusion / intersection etc.
ii) Image through transformation,
iii) One to one correspondence - number concept.
iv) Conservation of length, substance, etc.
v) Reciprocity of relationship - addition and subtraction.
vi) Special Coordinates, vertical, horizontal.
vii) Probability.
viii) Effects- "everything else being constant"
ix) Permutations and combinations.
x) Proportions and rate (velocity etc.)
xi) Projections.
xii) Proof.

The above make up the logic of mathematical reasoning.

Piaget's theory has major implications for all education and for science education in particular.

1. All science education must be activity based, particularly at the school level.
2. Motivation can best be achieved through challenging the mental structures.
3. Too much pressure can lead a student to rote learning instead of understanding.
4. The teacher can only produce an environment where the student learns by himself.

3. WHERE DO WE GO WRONG?

In a system of education such as ours, where teaching through spoken word and books are the methods used and evaluation is based on producing the desired response, students resort to rote learning. Almost by definition, it is obvious that this cannot lead to application of the knowledge. Even the best of students will learn "how to" rather than have a conscious knowledge.

So our system "derails" the natural learning process. In order to put it back on rails, we need to find out what structures the student has acquired and then give him activities to encourage his forming new structures and learning by himself thereafter.

4. WHAT ARE THE BASIC CONCEPTS NEEDED?

The concepts listed earlier in Para 2 are basic to all life and we have only to make sure they are acquired by the students. This should be done by the age of 13-14 years. The further concepts basic to school level science are as follows:

1. Matter; energy and universe.
2. Space and orthogonal directions;
3. Types of growth; linear and exponential.

4. Structure of matter, molecules, atoms, protons, and electrons.
5. Physical and chemical changes.
6. States of matter; gas, liquid and solids.
7. Intensive and extensive properties; vectors and scalars.
8. Nature of living things.
9. Heredity- genes and evolution.
10. Radiation, waves and their properties, reflection-refraction.
11. Electro magnetic phenomenon.
12. Forces and strength.
13. Work energy, power.
14. Velocity and acceleration; rate.
15. Accuracy and error.
16. Field and its properties.

All these concepts can be given through activity based learning and most of them make sense when given with reference to the experiences acquired in the practice of technology.

5. EXAMPLES

1. The IBM of conservation of mass and energy is one of the most fundamental laws, yet in the normal education it is hardly illustrated.
First let us note that it is an extension of the conservation laws the child discovers in its growth as per the Piaget theory.
Second, it gives rise to the concept of efficiency, stock inventory, and accounts etc., which are important in technology.
Third, it gives the basis for mass and energy balances - the very concept of balances; this is fundamental to all technology.
These are all covered in our system of science through technology application.

2. When we teach electricity, old books used to say it flows from + ve to -ve, Now we teach that electricity is a flow of electrons and

they flow from -ve to +ve, (high pressure of electrons to shortage of electrons). How do they flow?

We tell students sitting on classroom benches that one of them is an electron, and the other two are nucleus. The student in front walks off creating a "vacancy". The student behind moves into this vacancy and so on until the "vacant" seat moves to the back of the class, while the electrons move to the front. Thus the same process can be seen as electrons moving in one direction and positive charges (holes) moving in the opposite direction.

Similarly, we have illustrated 3-phase electricity by 3 boys running in a circle, representing the rotor in the generator.

3. The concepts of force, strength and work are a bit easier to teach as there are many applications of these in their practical work. To illustrate, we explain why trusses are based on triangles and why one strengthens a right angle joint by a diagonal.

Also they calculate the work done in many of their practicals e.g. pumping water.

4. The simple machines described in science lessons do not make sense in terms of the leaning of "machine" in everyday language. We therefore like to bring one common machine, say the bench drill and show how it is a combination of the simple machines as described in the book viz. the lever, the screen, gears etc. Then the student can go round the workshop and examine any other machine and identify the simple machines used there.

5. Genes, heredity and evolution.

The concept of probability as applied to genetics, stresses that what is a matter of chance in small numbers, becomes a certainty when dealing with large numbers. This is best illustrated through a game.

Later the rules of heredity, which involve permutations and combinations, are presented by making a number of labels of different shapes and working out permutations and combinations of these to understand how hybrid seeds give rise to variations in future generations.

The above examples illustrate how the concepts of science can be made easier to understand in technical education, based on wider, common, shared experiences. The students can also be asked to construct models for better understanding. This is easier in the technical stream than in conventional science.

The greatest benefit however should come from the continuous testing of their knowledge in the real life world. This is the basis of all science. Giving community services as part of the technical education ensures this.

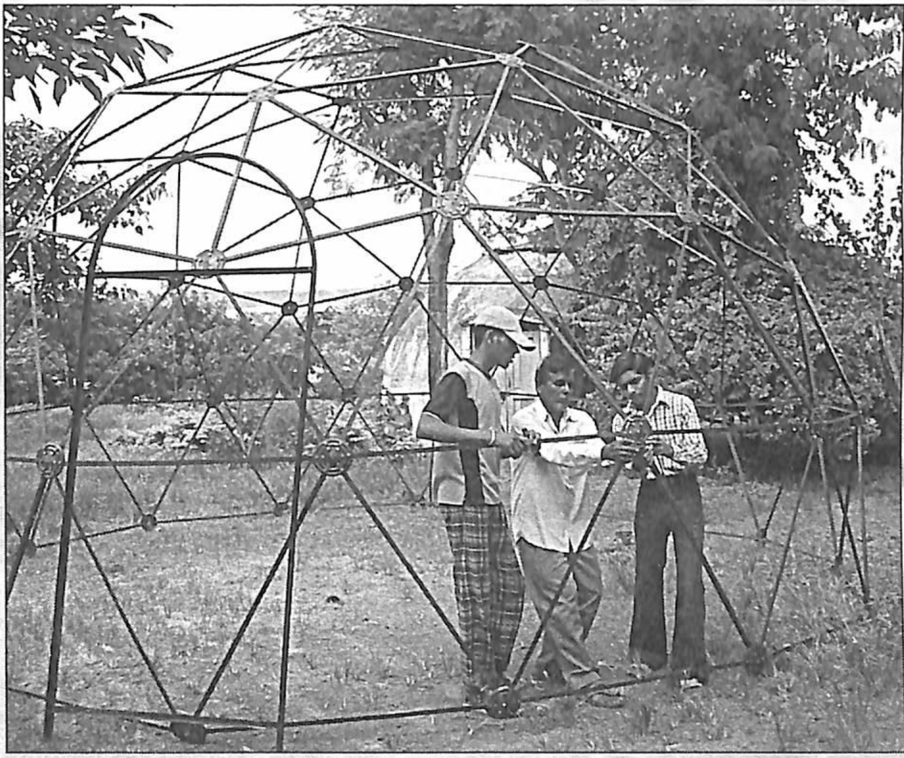
Paba?
8/8/83
7.30 am.

My dear Mira,

I am writing this letter for two reasons. My diary writing is not at all regular and I hope letter writing will be better - so this will record weekly current events and thoughts. Please keep them safely so that I can file them.

The second reason - we have at last got a mech. engineer and he has joined from yesterday. Dnyaneshwar Khaire is local boy with a good academic record - no experience but good motivation to make up for it. In fact I have some more candidates including another good local mech engineer - also fresh from the polytechnique. If I don't get an experienced one - I will take the other boy also. I wonder what happened about Gopal - I must wait till 15th to hear about that. From yesterday ~~noon~~ afternoon, it has rained very well - 43 mm. till this morning - bringing this seasons total to 250 mm. - We can't complain.

This project will be a good teacher for me in organization, selection of people and most of all patience. We still have no cement and no beginning has been made ~~in~~ in taking power to our site. To balance such frustrating items, we have now the engineer, and in our groundwater search, more reports are coming in of striking water as per our expectations. The demand for the tests has gone up and we have also started 12 new boys in this course. Demand for pesticide spraying is also up and generally The program is doing well.



The objective of environmental education should be to create awareness, impart knowledge, develop attitudes and skills, and encourage participation.

ENVIRONMENTAL EDUCATION IN TECHNICAL AND VOCATIONAL EDUCATION

This is a resume of the document prepared by Sven Grabe for UNESCO—UNEP along with supplementary comments by me, with particular reference to India and the Third World countries. This is intended to initiate discussion on the scope and place of Environmental Education for the technical and vocational streams.

The document from Sven Grabe is structured as follows-

1. Why environmental education for technical and vocational students
2. The main environmental issues
3. The needs of the various levels and sectors of T and V education
4. Integration of environment education into the curriculum
5. Likely effects of the curriculum changes on the instructor
6. Summary of the paper

The above paper is very thoughtful and comprehensive.
Naturally, it cannot stress or give weightage to issues relevant to a region. Yet environmental education has no meaning unless it relates to the local environment. So I have taken the liberty to add to, modify

or, in some cases, even to counter the points made in the original document.

The objective of environmental education should be to create awareness, impart knowledge, develop attitudes and skills, and encourage participation.

Chapter I Introduction

There are reports everyday of damage to the environment resulting from a wide range of technology applications. Forests dying due to acid rain arising out of sulfurous fumes from fossil fuels. Lakes and water streams polluted by detergents, animal and human wastes and excessive use of fertilisers, pesticides and herbicides further leading to choking aquatic life.

Even more frightening, are the increasingly frequent gas leaks, explosions and fires caused by sloppy handling of risky operations or neglect in control and maintenance of safety equipment.

In almost all of these, the human factor is to be blamed. The root causes are often ignorance and /or negligence. Somewhere along the line, is technical manpower that did not know, did not understand nor care what the effects could be.

The technical manpower is concerned with the environment in two ways:

I) As technical men, they may be at the source of the environment problem. They could help solve the problem or aggravate it.

2) Like all others in the society, they are also the victims of the environment problems. They should therefore, get environment education that will help them in both their roles.

Whatever environmental education they received as part of their general education, must be reinforced during technical education. In addition, they must get skills to tackle environmental problems and solve them at the source in the particular area they are working in.

The challenge in imparting such an environmental education to the technical and vocational streams (T V S) arises from the large variety of "trades" these technical personnel will undertake in their future careers. The training which these technical personnel get varies greatly, from the very formal and organised Engineering degree students at one end to the large number of agricultural workers (including independent farmers) who have had no formal or non-formal training but only "incidental" education on the job. This makes the environmental education task doubly challenging.

The objective of environmental education should be to create awareness, impart knowledge, develop attitudes and skills, and encourage participation. Environmental education should be a continuous and lifelong process; it is interdisciplinary (like all problems in life) and should be viewed from all dimensions: Local, national, international and at the planetary level.

What has been said above is a worldview. The weightage for the environmental risks will vary with the region.

In India and generally in the Third World countries, poverty is the main pollutant. Whether poverty should be considered an environmental risk factor, needs to be debated and this will be discussed further in the next chapter. Arising directly or indirectly from poverty are the following pollutants:

1. Animal and human wastes
2. Adulteration of foodstuffs
3. Ignorance in handling pesticides and other toxic chemicals and smoke from incomplete combustion.
4. Unsafe working practices and conditions.

5. Road and railway accidents.
6. Degradation of land and forests by uncontrolled grazing.
7. Anti-social practices, including "sati," dowry, obscurantism, superstitions, and corruption.
8. Diseases arising from lack of nutrition and hygiene.

On the other hand we, in the developing countries have less problems with sulfurous fumes, fluorinated hydrocarbons, excess use of detergents and fertilizers, pesticides etc.,

Poverty and ignorance go hand in hand and reinforce each other. Lack of proper infrastructure for education of the diverse categories of the students as described in the paper is the major hurdle in the education effort.

The objectives of awareness, knowledge, attitudes, skills, and participation are as relevant here as anywhere else in the world. Sven Grabe rightly points out that the education of technical personnel should provide a wide range of skills that are required in devising effective solutions to these environmental problems.

If we do not succeed in this, the technical man feels helpless and will rather aggravate the problems of the environment than give up the short-term benefits that accrue to him through the use of any technology. Thus, strategically, environmental education, in its broadest sense, gives us the hope of getting all the technical personnel to help in improving the environment rather than spoiling it.

Chapter II: Environmental Issues and Risks

For the purpose of discussing the environmental issues, the author classifies them as I) the outer environment and 2) the inner environment.

The outer environment is the world around the work place. The inner environment is the work place. The author cites as per the criteria, their impact on the quality of life.

Waste disposal is of prime importance in considering environmental degradation. Such problems are found in all types of human activity. Our understanding of the cause and effect of environmental pollution is complicated by certain findings. For example, what may often be inoffensive in small quantities can get concentrated in pockets and may enter the food chain and life cycles in quite unexpected ways, getting structurally transformed in the process. An example is the spread of chlorinated hydrocarbons like DDT or BHC and their concentration in bird and animal tissues. Another example is the concentration of mercury, arsenic, lead etc. in living tissues, mainly fish. An example of a different type, less malevolent perhaps, is the residual effects of open pit mining.

As a solution to such problems, Recuperation and Recycling is the most feasible option. More and more materials formerly considered waste, are being recycled, reconditioned and recovered. Literally, this is production of wealth from waste.

For technical personnel education should concern. l) What impact will his activity have on the outer environment? 2) What can be done to reduce the ill effects from the above? 3) How can the short term, and long term costs and benefits be evaluated?

The inner environment affects the technical person more directly and in the short term. The main issues here are l) organisational risks 2) equipment related risks 5) process related risks and 4) product related risks. These are mostly straightforward cause and effect relations and are easily perceived - but not necessarily rectified.

The organisational risks arise from bad layouts, poor training, improper work systems and procedures, poor discipline or drilling for emergencies.

Equipment related risks are improper tools, inadequate safety devices like guards etc. fatigue production, use of wrong postures in work, and perhaps even boredom. Process related risks include risks from radiations (welding, furnaces etc) fumes, toxic gas leaks, uncontrollable reactions, fire and explosion risks.

Product related risks include products that carry risks to the client. These may include unsafe, allergy producing or even carcinogenic components in the formulation, substandard designs that do not have adequate safety built in or even incomplete or improper user instructions that expose the user to above normal risks.

The author rightly stresses the need for more education for the agricultural labour in avoiding environmental risks from farm machinery, excessive or improper use of chemicals and waste disposal.

In order to get an insight into the problems of the Environment, I feel we should understand some basic "laws of nature".

1) Entropy: This may be defined as a measure of 'disorder'. The law states that all systems, left to them tend to increase in Entropy. This means that, if things are classified and segregated, they tend to get mixed up again in the non-living world. It is a distinctive characteristic of all life that living things tend to reduce disorder and increase segregation.

Thus, if a dose of mercury is let out into the environment, the inanimate world tends to disperse it throughout the planet, while the living components, from microorganisms to plants and animals tend to concentrate them in pockets. Thus, water hyacinth, considered a weed, (what is a weed?) picks up a large number of hazardous compounds, like mercury, arsenic etc. from ponds and these get concentrated in the plant tissues. NASA carried out studies to use these for effluent treatment. This is the good side of this effect. The bad side is, fish do the same for effluents which enter our system when we the fish.

2) Theory of Evolution: Though termed as a theory, it is an established law of nature, though not as mathematically precise as the law of Entropy. Living things undergo "natural selection" and only those that "match" with the environment survive. The others get extinct. This is why we find in nature so many creatures that beautifully blend into the surroundings. Boiling water springs breed microbes that need hot water for growth, Salt water breeds "salt loving" or halophilic organisms. Oxygen lacking environment encourage life forms that can do without elemental oxygen, (it can be even toxic to them) but use oxygen from chemical compounds in the environment. But all the evolutionary changes are very slow, compared to the life span of the human race and the history of our civilisation. They are therefore, unacceptable to us as methods of change. Mankind has produced its own cultural or intellectual evolution, which could also eliminate the incompatibles. Therefore, when we talk of environmental risk, we do not mean risk to the planet, but to the human race and the life species it likes. The mosquitoes, the flies, the smallpox virus and cockroaches are not in our "environment" list.

I have no qualms about being selfish in wanting to protect human and other friendly species. But, would someone want to extend the same principles to ethnic groups within the human race?

Environmental Education can start as an extension of Safety education, with which many in the Industry are already familiar.

3) Alternate Pathways: In nature everything undergoes change, though ever so slowly. And there are always many paths they can take. Not all of these paths, produce change at the same rate. Some are fast and some are slow. Some take precedence over others. But when the primary paths, cannot cope with the input, the alternate paths begin to gain significance. A simple example will illustrate the principle. When rain falls, the evaporation of water is the first reaction. When the quantity of water in the rain is more than what can evaporate off, it falls as rain on the ground. What falls on the ground is absorbed in the soil and when it saturates, it percolates down into the ground as groundwater. When the rainfall accumulates on the ground, it indicates that the rain input is more than the percolation rate and it starts to runoff- the third path.

Thus, each pathway is affected by others and has the capacity to affect others. Thus, when we ingest a "chemical" our body reacts to eliminate it through metabolism. Some are eliminated (after transformation) fast, some are eliminated slowly. If we ingest these chemicals, at a high dose, the common pathway gets saturated, and the chemical overflows into other paths. These effects may be harmful (or deliberately produced in order to deliver a drug) at a specific point in our body. The laws of nature are beyond our control. We can only understand them so that we can live in harmony with them.

(4) Laws of Scale: There are some operations which give economy of scale. Others act in the reverse direction, (the law of diminishing returns.) Both effects may be seen in the same operation in different phases of growth. Urbanisation is a phenomenon arising indirectly out of the economics of scale. Urbanisation overloads the processes of nature, causing the pollutants to "overflow" into unacceptable paths. We call this pollution.

On the other hand, it follows from the principles of entropy that it is easier to tackle a pollutant in high concentration, (which it is at the source) than after it has dispersed even partially. Also in high concentration, it can mean better recovery of the product (e.g. sugar) than when it gets dispersed as a pollutant (sugar factory washings). Thus, avoiding pollution can often mean better efficiency in the main operations.

Urbanisation is a pollutant by itself. However, the second industrial revolution may help to reverse the urbanization trend. There is a hope in this for the third world countries. We may be able to use the second industrial revolution to develop without excessive urbanisation.

Chapter III: Technical and Vocational Systems.

Estimating the needs of the various technical and vocational education systems in regard to the environmental curriculum and it implementation, is a complicated task. The main reason of this complexity is the diversity of technologies this education covers and the many levels at which it is given.

Diversity: Engineering, Health, Agriculture etc.
Level: Graduate, Diploma, Technician, General students,
Unorganised: on the job, extension, adult education etc.

The curriculum has to bring out the relationship between the "trade" and the environment, the specific hazards and the possible solutions. The variety of topics makes it difficult to be specific. The variety is almost as great as the variety of income generating activities in society. This makes it necessary to categorise and give ''models''.

This means abstraction and conceptualisation.

This brings us to the other dimension of this diversity, the levels at which the education is given.

The training of graduate engineers does not pose much of a problem. They are trained to learn through abstraction and can (or should be able to) use concepts to develop a line of action. These engineers will also be occupying more influential positions in their future career. The variety of graduate technical courses could be counted in tens and many of these could share common courses.

At the technician level, the number of different courses will already rise to hundreds and the trainees need more specific instruction with less conceptualisation. They also need more practical demonstration of actual practices desired.

At the non-formal / adult education / extension work level, the short term training courses will run into thousands. The materials they handle, the processes and the local environment, will all be different and changing all the time.

Environmental problems are interdisciplinary. They relate not only to the physical sciences, but also the biological sciences and the earth sciences. The students are likely to be familiar with only one of them. How can they be taught the principles of all of them?
This is the contradiction in the modern world; even as specialisation increases, the importance of multidisciplinary studies also increases.

In order to tackle this complex task, Sven Grabe proposes three channels, l) Adult training and retraining systems 2) Extension wings of agriculture, health and engineering education centres, 3) Public and private enterprises, who in the end are related to every possible technology, either as producers of inputs, users of output, or actual processes (e.g. fuels/chemicals, consumer goods,). Somewhere in the environment chain, the public and private enterprise could intervene to show the way for tackling environmental problems. They are often the generators of new technology and are in the best position to influence it.

In short, if the environmental education needs of each technology are different and complex because of the diversity, the environmental education is best given by integrating it with the technological curriculum itself. How to do it, is discussed in Chapter IV.

Chapter IV: Planning Environmental Education.

Conclusions from earlier chapters are as follows:

1) General environmental education should precede entry into the technical - vocational stream.
2) Environmental education in technical streams should relate to the outer environment and the inner environment.
3) There should be differentiation in what is taught about the environment, depending on how the trainee is concerned with the environment and what possibilities exist for him to influence it.
4) Environmental education should be a life long process.
5) A multitude of channels should be used for giving environmental education to technical streams.

1. General (Initial) Environmental Education:

This should include the concept of ecosystem, energy, and material flows in the various "cycles" that we consider important in nature. The dynamics of population growth (not only of humans, but animals, insects and microbes, the common mechanics) are important.

This pre-education will be more effective for the higher level graduate engineers etc. For the technician levels, it may not be absorbed in the first place and may be less critical. For this the relevant parts of the general environment education are best integrated with the skills training. The parts to be stressed are the awareness, development of skills, and participation in maintaining the quality of the environment.

2. Occupation Oriented Environment Education.

This should deal specifically with the following:

a) Create awareness about all the outflows from their activity and how they merge into the outer environment.

b) Information and skills for recycling by-products, waste disposal practices.

c) Maintaining the "beauty" of nature.

d) Safety consciousness in work.

e) Standards of performance of their products.

f) Indirect costs of damage to the environment, arising from their activity.

In all this calculation, the habit of looking ahead into the future, of visualising, is one of core importance. But this is not possible to the same degree or for all levels of technical personnel. For those who cannot visualise easily, drilling in safe and sound working practices is all that can be ensured.

3. Adult and Continuing Education.

Both Science and Technology in the present age are moving fast with new processes and new materials, products etc. coming into use. Science is giving new methods, instruments and analytical techniques, modeling etc. to detect and trace even minute perturbations in the environment. Every curriculum can become out of date even before its implementation becomes standard.

Environmental education, therefore, has to be a continuing life long process. Adult education; therefore becomes an important channel for environment education, not only for those who missed it in their youth, but also for those who have entered the working life with a proper background in environment studies.

The prime target group in adult education should be those responsible for products and processes particularly important for reducing environmental risks. Training and personnel Development Officers should be trained first.

Environmental education for adults will also make it easier for the younger generation to implement their ideas on environment clean up, because their elders may understand what they intend and accept it readily. Environmental Education can start as an extension of Safety education, with which many in the Industry are already familiar.

The awareness and standards for environment will vary from country to country as they do now for safety. But essentially every region has to start from where they are.

Subjects in Environmental Education:

In higher technical education, the curriculum should include:

1. Pollution from wastes and emissions and technologies for cleaning up.
2. Basic ergo metric and Industrial Engineering.
3. Activities and norms for public authorities and public bodies dealing with environment.
4. Sources of authoritative information on environment and pollution.

The course work will be theoretical and practical, and the practical content will increase in the intermediate and lower level technical education. Students should be encouraged to take up projects, particularly at the graduate and postgraduate levels of technical education. They will include identifying, defining and solving problems.

The following topics are, in my opinion, of prime importance in India and perhaps in all Third World countries.

1) Operations, which are inefficient and cause pollution as a consequence:

a. Incomplete combustion: domestic stoves, industrial furnaces, IC engines-diesel and two stroke.
b. Incomplete Recovery of product: e.g. sugar, other food and chemical industries.
c. By-products not fully utilised: Sugar and many organic and inorganic industries.

In these, there is money in stopping pollution. What is lacking is organisation and knowledge.

2) Factors responsible for loss of production, life, and property:

a. Lack of discipline - instructions are not followed meticulously.
b. Road and rail accidents.
c. Concepts such as pride in work, good Citizenship, civic sense, garbage, unhygienic public places, disregard in use of public property, disregard for other peoples' needs.
d. Lack of health consciousness.
e. Adulteration and use of non-permissible ingredients in food products.
f. Lack of safety consciousness in working/handling energy, hazardous materials, fragile things etc.
g. Economical use of scarce resources e.g. water.

h. Training and drilling in emergency procedures- first aid and fire fighting, explosions, collapses, snake bites etc.

On the one hand, third world countries recycle more material (for example, waste paper, plastics, metal scrap etc.) and on the other, they spread more garbage around and are less conscious of aesthetic needs (slums particularly) during urbanization, lacking discipline and awareness.

3) Factors where environment could be more pleasant and healthy, with little monetary cost but a lot of collective effort.

a. Afforestation, good sanitation, clean villages, removal of slums.

What is lacking is awareness and local leadership.

Chapter V: Teacher Training.

All technical and vocational education should combine:

1. Study of related science and technology.
2. Development of skills.
3. Application of knowledge and skills.

The environmental education must also have the same three components. The trainees must handle live environmental problems; experience the constraints and limitations of the work place. They must learn about the organisation and the role of economic and human factors that mould decisions.

Environmental discipline is best learnt by having the direct experience of working in a well-organised group. Unfortunately, such groups are not too common. If teachers can be induced to maintain such a work place, the problem will be much simpler.

Environmental discipline is like a "health" factor; lack of it attracts criticism, having it does not bring rewards. The decisions, therefore, give precedence to output rather than the environmental discipline.

There are two distinct groups among the teaching staff: The "lecturers" and the "instructors". The former are more at ease with preaching and the latter have less concern with theory and are concerned with getting ahead with the job in hand. The teaching and practice are bifurcated. This is a major problem in teaching environment related curricula.

The core of teacher training should relate to ergonomic principles and practices, work place organisation, and sources of information on environmental issues, including safety and health. It may be integrated with industrial engineering programmes. The bulk of the environmental education however, will have to be sharply focused on individual subject areas and the stress should be on practicing rather than teaching only.

The general, education on environment would have been given already to the trainee teacher; therefore the task will be to 1) update 2) Supplement those who did not have the formal initial education.
The channels for environment education will be 1) Teacher Training Institutes 2) In-service training for full time teaching staff 3) Extension services: Management training institutions, Industrial training and Development associations and 4) Professional journals, reaching the teachers.

SUMMARY AND CONCLUSIONS

The subject is complicated because of: 1) the wide variety of environmental risks 2) The diversity in technical Institutions 3) Fast changing scenario.

The technical staff has a great responsibility towards environment protection as they play a strategic role in improving or damaging it.

The objective of this education as defined by UNESCO/UNEP Conference is to create awareness and give the ''tools'' to solve the environmental problems.

The paper repeatedly stresses the complexity of the task of environmental education. But it does not formulate any strategy apart from seeking integration of environment education with the technical curriculum.

This is because the implementation has to be tailored to each group individually. I recommend that each group identify and prioritise its list of environmental tasks. In the Third World countries, poverty should be priority number one.

I suggest the following strategy to initiate the debate:

- Identify the environmental risks, which do economic damage.
- If these are tackled, not only must the environment be improved but also, it will bring economic benefits to the society, thus encouraging the solving of other environmental problems.
- Demonstrate the results in as many situations as possible.

Examples -

i) Complete combustion of fuels.

ii) Optimal use of animal, human and agricultural wastes.

iii) Recycling of waste and by-products.

iv) Packaging and distribution of essential foods to counter adulteration of foodstuffs.

v) Safety in work, home, and road-rail systems.

vi) New forest and common land policies that will give a vested interest to the section of the community whose life is dependent on them.

vii) National campaigns against health hazards like smoking and chewing tobacco and similar products.

viii) National campaigns against anti-social practices, such as dowry, discrimination against women and certain castes etc: Many of these are already being done, but not seen as part of the battle for a better environment. Also they do not go into the educational system.

The new education system will by definition produce development of body, mind and society, and be suitable for all.

VIGYAN ASHRAM: WHERE DO WE GO FROM HERE?

Introduction:

What can make people forsake the city and a settled life and go to a remote village and start life anew?

It is the dream, that they pursue. We should, therefore, start from that dream and follow the progress of this dream and see what chance it has of becoming a reality.

The Dream:

Restore India to a glorius status in the world, prosperity with social justice. Compare Ashoka period; when India sent out ambassadors of peace to all the world and we influeced the whole of Asia-east, north and south of India. The dream is always accompanied by some vision of how this should be done. Every one has a model of how one should try and fulfill the dream. The model is not a 'rule book', but certainly it is a guidepost.

Before we describe our model, let us see what models are around. Most groups, government agencies included, usually have some fixed ideas and rarely see beyond that. In all their plans, forms and programmes, they try to fit others into their cast iron mould. It helps therefore, to put all these models together and say 'we are not following that model but this is our model'.

The new education system will by definition produce development of body mind and society, and be suitable for all

Models:

1 Empowerment through Education. (Mahatma Phule, Maharshi Karve,)

2 Cooperative enterprises; to give income generation; (Amul),

3 Social Reform; remove superstition; liberate from caste and tradition shackles etc. (Raja Ram Mohan Roy)

4 Mass Movements; resistance; confrontation; (Chipko, Narmada Bachao)

5 Give access to finance: (Gramin Bank; Mahila Savings groups etc.).

6 Rural Development; Projects; (Water Shed Development, Health Projects; Sanitation. Housing projects; Supply of drinking water.)

7 Science and Technology: Ultimate benefit to the whole humanity. (Louis Pasteur; Edison)

8 Strengthen the Moral Fibre of Humanity; (Gautam Budhha; Swami Vivekanand; Mahatama Gandhi.)

9 Economic restructuring; (Either through socialism; or open market system);

10 Do Good ; Charity; Compassion: (Mother Theresa)

All the above are models that have been used by many. We have to choose a model, based on our conviction, temperament and abilities. The models are not mutually exclusive but the main direction has to be clear.

The prevalent idea of an NGO is represented by the Mass Movements,'Andolan' or the Water shed development- Sanitation type 'Rural Development' programmes, or the women's self finance groups. These are desirable programmes but are not part of our dream.

With my experience of what can be a good education, the commitment to moral values and belief in Science as a tool for human progress, I chose the models of Education for Empowerment, (1), Science and Technology (7) and strengthening the Moral fibre (8) and expressed our mission as follows.

The mission:

To develop a system for giving to all the capability to think and act, keeping equity in mind. The new education system will by definition produce development of body, mind and society, and be suitable for all.

Vigyan Ashram was formed with a commitment and mission: HRD of the educationally handicapped. Why Education? because the ability to think and act determines whether you can stand on your own or be a victim of exploitation Value system determines whether you will exploit others.

The Strategy we have adopted is:-

- Learning While Doing in Real Life Situations
- Using Science for providing new opportunities
- Using the Value System that is universal and applies to all the people..

  The journey to development becomes smooth by involving rural population in the technological development in life situation.

We feel we have some success, sufficient to keep us bouyed up to pursue our goals. Some examples will illustrate.

Examples:-

1 The Rural Laboratory programmes teaches health related techniques and at the same time has the potential to reach the

smallest village at a very low cost, unthinkable by any other method. The service enables the understanding of the technique by even school dropout girls, and the learning process makes the service available to remote villages. Now this is being done in 15 schools, spread over Central and Western Maharashtra.

2 The same rural girls are developing and learning new technologies that help income generation. (Food products as an income source)

3 The rural girls and boys are now becoming familiar with modern multimedia computers, and in fact help to make lessons that will make learning easy and enjoyable. All our computers are made by us and maintained through rural youth. One representative from each of the schools was given training in for weeks in using the Computer (Windows operation, MS Word, PowerPoint, Access, and Excel and an Account system) and to assemble and dismantle the computer repeatedly until they feel confident. They have taken it to their villages and set up and started using. They can install, partition, and format hard disks and load operating systems and other programme.

4 Many rural girls have not only learnt the use of computers but also have contributed in making computer lessons for others and some are training students.

5 Many girls and boys have started their own enterprises with own or bank funds and the total output of our ex-students in this 25 km area alone is over 2 crores per year. Shubhangi Shinde (who is a polio victim is running a Poultry using our techniques and has a turnover of about Rs70-80,000 per month; she is planning to have a 25% expansion. Sindhu Borhade (education 5th standard) has a poultry with more than a one lakh turnover per month. Sunita Jadhav makes and sells Chikki , a snack, she herself helped to develop in the Ashram and earns a profit of over 2 thousand per month.

6 Shindade (a drop out, SSC failed) has a workshop, where he

makes and sells MechBull minitractor . He helped develop this at the Ashram and now he has commercialised it. This year he has sold 3 units worth nearly 2 lakhs, beside normal steel fabrications worth about a lakh per year.

This education system has been found effective for Adivasi boys and girls and this year they form 13 out of 23 students in our Basic Rural Technology course. All of them pay normal fees and have no stipend, but have the opportunity of earning while learning.

The network partners in this endeavour form a technology delivery channel. Because they have the facilities as also the training and experience in various fields such as Engineering, Energy-Environment, Agriculture-Animal Husbandry and Home and Health, and because they are also familiar with Computer Technology, new technology can be delivered through them and they can themselves develop as per their needs.

Our Rural Lab Technology is now being operated through these in as many villages. The combined Community Services of these is over 2.2 lakhs in the last 7 months. We are building up a network to raise this to 5 lakhs per year.
More NGOs are approaching us to join our network and we plan to increase the network to cover 25 NGOs by 2002. After fine tuning our software and training systems, the system should be ready for broadcast to hundreds after the year 2004.

Has our mission succeeded? No. We have yet a long way to go. And it is a race against time. If we do not achieve a perceptible increase in the tempo of progress, we shall be overtaken by other corruptive, disruptive and violent forces, already visible in the country.

The New Millenium

Where do we go from here?

We have to increase our tempo of work several (may be 10-20) folds. If we analyse the delays in our work, we have identified two critical sources.

1 Delay in communication, causing delayed feed back and slow and often too late corrective action. So speed up communication, using e-mail and internet.

2 Poor quality training systems: Learning does not take place as desired. At every stage there is a distortion in the learning and what reaches the lower levels is poor quality learning. Here, we are aiming at Computer based learning. We have found this more cost effective and has the potential of faster replication and with assured quality. It will also give access to a wider world of information. We have started making Multimedia lessons developing new pedagogy that fully utilises the multimedia potential.

Assuming this eradicates poverty, brings prosperity, shall we be happy and peaceful? No. Already we see that the world cannot support spending of its resources in the way the present prosperous society is spending. It is not just a question of the environment. Are the people actually happy? Do they have the peace of mind? Neither the rich, nor the poor are happy. Neither the 'materialist' west nor the 'spirtual' India /east are happy. It is not the Western Model or the Eastern. We have all, by and large, lost the Art of Living. We are confused about what the quality of life means. We do not know how to progress in S and T and yet live a frugal and happy life. We need to recreate the atmosphere of the Ashoka period, when individual purity of the mind was stressed. This is the process by which we shall satisfy all our needs without having any greed.

This will need the spread of the environment of goodwill and trust through strengthening of the moral fibre. This is something we cannot do by planning. We can only start with ourselves and produce an environment in which it spreads by example. We are trying to use the same techniques (Vipassana), that brought the Golden era in the Ashoka period.

If we did it 2500 years ago, we can do it again. That will be our Mission.

Scientific temper or scientific approach is a refinement of this same thinking process that comes naturally to every human being.

DEVELOPING SCIENTIFIC TEMPER

From the time of our independence, beginning with Nehru, we have been saying "our people must develop scientific temper; then only we can progress". Scientists, political and social activists are all for this scientific temper. But what is this scientific temper? How can anyone develop it? I feel this is generally not clear. This is what I shall talk about today.

Some consider scientific temper to be the same as rational thinking. Some consider it as not believing in superstitions. But I feel scientific temper is something more and somewhat different. Rational thinking is a subjective idea. Every thought is rational to the thinker at the time, in that state of mind. Later to him or others, it may appear irrational. Superstition is also based on an explanation put forward by somebody with incomplete knowledge and accepted by others as rational from their point of view. Nobody accepts anything that he considers irrational. Even among scientists, there are often debates as to which explanation is more rational. On the other hand, we often do what suits us, and then try to rationalise what we have done; this is finding excuses. Intuition often leads to action and if it succeeds, we look for the rationale later. This shows that what is rational to one, can be irrational to another. Equally, what is considered

__Scientific temper or scientific approach is a refinement of this same thinking process that comes naturally to every human being.__

irrational at one time may appear rational when newer information is available.

The very process of learning by the human mind is based on rational thinking. We get all our information through our senses. On this basis we make a "model" of the external world or reality. This model is a set of "rules" that we all accept on the basis of common experience, such as, fire burns, all things fall down when thrown up, two and two always make four and so on. This leads to development of concepts such as the concept of groups having common properties, the concept of numbers etc.

Whenever our model fails, we either change our model to accommodate the new experience or keep it aside as a "miracle"

What we call rational thinking is anything that fits 'our model.' This model changes with age and experience, therefore, rational thinking is not constant. If we think more about this process of learning we can see the similarity with what we call scientific thinking. We collect experience through our senses, make a hypothesis or a model, and then test it in a real life situation; that is our experiment. Even the idea that when you consider the effect of something, everything else must remain the same or unchanged, is a concept that every child develops at some stage. Piaget, who for forty years studied, the process of learning in children, has enumerated a large number of such scientific concepts which come naturally to all children through life experiences.

Then why does not everyone have the same kind of rational thinking? Making use of information is a skill that is not developed equally in all. This is where some people, who do not make use of all the information or draw wrong conclusions, appear irrational or unscientific to those who are better in these skills.

So in conclusion, the rational thinking process is natural to all human beings. What goes wrong is the set of rules or the model one uses for this thinking. This in turn, is based on the inadequate experiences of that individual.

Scientific temper or scientific approach, as I prefer to call it, is a refinement of this same thinking process that comes naturally to every human being. Let us see what the components of this are and how they make a difference.

1. Observation:

We get signals from the outside world all the time; sounds, pictures, smell, etc. We cannot possibly take note of all these. We select from this what we want and are also alert to anything that is unusual. This is observation. It is a skill that needs to be developed. Observation is focusing our attention on selected stimuli, generally for a purpose. This has to be developed. Otherwise, our information base is likely to be inadequate. Some people who have their eyes open but mind somewhere else cannot get the same information as others who think about what they see.

2. Quantification:

Quantification of the information is an important part of the scientific temper or approach. Measurement and familiarity with the different units of measurements are important skills. Quantification increases the resolution of our observations. This means we can detect smaller differences that would otherwise be missed.

3. Organisation of Information:

Information, however valuable, is almost useless, if it is not organised. Organisation includes classification, tabulation, pictorial representation etc. In this connection, the observation of Al Beruni, the 11th century traveller, on the state of Indian Science at that time, is very relevant. He commented that, we lacked classification and gave equal value to 'pearls' and 'rubbish'. Organising information reflects organising our thoughts. It arises from both creativity and tidiness. It often makes all the different between the right conclusion and the wrong one.

4. Comparison of Information:

This is an important process in the scientific thought. We compare only after we bring the observations to a common base. This sounds commonplace, but its implications are deep in everyday life. The farmer rarely calculates his yields/acre or hectare and can hardly calculate the rate of application of fertilisers or pesticides. The urban shopper rarely knows the price per kg. of the packaged product he buys. By not comparing we lose the opportunity to adopt the better of two alternatives and improve. Comparison implies exchange of information.

5. Recording of Information:

Lack of habit of recording is another cultural weakness in our society. A large part of our history has been written by ancient travelers. We do not realise that information is a capital asset and by not recording it, we are throwing away assets. Then we spend more money and time collecting it again. Or else, we forego it and suffer the consequences – lack of progress.

6. Recognising Trends and Patterns:

This is an intellectual skill. This should also be practiced. We can start from kindergarten and train our new generation to look for trends and patterns. From trends and patterns we begin to wonder and question "Why?" and "How?"

7. Hypothesis:

The Why and How questions lead us to a hypothesis. We should not be satisfied with one hypothesis. We should form the habit of making alternatives – this is what we call rational thinking. We often forget that we can rationalise almost contradictory observations. Rational thinking alone leads us no where. Making hypothesis without sound information can be counter productive.

8. Experimentation:

Last but not the least, testing of the hypothesis is an important step we cannot forget. Every experiment is a test of a hypothesis. This testing is also a skill. Experimentation needs manipulative and organisational skills. We need these also in our everyday life. Experimentation is not only for the specialists and the Research and Development establishments. To say that "I will find out by trying and learn", is research; and "I will keep trying and improving", is development. Our society must imbibe this spirit of R&D. I believe that if our society learns the above methods of science, it will be far more important than learning the laws of physics or the formulae of chemistry. Moreover, once the methods of science are absorbed, children will be motivated to learn the concepts of science and the facts by themselves.

Out of all the above skills, the organising of information, recognising patterns and making a hypothesis, are expressions of creativity. This is what intelligence is. The same information may be sometimes, tabulated in different ways to bring out startling conclusions.

Another quality, not a skill, is often an important part of the scientific approach. This is the ability to bring out more than one hypothesis so that we can choose the best from the alternatives. The tendency is often to stick to the first thing that comes to the mind.

Another skill that is not part of the scientific approach, but a valuable asset in scientific thinking, is the ability to express, precisely and concisely. There is a strong belief that we can only think in a language. To be able to put our ideas clearly, therefore, helps in thinking.

Therefore, in conclusion, developing scientific temper involves refining the natural process of thinking by inculcating certain habits and skills. These include sharpening our observations, acquiring a habit of quantifying information, practicing recording of all relevant data in a systematic way, organising the information to be able to recognise any patterns, thinking about why and how those patterns arise, making a hypothesis, that is, thinking of a possible explanation for the observed phenomena, and finally verifying whether the explanation holds good in other similar situations.

It is my experience that the above approach is not only useful in technical matters but also in all everyday activities. Such a scientific temper gives immediate economic returns by increasing efficiency and productivity. I feel that if we succeed in giving this scientific approach to all our students at the school leaving stage, they will learn by themselves for the rest of their life. Unfortunately, even many of the science and engineering students do not have such a scientific temper and therefore make poor scientists or engineers.

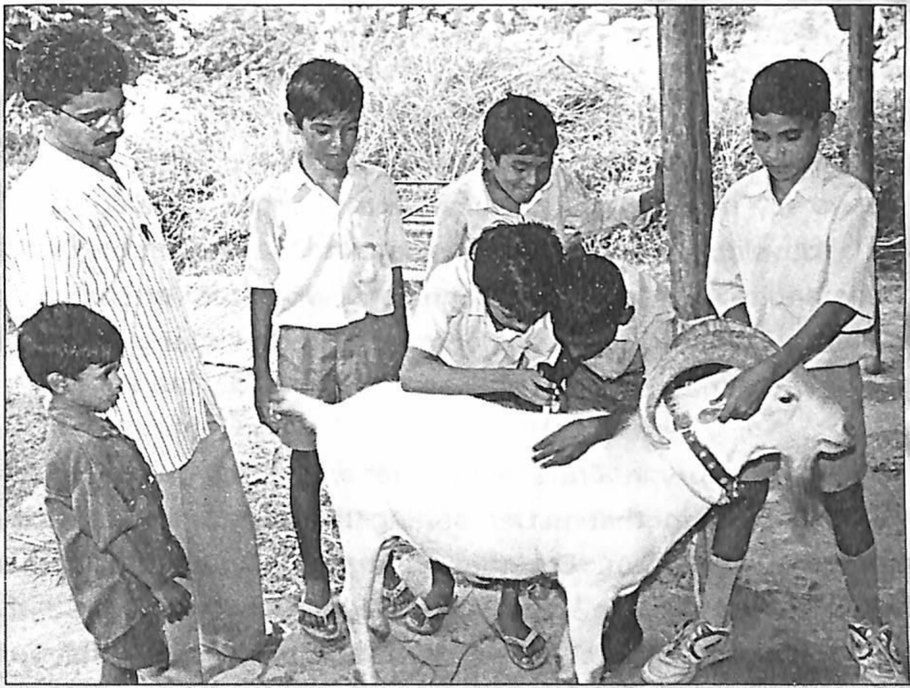
Pabal
3 Sept 1983

My dear Mira,

In the big book by Ravi Mathai entitled if I remember "Jawala Letters – Rural University" or something like that, he defines a University as a place where everybody – the student as well as the teacher are learning all the time. I liked this definition. That book was interesting reading but what the organizers had learnt was that their idea does not work.

Our Vidnyan Ashram is also a rural University in this sense. While we are here to educate, what gives me joy and pleasure is not the joy of teaching (it is certainly there) but the joy of learning. Throughout my career I tried to keep learning something new. But I am now learning probably at the same rate as when I was a student just about to graduate. Learning makes one feel young in mind. The difference is that about thirty-five years back, the learning was mostly academic but now it is in doing. This project is giving unlimited opportunity to exercise my creativity (Can there be any field where one cannot show creativity?) I am also learning about people, how to work more with less tension and so many other areas you would call "Philosophy". So I am looking forward to the time when you can join me here – in the learning process – learning by doing.

The first house unit is nearing completion, the target is still 10th Sept. But only after electric connection is given, we will shift. They have at last erected the poles and I hope they will draw the cables soon. Our electrical contract has been given and the work will start on 7th & expected to complete by 16th or 17th.



Our rural areas are unexplored lands, figuratively and a creative scientist/technologist will find it like a gold mine of opportunities, where he can apply the simplest of science and get good results.

RURAL AREAS: GOLDMINE OF OPPORTUNITIES FOR CREATIVE SCIENTISTS

Development means change for progress; this is what we mean when we say research and development or urban development or National Development. But when we say rural development, there is a connotation about low-level technology, voluntary agencies and 'sacrifice'. The term rural development connotes many things but not science or modern technology.

Setting up a factory in a rural area is generally not considered rural development, nor for that matter, setting up a farm or a plantation or construction of a dam. But these are major rural development activities. With this background, I will attempt to remove this misconception about rural development and try to show that rural development in the true sense has been a largely unexplored field for our scientists, technologists, and entrepreneurs.

The present kind of rural development is low in technology, because most of the agencies and individuals involved are not trained in science and technology. Yet this, in no way indicates the relevance or otherwise of the sciences in the rural context.

Working for Rural Development is also in someway associated with 'sacrifice'. I would like to show that there is no sacrifice involved at all. You lose something but you gain something too.

Who were the pioneers, who ventured into the western parts of America, after the first settlers landed on the eastern shores of the new continent? They did not "go west" as a sacrifice; they went in search of opportunities and adventure. The people who go to the Himalayas for trekking and mountaineering certainly forego the comforts of a city life, but do they sacrifice? No. They go for excitement, thrill and adventure.

Our rural areas are unexplored lands, figuratively and a creative scientist/ technologist will find it like a gold mine of opportunities, where he can apply the simplest of science and get good results.

Isn't a good scientist expected to select his project, where he will explore the unknown and feel the thrill and excitement of discovery?

Our rural areas are unexplored lands, figuratively and a creative scientist/technologist will find it like a gold mine of opportunities, where he can apply the simplest of science and get good results. Every problem is an opportunity for a creative scientist. It is only a creative person who sees opportunity in a problem. Lesser persons are blinded by the magnitude of the problems or their persistence. Therefore, a creative scientist or engineer will not consider it a sacrifice to tackle the problems of rural India.

Everyone knows the difference between discovery and invention. Discoveries push the frontiers of knowledge. Inventions make the tools that make discoveries possible. Both bear testimony to the creativity of the human mind. We owe our debts to the Edisons and the Einsteins of all times.

The question is not whether creative and adventurous minds should go for invention or discovery or whether one should work for pure science or industrial research or rural development. They will go where they feel the challenge. Louis Pasteur went to help the wine makers of rural France and laid the foundation of microbiology. We commonly start with techniques invented by others and then look for a problem to apply them. There must be an equal thrill in taking up a problem from real life and then inventing a technique to tackle it. But we do not do much of this in our laboratories.

Trying to solve a real life problem, a problem that is significant, could unearth new observations that could give new directions or new meaning to existing knowledge.
Maybe the problems of our rural areas are like mopping up operations for an army of scientists, while the real frontiers have been pushed far beyond. There may not be much chance of radical discoveries, new observation or theories but new techniques can be developed. We are still unable to control the tiny mosquito or the pests on our crops. Finding a solution to this presents a challenge.

Sophistication and creativity do not necessarily go hand in hand. A scientist working with sophisticated instruments may have more glamour but not necessarily more creativity. Not everyone in today's universities is going to end up being an award winning scientist or engineer. Many of them could get more satisfaction and seek an outlet for their creativity by solving some of the myriads of problems in the rural area.

Do scientists working for rural development have to stay in the rural areas? There is no doubt that there is a relation between the site of the problem and where the work is done. To observe the problem and sense an opportunity, one has to be "immersed" in the problem. One has to be on the site. During the stage of formulation and conceptualization, we need to be a little bit away so that we can look at it from a distance and see it in its perspective. The details can be worked out anywhere as long as there are constant reminders of the rural environment and its constraints. Finally, one has to constantly test it on site.

Keeping in mind that one has to handle many problems in different stages, one has to be close to, if not surrounded by the rural environment. The best solution seems to be to have urban and rural centers with a close link and work going on in both places in the same way in which industrial research and factory development are linked. But the idea that good rural development can be done only if you wear khadi must go.

I suggest senior scientists could spend their weekends or vacations in real, not simulated, rural environments for this would enable them to enjoy the outdoor life. Fresh graduates, particularly engineers, could spend anywhere from 3 months to 2 years learning how to tackle problems on their own, seeking guidance only when needed.

I shall now list actual specific problems to illustrate the kind of opportunities that a traditional rural development worker does not perceive. Somebody with a different background will see another set of projects, but no scientist-technologist with a creative mind will say nothing can be done. There is a lot that needs to be done and can be done in different fields.

Water: Water is the most critical parameter in the whole of India. In most parts, there is a lack of water and in some parts, it is in excess. Science can be proud of the accuracy, with which areas can be mapped, but the subsurface geology of our country is known only on a gross basis and all selection of sites for percolation tanks and wells is done through casual geological surveys, if at all. The scarcity and high cost of these geological and geophysical services is the main constraint. Demystification of this knowledge and training at school level will make it widely accessible. All services related to water, microbiological testing, pump installation and repairs, plumbing etc. fall in the same category.

Construction: This is widely recognised as a priority area for both urban and rural needs. Operation Blackboard aims at providing just two classrooms of 28 m^2 for every primary school. But at Rs.25,000 per classroom, the budget is going to be a major constraint on this program. Yet, if you look at the cost break-up and the specifications, there is no reason why the cost could not be halved. Roofing is the most expensive and critical part of the construction but there is not enough being done to explore new composites and new designs.

Sanitation is a high priority. So the cost (Rs.1100 per sanitary block) could be reduced to Rs. 250, by substituting the roof and brick walls with reed screens and plaster. Water storage is an important need in the home. A ferrocement tank with a tap is cheaper and more hygienic than steel barrels but they need to be made locally.

The geodesic dome offers an attractive possibility for a variety of applications, from homes, classrooms, hospitals, green houses, cages for poultry, silos etc. The concept of modular, prefabricated construction has good potential. Standardized RCC columns and panels could provide simple constructions for cowsheds, storage spaces etc. Ready-made trusses could be more economical than wooden trusses that are very expensive now. Similarly, doors and window frames offer scope for being sold as standard products.

Workshop services: This offers very good scope. One cannot expect farmers to use pumps and engines and take the pipes 20 kms. away for cutting and threading or for minor repairs. There is need for a workshop facility within 5 km. of every place. The workshop with welding, drilling, and fitting facility is not just a service. It is an invitation to the lay public to modify and invent. Once the facility is available, people begin to think what else they can do with it. If the skills are spread out, the number of inventors will also multiply. Even if the rupee value of this service is not great, the strategic and economic value is high. When a water tanker has a breakdown or springs a leak, a local repair facility is worth much more to the community, than the cost of repair to the owner.

Energy and transport: This is one of the most neglected fields in rural areas. Even when electricity is supplied, it is most undependable. Voltage surges reduce the life of filament lamps to 1-2 months and tube lights do not light up when the voltage is low. A small Induction coil for the filament lamp and an oscillator for the tube light are possible solutions that will be cost effective for these applications. Most of the kerosene used in the rural area is for lighting and the hurricane lantern is an inefficient device. Even when all villages are electrified, a large population will not have electricity for lighting, simply because they are too far from the nearest pole. A battery operated tube light even 8 W would be brighter than the lantern. Battery recharging by photovoltaic system or windmill could be viable even at today's prices. But the accessibility and services are lacking.

I have already mentioned wheelbarrows for improving productivity but nobody sells wheelbarrows even in a city like Pune; they are made to order. They could as well be made in the rural workshop. The bicycle is not a mere personal transport but a goods carrier – often carrying 100-200 kg of load. It will surprise many that the maintenance cost of a bicycle comes to about Rs. 10 per month. So many of them have broken frames etc. and need welding. There is need for designing a stronger vehicle. A motor-assisted bicycle may be an alternative to a moped at less than half the cost and offering many other advantages. Mopeds and other two wheelers are rapidly increasing in popularity but none of the services are available.

The bullock cart is not an efficient system. If we get rid of the bullocks we will have more fodder for the milch cattle. But today the bullock cart is essential. A pair of wheels for the bullock cart cost Rs. 2000 and more. But the axles are not standardized. Steel wheels of identical size cost half the price, but they are not widely available and the skill of making a wheel is not as common as the wheel itself. The pneumatic wheeled cart is at par in cost with the conventional, but air and tube services are not common. Mechanisation of the "bullock" cart is possible and viable but workshop services need to spread fast.

Agriculture: Pump sets; pesticide spray pumps, tractors, and many other mechanical devices are quite common but suffer from lack of services. Systems like drip irrigation are capable of simplification and wider application. In water scarcity areas, the opportunity cost of water is very high. The economics of intensive green house cultivation of vegetables should be explored.

Protection of farms and forestland is an important need. Fencing is quite expensive. Even live fences are difficult to grow and maintain. Electrical fence controllers need to be explored.

Nursery operations need investigation to improve rate of multiplication. Use of hormones and chemical regulators is not fully exploited. Hybrid seeds also need many services. All these give opportunities for employment generation. There are enough indicators to show the possibilities.

The storage of grains and the packaging of fruits and vegetables needs a lot of attention. The cold storages also need attention to reduce water requirements.

Animal Husbandry: The economics of the cross- bred cows is threatened mainly by the fodder cost. Concentrates are the cheapest feed for cows in terms of milk production. There is a need for roughage feed or an increase in fodder production. The other constraint is a source of calves with known pedigree. Nobody breeds cows; poultry is more popular. Hence, for cow breeding, embryo transfer technique will be most useful.

One of the factors that upset the economics of the dairy industry is the uncertainty of conception after artificial insemination. The calving cycle often exceeds the ideal of 360 days by 60-120 days. Lack of a pregnancy diagnosis test kit creates an uncertainty for about 3 months. Goats have many potential advantages but the technical services are even poorer than in the case of cows. Artificial insemination of goats becomes even more important because of the smaller number of good quality sires and the infrequent heat cycles of the animals. The need for a technique for synchronization of oestrus is also important.

Poultry is a rapidly increasing agro-based industry where breeding is being done by an organized sector on a scientific basis. But poultry housing, feeders and water holders need new designs to help the small poultry man. Egg storage, poultry transport and marketing could be developed further to encourage the small farmer or the landless, like in the case of milk production.

Health and Home: Biogas is a good energy source and also fulfills sanitation and health needs. In spite of the subsidy and the effort aimed at its propagation, it is growing relatively slowly. One of the reasons might be lack of services. All the Biogas Repair Units are expensive set-ups and the repair cost/unit comes to approximately Rs. 2000 per plant, which is about 30% of the new plant.

Nutrition and Health education including education on the ill effects of tobacco and excessive use of chilies is important; many seem to suffer from ulcers. First aid training needs to be given widely. Scorpion, insect bites, snakebites and rabies are dangers in rural life.

Food preservation: This has a wide scope on home scale. Here, the use of modern plastic packaging and the pressure cooker should take us beyond pickles, papad, and dehydrated potatoes. Fermentation as a food preservative technique is not fully exploited.

To summarize

The rural scene provides ample scope for an adventurous and creative mind to apply science and technology. Education could be the main medium for bringing about this change.

We should spread scientific methodology through education to all sections of society, in a way that it is absorbed into the culture.

EMPLOYING METHODS OF SCIENCE AND TECHNOLOGY FOR THE BENEFIT OF RURAL INDIA

We are all aware of the substantial investment that our nation has made in S and T education and research. It will also be generally agreed that the benefits from this huge and continuing investment do not flow to all sections of our society in equal or fair measure. While part of our nation lives in the late 20th century, another part is still living in the medieval ages. No nation can progress much beyond the "national average". When these differences are too wide, they create not only social tensions but also slow down progress and make it expensive.

How can the whole nation benefit from whatever S and T we have invested in? This is the question that worries not only politicians but also scientists. There is one group that feels we must set up separate establishments for "Appropriate" technology for Science for Rural Development etc. There have been demands for establishment of "Vedic Science" "Indian Science" or "Indian Medicine" etc. While there is a case for funding organisations for specific objectives, I think we should not consider "Appropriate Technology" or "Ayurvedic Medicine" as a separate kind of science with different basics, where normal scientific principles are not valid.

We should spread scientific methodology through education to all sections of society, in a way that it is absorbed into the culture.

Terms like "Appropriate Technology", "Renewable Energy" etc. in relation to the use of S and T for rural Development, has produced some distortion in our efforts. It is my objective to try and show how the methods of S and T investigation used in basic and industrial research are badly needed for the development of Rural India.

How can we get more S and T effort channelised to develop the backward regions and sections of society? Is it enough to just allocate more funds specifically for that?

Briefly my thoughts in this regard are:

1. We should spread scientific methodology through education to all sections of society, in a way that it is absorbed into the culture.
2. We must have a system that poses the right questions/ problems to the right people.

If these things can be done, I believe a lot of benefits will flow even from the existing S and T establishments to rural societies. What is more, this will elevate the overall quality of our S and T effort and make it more original and less of a blind follower of the west.

There are two ways in which we apply S and T progress. First, we have some novel technique or product that fascinates us. We are therefore on the lookout for an opportunity to use this information to our greatest advantage. Here solution of the problem is secondary and a successful application of our "idea" is the main objective. Most of our effort in S and T application falls in this category. In the second situation, we have a problem that seriously bothers us. We look at it, analyse, diagnose, think of alternatives and select the best idea to meet the required situation. Relatively less effort goes into this kind of problem solving.

Both methods are valid, proven tools and are complementary. The over dependence on one however, will impede progress. My belief is that at present, we mostly look for "problems" to fit known solutions, but not the other way around. Primarily, this is because the "problem" awareness in the scientific community is biased by poor information flow from our rural segment. Therefore, published scientific information from (mostly western) journals becomes the major inspiration for selection of new projects for investigation.

We have to select, on some basis, problems to be tackled, as we have finite, limited resources. This is therefore a crucial decision. What are the scientists' expectations? I believe that every scientist hopes for recognition and appreciation by his peers. Recognition comes from success in a challenging situation. If the work is trivial, success is not valued. If it is too difficult, success is elusive. A breakthrough is what makes the scientific work respectable. I am suggesting the following guidelines for selecting projects, which, I believe, will meet the aspirations of the scientist and the needs of the society.

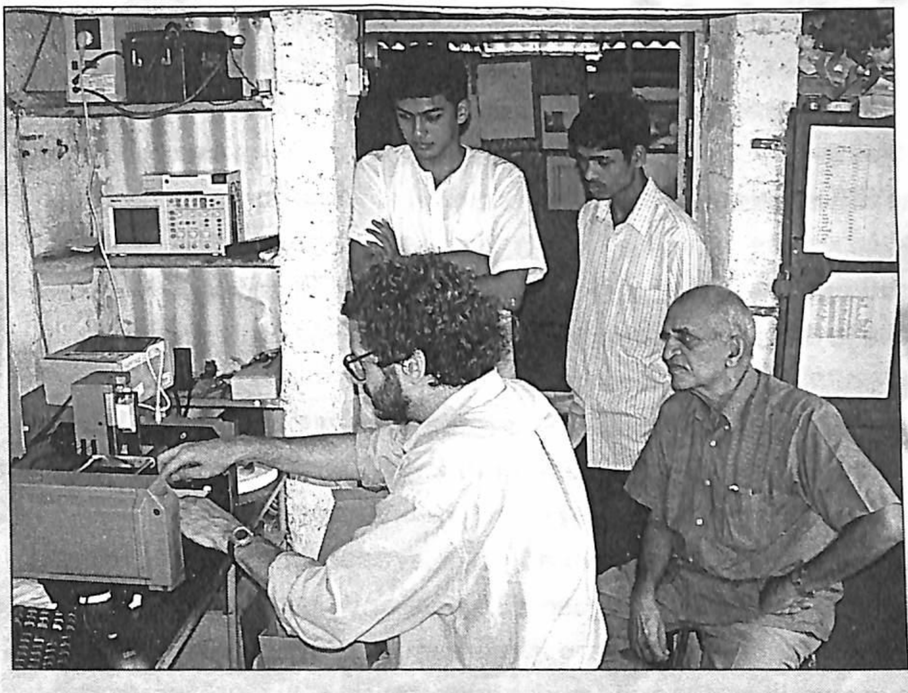
1. We should be able to utilise our strength – viz. technical skill. There must be a challenge. The exercise must sharpen our skill and we must thus "grow" by solving or even attempting to solve that problem.
2. If solved, the programme should experience exponential growth. All successful products or technologies show a sigma type growth curve. If our solution depends on charity or subsidy, the growth will be, at best, linear.

3. We should look at on -going activities for "Problems" to tackle. They usually have relevance and urgency. Even small improvements have a big impact.
4. We should involve costing and economics from the selection stage of the project. Without cost consciousness, developmental efforts can go astray.
5. All activities have bottlenecks – limiting parameters. When these are tackled, there is progress. When new parameters become limiting, these, in turn, are tackled. Removing bottlenecks is therefore a continuing activity that ensures continuous progress until the law of diminishing returns makes it unattractive.
6. Measurement of productivity of every operation brings out areas needing development.
7. Any project must have a well defined "user population". The specification of this population defines the boundaries within which we have to find our solution. Our sights should always be fixed on this population for all decision making.
8. Finally, we should select a project that has a reasonable chance of success. This is necessary for morale as also for keeping open the flow of funds.

An important criterion of a project is its success in implementation – the success in the market place, not in the laboratory. S and T is a hard taskmaster. Unless all the "nuts and bolts" are property tightened, it does not yield results.

The information system is the nerve centre of any S and T program. It is not often realised that the information system is as important for the selection of the problem as for solving it. The foundation of any information system is the source and quality of information. If we are going to solve the problems of the rural society, then this section of the society will be the ultimate source of our information. It is a fact that, at present, this source is not capable of giving relevant information in a usable form. Such information now comes from estimates and is usually old, obsolete, incomplete and often unusable. The first requisite for our information system is therefore, a population educated in the methodology of science viz. trained to observe, measure, record, classify, compare and interpret simple information. This, in my opinion, is the true scientific temper. If this is absorbed by even a section of the youth in the villages, we could build on that, a reliable information system that will define, quantify and document all "problems" perceived at the village level. A referral system is then envisaged, whereby these defined problems go to an appropriate S and T establishment, where the level of knowledge and the skill match the challenge posed by the problem. Backing up this referral system should be a computerised information storage and retrieval system that collects and updates, on a continuing basis, technical and economic information, performance indices and also makes this available to anyone on demand.

I have no doubt that when the awareness of opportunities for the application of good science spreads among the scientific community, the complexion of scientific research in our country will change to bring greater benefits to our own rural societies.



Teaching a skill involves not only long training periods but also the recipient has to learn how to tackle change, from the conditions during training.

HOW TO USE TECHNOLOGY FOR RURAL DEVELOPMENT

Objective: – To Increase the Generation of Rural Income; mainly in the BPL sections.

Assumptions - Technology has a key role in this and we have the skills to develop the needed technology.

Introduction - "Technology" as referred to in this context, consists of a) Products or b) Processes/operations. These two types need to be handled differently. But there are common features also.
A new product is delivered to the appropriate user, through a distribution system that can also give any help needed in the use of the product. The hardware is more important and the training for its use is simple and therefore less important.
Examples: Groundnut sheller, corn remover from cob, solar cooker and other devices, HDP beats, Pabal Dome kits etc. The complexity of user instructions may vary from product to product, but the hardware is the main product sold.

A new process is taught. The main stress is on the skill and technology. The hardware is usually conventional. Examples: Cultivation of high yielding varieties, construction of mud houses, fabrication of carts and other designs, poultry rearing, dairy, all vocations and manufacture.

Teaching a skill involves not only long training periods but also the recipient has to learn how to tackle change , from the conditions during training.

Here, teaching a skill involves not only long training periods but also the recipient has to learn how to tackle change, from the conditions during training. He must learn how to manage people, money and materials. This becomes important or even critical. Such training can only be given as building up on an existing level of skill. Those who have some successful practice in one skill, can be given a skill a step higher in sophistication, but rarely can it be given on a raw base.

The common requirements for both products and processes are:

1. To know and define the target group - its needs, environment, and level of skills
2. Whether communications reach them and how they perceive it
3. Feedback from the use of the product/process is most important during the development stage itself. Development is not complete until the feedback is incorporated.
4. Follow-up services, distribution and maintenance for products; commissioning and quality control for processes.
5. Proper economic costing and comparison for alternatives/competition.
6. Market/field test in real life economic situation.
7. Complete documentation, defining the product:- user, use method and performance. For processes:- raw material, product and process specifications, economic parameters, fault finding manual, sensitivity to variables etc.

Our Common Failures:

1. Target group is not defined properly.

2. Technology for products and processes are not treated differently.
3. Economic parameters and alternatives are not studied sufficiently.
4. Field tests are done at the end of development not as part of development.
5. Poor or nil documentation.
6. Communication messages are not tested to see how the target group receives them.
7. Poor organisational support for follow- up. Evaluation of Technology is not for accepting or rejecting it but for helping it to develop and attain the objectives. If the objectives are worthy and the approach tried, does not work, we should try other approaches and test again by evaluation.
8. Most projects make too much investment even before basic concepts are tested. They do not grow with feedback, but plan everything on assumptions. Therefore, later changes become difficult and they get tied to one approach. If this is shown as ineffective by evaluation, the whole effect gets threatened. This is partly because funding agencies act very slowly and it is considered prudent to ask for the total funds at once rather than in phases.

Recommendations:

1. All new products and processes must be properly and fully documented. Funding agencies can enforce this.
2. Field testing and evaluation as an aid to development must he carried out, preferably by a third party, but the originator of the technology must be fully involved. Funding agency has a vital role in coordinating this.
3. CAPART must set up a Market Research and Evaluation group. Help of professionals like ORG may be taken in forming this. This may be considered like a technical audit and information source.

4. Projects in priority areas must be sponsored, not just supported. This will give a direction to the developmental effort. This is not to replace the initiative of the voluntary agencies but to complement it.
5. National Information System to collect, and disseminate technical, economic and social data, must be set up. These are not archives but a dynamic system that gives the current status and figures. A library of technologies is part of the documentation but not a substitute for the current information. It will give data on how parameters are changing with place and time.
6. More involvement of education is needed, not just short-term training courses. This is needed to bring about a change in the basic complexion of the skills-base of the target group viz. the BPL section of society.
7. Funding processes and methods and patterns must move in the direction of bilateral contracts.

Historically, in other countries, many big constructions like bridges, tunnels, harbours etc. were given by inviting not tenders of construction but tenders of design and then contracts were given on the basis of the winning design to the designer. Such a system should be adapted to our developmental needs.

We do this sometimes for architectural designs for monuments. We should do it for solving problems too. It is not obligatory that only one design be selected. It is possible that the best two or three are selected, tried out and then the best among them is replicated. This assumes that the problem is studied and defined, with very clear, precise objectives, constraints and time frame.

Pabal
3 Oct 1983

My dear Meria

I hope you are now back to normal and again at home. We have been generally fortunate — (it cannot be luck - it is the effect of our style of living) That we have kept good health. It is easier to be "brave" when we are in good health — our mind and will is also strong. But when the health is ~~poor the mind~~ becomes weak also. But every one has some ups and downs in health. The mind can take these hurdles if they are short. When in need, the mind can take outside help. And this is where husband and wife really need each other. By force I have to spend 25 days in a month here away from you. My health is good, my food and other needs are taken care of. I feel at ease, able to concentrate on my work, because at the back of my mind, I know you are behind me. It is like a child that is happy playing - even forgetful of its mother - because it feels secure in the knowledge that mother is around. As soon as it notices mother has gone away - it feels insecure and cries. Adults are no different. It is for this reason I feel uneasy when you are not well. I am sure you must be having similar feelings. I feel a bit guilty to be here alone - there is no "sacrifice" in staying in this village. - it is you who are doing the "sacrifice" facing problems alone. This thought spurs me to greater effort to push our construction work so that you can join me here - I hope by Diwali. Of course, I will still need to go to Bombay every alternate week - even if for a day. Because we need to attend to post and also take care of the house etc. I hope Aleka will also find it to her liking here.

Productivity is the ability to increase the assets with the given resources.

SCIENCE AND TECHNOLOGY PROJECTS FOR RURAL AREAS

Rural development is an integral part and a key component of national development, along with industrial development. Yet, rural development has meant many different things to different groups. In this paper, I will try to link rural development to the practice of Science and Technology (S & T) and discuss mainly the kind of S and T projects that need to be tackled by agencies working in or for rural areas. The actual Science and Technology involved will not be discussed, but may be raised as a topic for later discussion. As the selection of projects is linked to our criteria and objectives, some basic issues will be discussed first. It is likely that everyone may not accept these ideas, but it is important that the basic premises be clear before one takes up the rural development programme.

It is my belief that there are certain qualities, viz. dedication to work, technical competence, a broad spectrum of experience, an adventurous mind, a creative intelligence, patience and perseverance that are needed as much in rural development as in any other walk of life. There are more things in common between rural and other kinds of development, than there are differences; both activities complement each other.

Productivity is the ability to increase the assets with the given resources.

Production of Surplus; Building up Assets

All civilization and human progress is based on production of surplus, which is converted into assets or capital. If any activity does not build up assets, it becomes difficult to sustain – it becomes a subsistence activity. Also, we need to stress the difference between a linear growth and an exponential growth (simple interest and compound interest). Our efforts must earn compound interest. Donations/ subsidies/ charities produce only linear growth. Activities producing surplus earn "compound interest". Our nation is fortunate in having a high rate of savings. Unfortunately, these savings are frittered away in non-productive or low productive ways by individuals and groups.

Drudgery v/s Employment

We have both these as our national objectives-removal of drudgery and generating employment. Unless we are clear about the boundary between the two, we may be working at cross-purposes. I would like to define drudgery as non-productive or poor/low productive employment. Therefore, it is productivity that distinguishes drudgery from employment. The same activity could be drudgery if carried out at low productivity and good employment if operated at high productivity. So, to eliminate drudgery, we need not eliminate the activity but raise the productivity.

Productivity

Productivity is the ability to increase the assets with the given resources. The assets and resources can be in any form – not necessarily money.

Capital and Labour-intensive Activities

The true capital of a nation or an individual is the human resource (weighted for skill) and time. We always carry the impression of money being the capital. Money is only the token of surplus assets built up in the past by the use of Human resource and time. Other natural resources do add to the capital but are subsidiary to these primary forms of capital – as so well illustrated by Japan.

Therefore, the question of labour intensive or capital intensive should be decided on the basis of which produces faster growth of assets with available resources (which will include human resources and all other forms of capital). It is not the immediate growth but the rate of growth that is important. Exponential growth may start slowly but easily overtakes the linear growth pattern.

Luxury v/s Necessities

What is a luxury? What is a necessity? Is bus service a luxury? Is electricity a luxury? Something that is a luxury today, if it becomes widely available to the population and has a great impact on their life, can become a necessity tomorrow. The motorcar did that in USA in the first three decades of this century. The electronics industry has done that in the developed nations now and seems likely to do the same in some developing nations also.

In deciding priorities, we should not consider whether a product is considered a luxury or a necessity now, but whether it has the potential of being widely accessible and whether it could make a quantum jump in the life of the population. If it has this potential, then sooner or later, S and T can bring the change.

Problems are opportunities

A creative mind sees an opportunity in every problem. This is what is meant by "Necessity is the Mother of Invention". A lesser mind runs away. However, we cannot tackle every problem. If we make a balance between the significance of the problem and the probability of solving it in a reasonable period with the given resources, we could have a good project for S and T.

Having clarified some of the basic issues, in the context of the rural situation, let us now look at the types of projects S and T can be applied to.

Types of Projects:

1. Cost Reduction

Cost reduction is one of the primary applications of S and T. Cost reduction extends the availability of an existing service or product to a wider cross section of the people. The benefits from S and T are immediately applied and because the scale of operation is already big, the savings are multiplied many times over. Success in such projects also boosts the morale of the people doing the work. There are no extension or marketing problems. This is as important for government services as for private enterprises, small or big. Henry Ford had a concept that the difference between the cost of the end product and the cost of materials that go into it represents the scope for new technological development. If a motorcar costs Rs. 1 lakh and the cost of materials is only Rs. 20, 000, the difference of Rs.80, 000 indicates the scope for better technology to reduce the prices and increase the market size. The other valuable concept we could take from Henry Ford, is his model T. If you want to reduce the cost and make it available to a larger population, stick to the main function and strip away the decorations. Another type of cost reduction comes from a radical change in design-reduction exercise. Value analysis is a useful technique in cost reduction projects.

2. Improving Productivity

Improving productivity is another useful activity often allied to the cost reduction objective. But it is much more important than cost reduction itself. Improving productivity usually has an exponential effect. Unfortunately, it always gets a low priority in India. When we look for a labour intensive project, we need not, but we tend to use labour unproductively. Such programmes can be counter-productive. Some EGS (Employment Guarantee Schemes in Maharashtra) fall in this category and can spoil the impact of an otherwise pioneering programme. When we build bunds, do we need to carry earth and rubble on head loads, instead of using wheelbarrows? If we neglect productivity in labour intensive programmes, we are also neglecting it in the Capital intensive Public Sector projects. That is why they do not produce a surplus that could fuel further growth.

We need to look at productivity of simple operations like digging wells, building a bund, even sweeping and cleaning, making pits etc. Productivity cannot be improved unless we first measure it routinely on every job. We must realise that the basis of all S and T is measurement; what we can measure we can improve.

3. Demystification of Science & Technology

Demystification of S and T is an important area for S and T work. It is not only products that need to be within the reach of all the people but also the services must reach the masses and knowledge as well. It is possible to make a difficult subject simple, at least, to be able to widen the circle of use. But we seem to have a knack of building an aura of mystery around knowledge. I suspect that the people who try to mystify science are either those who do not understand it fully and want to hide their ignorance or those who want to preserve their importance or monopoly. But, if only they become more open, they are bound to gain more and not lose, as they fear. Knowledge is one commodity that grows when we give it away.

The test of true knowledge is in its application and results in the field. In science Truth always wins. Even if we fail in the beginning, experience is a great teacher and we will build a better science this way.

4. Product Industries

While the chemical industry is inherently unsuitable for decentralisation, formulated products are suitable for small-scale development. There are needs of rural areas that are distinctly different from urban needs. These needs could be met by inventions and formulations for local needs. This should be the way to growth. Plastics and electronics also have good potential for wider spread.

5. Service Industry

Lastly, there are gaps in the infrastructure as far as development of rural areas is concerned. All rural population suffers from lack of services. This hinders development. There is, therefore, immense scope for generating employment by training rural youth in giving these services.

Let us now look at the "Thrust" areas, where more effort is needed

Thrust Areas:

A. Water

We need techniques for development and exploration of water sources that can be faster, less expensive and more dependable. We also need tests for chemical and microbiological quality of water that could be carried out, if possible in every village. It is not the technology that is to be brought down, but the skills to be upgraded and costs to be reduced. This will enable these services to be extended widely.

B. Health and Sanitation Services

Kits for diagnosis of diseases, based on monoclonal antibodies are becoming available in other countries. They can be used by any technician with a brief training and do not need elaborate laboratory facilities. We should be able to develop and use such kits for tropical diseases. They are potentially low cost services.

Cost reduction in designs of latrines will enable this facility to be extended to more people. Techniques of health services are also important, like sanitation in food storage and handing. This could be improved to raise health standards. In all the above, cost reduction would be a major objective.

C. Low cost Housing/ Construction

Are we using a double standard for urban and rural areas? When we talk of rural areas, we sing the virtues of mud bricks, renewable resources, local skills and materials. But these are not mentioned in the urban context. Is it because, this is the only way we can think of reducing costs?

There is ample evidence that designs and construction techniques have a lot of scope for producing lower cost alternatives. The science and technology of composites and laminates is yet largely unexplored both in the rural and urban contexts. Even facilities like plumbing and sanitation have scope for change and cost reduction. Productivity also needs to be looked into.

D. Agriculture and Animal Husbandry

The Green Revolution has shown what can be done. Techniques for saving water, effective use of pesticides and fertilisers, identifying bottlenecks in the extension of existing technologies to small and marginal farmers, are all awaiting a creative look. Horticulture is poised for a "fruit and vegetable" revolution. Green house cultivation has the potential to be an "industry" within agriculture, by virtue of its high productivity, minimal use of pesticides, isolation from ecological constraints etc. This could be for agriculture, what poultry is for animal husbandry.

Forestation including methods for digging pits, protection of plants in early stages, could be crucial subjects for study.

Storage and preservation of food products and perishables (including fruit, milk and eggs) are important economically and we have not gone beyond traditional techniques.

Cost reduction in all these will be possible if S and T is applied.

E. Transport, Energy and Engineering Services

This is probably a very fertile field for S and T application in rural areas. Development of services in the countryside is one of the major problems and a golden opportunity for S and T application. It plays a pivotal role in all rural development but has been largely neglected as being the concern of other agencies. Here, management techniques, cost reduction (through demystification) and wide technical training will be most important. While industrial infrastructure is always taken care of in development, rural infrastructure is ignored. Beyond starting a state bus services, taking electric poles or cables and now borewells, government planning ignores all infrastructural needs. The quality of these services is very poor and undependable and almost every negative factor goes against the development of rural areas. It is a vicious circle that needs to be broken.

F. Education

Education is not at the forefront of development in our country, but is a follower to fulfill the needs of labour, created by development. Education should lead development; that is the test of good education. Development of teaching/ learning material, tools, kits, techniques, all need application of S and T. There is an opportunity to link education directly to development, which will make education relevant and fruitful and which could increase the tempo of development substantially, and save resources.

G. Information Storage, Retrieval and Dissemination

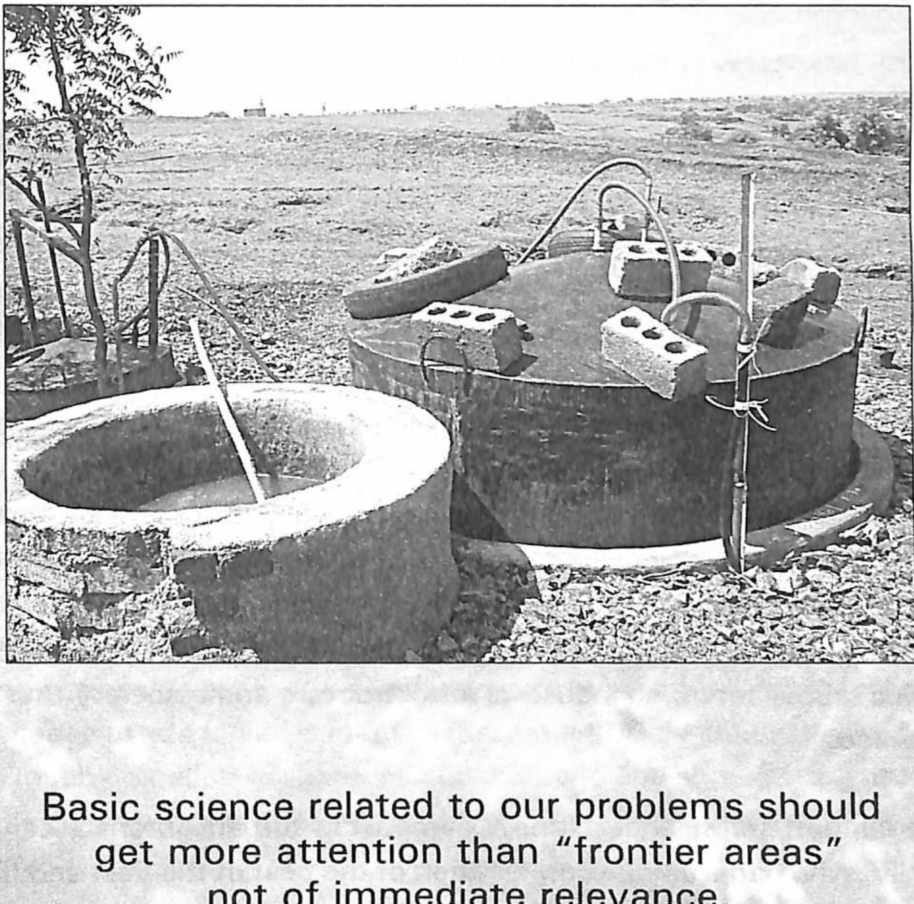
This is a key area for all development and could be developed with a little effort. But it is badly neglected by every agency, govt. or voluntary. Dependable, organised information is a major need for all S and T work as well as development. Crores of rupees and several years of time on big dams have been lost because of faulty data and wrong assumptions. Few agencies have their development work scientifically documented, and even where it is, others do not get access to it quickly. Most people do not realise that information is a valuable product of all development activity, critical for its future pace and direction. Yet, we throw it away like rubbish.

H. Industry

We need to look for new opportunities for manufacturing industries in rural areas, with their special need in mind. This will depend on the inventive ability of the people. These are likely to be in the areas of agriculture, water, housing, transport, services, etc. They will lie mostly in the engineering materials (plastics, laminates etc.) and formulation areas. But at present, we look only at traditional crafts, many of them with an uncertain future.

Lastly, we need to know what the criteria of success or the finish line for the S and T project are. Most tend to stop when they think they have achieved the result. The rest is for extension or marketing people. This is wrong. The project has often to be recast, when a market test shows that the consumer is not happy with it. The S and T project is not complete until the result is proved in the field with the target consumer/ client accepting it repeatedly and the role of the market researcher does not start after the S and T work is over; it starts when the project is being defined.

The final judge of the success of the S and T project is not the funding agency but the people who have to use it. It is a slow process, often taking 6-7 years or more. One can mark the milestones on the way to see if one is going in the right direction, but there is no simpler easy alternative. This is what the history of all technology has taught us. Rural development is no different.



Basic science related to our problems should get more attention than "frontier areas" not of immediate relevance.

STATUS OF SCIENCE IN INDIA

The major points of the case for more funds for science may be summed up as:

1. Basic science is important for the long-term future of the nation. There is need for support at least in the frontier areas.
2. The budget for science in India is less than in other countries on GNP ratio basis and is now dropping. This needs to be increased.
3. The research costs in India are less than in other countries – the wages of scientists are less.

All the points mentioned above are true and valid. But there are some other points not considered by many scientists. There are certain other requirements to be fulfilled before science can benefit the nation. Without these, science cannot deliver the goods. These are a skilled labour force, an industrial infrastructure and a society that is at peace.

The support for science till now came from the enlightened Nehru family, who had a unique combination of the best of the East and the West. That era is now over.

What will be the basis on which we should "sell" the need for more basic science? The society at large does not understand sciences; it

knows and appreciates technology. It is therefore proud of our rocket launching, our missiles, and satellites. It will also take pride in Nobel prizes or other very prestigious awards.
Like a family in bad times, our country is facing severe financial crisis. Like the members of a family, we have to sacrifice something so that the nation survives. Which activity should get priority?

Basic science related to our problems should get more attention than "frontier areas" not of immediate relevance.

Poverty alleviation? Literacy and primary education? Water and food for the year 2000? Or removal of social tensions? Or basic science research? It is a difficult decision for any government, particularly when non-issues like the Ram Mandir-Babri Masjid controversy shake up the whole society. If the society is backward looking, we, as citizens, are also to blame. What have we done to spread the benefits of science to the rest?

If the disparity in society is not checked, social tensions increase and any thing could rouse and ignite passions. If an upheaval erupts, it will engulf all the scientists also.
I suggest the following as an approach for science in India:

1. Science establishments should analyse their budget; and should bring noticeable austerity. I know scientists who gave up their own privileges to add facilities in their laboratories. They should not spend too much on buildings, gardens and auditoria and should bring to the minimum, the cost of meetings and seminars. **Make austerity a way of life.**
2. Frontier areas are created by scientists, by making a breakthrough in research. Pasteur served industry and founded a new science. Earlier, in India, malaria, and cholera have proved excellent subjects for "frontline" work. **Basic science related to our problems should**

get more attention than "frontier areas" not of immediate relevance. As Mashelkar has said, why cant Engineering Science give India a frontline position in railways, roads, irrigation, water shed developments, metallurgy etc. This will bring immediate economic returns and bring more funds for science. This will give the society faith in science and prepare the ground for real basic research.

3. There should be a strategy for getting a long-term foothold in basic science. This may include:

i. Enlarging the catchment areas where young scientists are attracted. At present, it is about 5% or less of the total population. This should be increased to 50% by improving quality and amount of school science.

ii. Remove the deadwood in science teaching and research institutions. Those who go for a masters degree, should "go through fire" to prove that they love science. Higher education should not be subsidised but prospective students should be given opportunities to earn their fees and material costs, by working part or full time on the campus or in the laboratory. This will eliminate non-scientific staff from the campus and bring a better work culture and perhaps make the scientists more skilled generally in life.

iii. Instrumentation research, design, fabrication, repairs should get much wider and more intensive attention. This should be a "frontier area" for us. I believe that instrumentation is one of the major cost centres in today's basic research. We should follow Raman and J C Bose in this. Pioneers have necessarily, to design, and build their own instruments.

4. In the same issue, in the biography of J B S Haldane, there is a mention of his suggesting research in animal behaviour because it will cost less. I feel this is a good strategy. Should not, the topics for research for universities be selected such that, the research approach is taught without too high an expenditure? It may also teach the students how to measure when no ready instruments can

be ordered. Such topics will encourage creativity, not only in research but also in instrumentation and techniques.

In this era of "no subsidy" the scientists will have to sell their case to the society to earn a bigger budget for science and not depend on a "Nehru". For this, they will have to give up something. What will they give up to prove their love for science? Science should not be just a career, but a life mission. Those who are not committed to science will go elsewhere when there is less money in science. And in the long run, this may help Indian science to become slim and agile.

Pabal.
5th Nov. 1983

My dear Mira,
The postal service has done a good job. My letter posted on 31/10 reached you on 1/11 & your letter dated 2/11 reached me on 3/11 by noon. All our activities have come to a standstill as everyone has taken leave for Diwali.

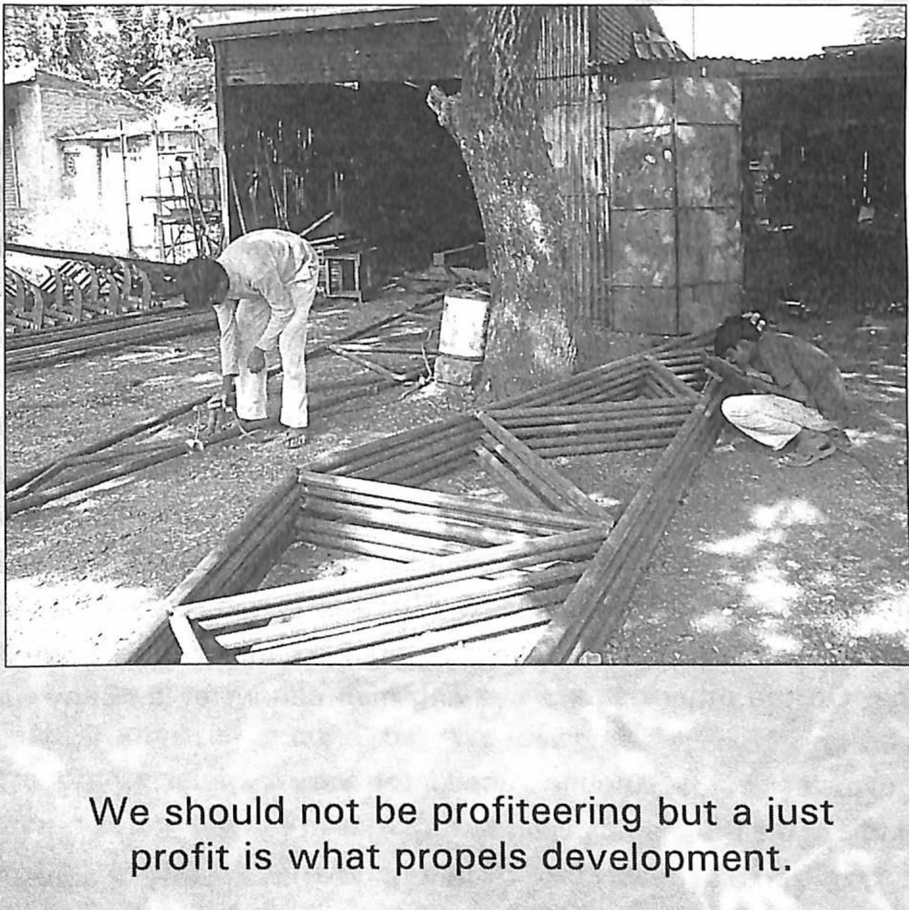
Spending 3 days doing nothing worthwhile, because it is a festival annoys me - even though I am working, writing reports, notes, accounts etc. But why should people waste valuable time just idling away?

I have been thinking on this. In urban life we go by time, we are paid by the time. Here that system does not work, but there is no other system to take its place. If there is individual motivation, time control may not be necessary. In Europe, "flexitime" gives each individual some flexibility to take care of his personal needs. Here in way it already exists. But the commitment is rather poor. It is not contentment - it is cynicism. The former is optimistic the latter is pessimistic.

I need patience - so that by my example I can convert a few to my way of thinking. I don't want identity of thought - I want identity of objectives - to change the scene in rural India.

When I see things happening, I feel optimistic. In periods of low activity, there is a nagging doubt whether my efforts will be too little and wasted. But there is nothing else I want to do and I see opportunities for doing new things everywhere and then I feel optimistic again.

Have I confused you completely? Then I have given



We should not be profiteering but a just profit is what propels development.

DEVELOPMENT OPPORTUNITIES

1. India and the World

India is now the second most populous country in the world, second only to China. India has only 2.5 % of the total area of the world but 17% of the world population to support. And this population is increasing out of control; that is why India is a poor country. Our annual national per person-income is Rs. 4550 whereas among our neighbors, only Bangladesh and Burma are poorer than us. Pakistan, has Rs. 5250, and Sri Lanka has Rs 60,000 while the "developed countries of the west" are around Rs 1,50,000, USA being over Rs.2,55,000. (ref; Statistical Outline. of India; figures in dollars converted to Rs @=Rs.I5;1985-86-Tata Services Ltd). We may console ourselves that happiness cannot be measured by wealth alone. On the other hand, a starving man cannot be a happy man either.

2. India in the Developing World

India is gifted reasonably well by nature. We have plenty of sunlight, a good average annual rainfall, fertile land, sufficient coal, iron and other mineral resources and a fairly hospitable climate all year round. This is why among the human species, a big section settled in this land and developed an oldest culture which is surviving till this day.

We should not be profiteering but a just profit is what propels development.

But what have we made out of these gifts of nature? We are today ranking low even among the developing world, in terms of productivity, well being etc. But we are fairly high up in the number of educated people and the skills that we can practice. But this intellectual asset is not spread over the whole population and is restricted to only a small section of the society. If only we spread it to all, we can be at the forefront.

Our lack of skills is conspicuous on the agriculture front. We produce 17% of the world's rice but our average yield/ hectare is 20 quintals, while China produces 54q, Bangladesh produces 24 and Burma 29; Japan has the highest with 62q /hectare. The story is repeated in groundnut production also. We produce 22% of the world's groundnut but not very efficiently; our yields of groundnut in shell, are 700kg/hectare, Burma is 1000, China is 2000, and USA is 2600 kg /hectare Wheat is a better picture. We have an average of 2000 kg/hectare and UK with 5900 kg/hectare is the highest. China has 3000 kg/hectare USA has just 2500kg/hectare But this should give hope that we can increase our agricultural output several folds, with the same land under cultivation. That is the basis of our Development Opportunity increasing productivity in our agriculture and industry.

3. What is an opportunity? What is Development?

We see turmoil all around us. We see misery, suffering and frustration. Certainly, we are not a happy nation. But we see smiling children playing even in miserable surroundings. There is hope and there is potential. If all the youth can aspire to make the best use of their faculties and live a life with pride- that will be our aim for development.

When we see a problem and we have possible solutions to these problems, these are opportunities. And we will see that we have unlimited opportunities.

Then what is holding us back? The Will and the Effort. Ours is an ancient culture, of which we should be proud. If we practice what we profess, we should be well on the way to development.

Our development has to begin with our own self. Our culture prescribes Bhakti, (Commitment), Karma,(action) and Gyan, (knowledge). If we have Bhakti in our Karma, the activity will succeed. If we keep our tempo in Karma, with Bhakti, Gyan will be acquired. This will be a sustainable development. This is what all our sages from the ancient to the recent have prescribed, but we have ignored them and we see the result around.

4. The Wealth of India

India is gifted with adequate total rainfall/precipitation. We have the Gangetic valley, one of the most fertile alluvium tracts. We have around 300 days of intense sunlight and an equitable climate through most of the year.

We have around 56,000 million tons of coal, 9000 million of iron ore, 2000 million tons of bauxite for making aluminum, over 50 million tons of manganese ore, 129 billion tons of chronite ore and not inconsiderable amounts of copper; zinc, lead etc. (ref Statistical Outline of India.)

We are not quite well placed in regard to petroleum products; our reserves are estimated at 600 billion tons and only 1% of the world output.

If we look at Japan, they do not have even what we have. But through sustained effort, they have built up wealth for the nation.

We have a good climate for growing organic materials, and we have adequate mineral and water resources. We must therefore, make the best use of our main resource, the human resource.
We should look at history and plan our strategy.

5. Evolution of Industry

In the history of man, collective hunting, the invention of fire and its use for cooking food, could be considered as the beginning of industry. Then only about 10,000 years ago came agriculture and the domestication of animals. This gave rise to production of surplus goods. That means the producer had something for his own needs and more, which he traded with someone else in exchange for goods. This was the barter economy. Production of surplus food by agriculture lead to shifting some people from agriculture to other activities, such as making tools, helping in making shelters, arts, trading or just philosophy. This production of surplus resulted gradually, in the segregation of activities (trades), development of knowledge as an activity and formation of settlements based on activities other than agriculture. These later became cities.

Initially, agriculture was the major producer of wealth and land was the prime asset. Those who were strong controlled the land and dominated over the rest. This gave rise to landlordism. This continued for thousands of years. Around 300 years back, came the inventions that allowed man to use energy from coal and other fuels. This led to factories where manufacturing activities were organized and the industrial revolution came about. This increased wealth rapidly. Gradually, wealth from industry became more important than wealth from agriculture. By this time, barter trade had to give way to the money economy. Money Capital became the most urgent need for setting up and operating industry. Landlordism faded into the background and capitalism took over. In the industrially developed nations; the percentage of population dependent on agriculture dropped down to around 10% and even less. Even with this small number they could produce enough food for all, and to spare.

With the growth of industry manufacturing goods, there raised another industry - the service industry. As industrial development grew, life became more complicated, giving rise to specialization - needing help from others. This help was required because of specialization or because one did not have the time to do a certain job. Thus, when electricity became wide spread, help was needed to install and repair appliances. When the factory culture spread, one had to spend time travelling and so the transport services as well as domestic help became necessary. Thus, the service sector of industry started and grew rapidly with the increasing complexities of life. Today, the service sector is the fastest growing industry.

6. The Information Industry and the future

Along with industry grew the importance and complexity of taking decisions, organizing and planning. This became the art and then the science of management. Management of technology gradually became more important than just acquiring the technology. Management functioning is critically based on information and how much, how accurate and how fast one can handle it. This is why the telegraph and telephone services have expanded explosively. Then came the semi-conductors and the computers. This has now given rise to Information Technology and we are now witnessing the second industrial revolution that will bring a new class who will gain control and push back the landlords and capitalists. Those who master Information Technology will master others.

The growth of agriculture saw man using animals for his own gain, the industrial revolution saw him using machines (which worked on other energy sources) and increasing his output manifold. He also developed techniques of "mechanization" so that less skilled labour could produce goods that formerly required more skills. This meant that a person with greater skill could put his skill into designing a machine which could later be used by a less skilled man to produce goods continuously. This led to an exponential growth of industry. Yet, the management of that industry was an intellectual skill that was not very easily available.

Now the coming of the computer and the Information Technology is bringing higher management skills within the reach of the less skilled person who can collect, store and retrieve selective information and even use expert systems to take routine management decisions. Computers are to management what jigs and mass production machines were to manufacturing industries.

India lagged behind when the industrial revolution came; we are still to catch up with it. We cannot afford to miss the Information Technology revolution. On the contrary, we should use it to catch up on the industrial revolution, as well. The basis of the information technology is, of course, the collection of information and this is done by humans. It is most important that we train our rural youth in the matter of measurement and systematic recording of this information. Unfortunately we are culturally weak in this.

7. The Technology Ladder

The real world of work is the best education where working people are constantly learning and improving their skills. Some learn faster than others. Those who learn, now make more value addition in their work than before. This gives them more importance. Their time is now more valuable. Their wages go up. They have perforce to use their time for more sophisticated products. Therefore, they change over gradually to more sophisticated products and stop making the simpler products.

This gives rise to a technology ladder. Each technology on this ladder needs more skills than the one below. So anyone who "steps on'' to this ladder, slowly climbs up the steps and vacates the one below. Thus, we need to train people enough for them to be able to manage a small "industry". They will then climb up on their own.

The skills required for management of technology are basically, simple accounts, decision making by rational thinking, planning, purchase of material, dealing with clients and looking for new opportunities. It is the skill in these that propells an entrepreneur upwards.

This also makes it obvious that one cannot crash land directly into a high-risk venture, if previous experience of management of technology is lacking. Therefore, in dealing with the rural/ weaker sections, it would be an advantage if management skills are given by on-the- job training in work stations, operating on commercial or semi-commercial basis. These can be simple ventures such as agriculture related small industry such as poultry, dairy etc. or small workshops, service groups etc. These would be better launching pads for new entrepreneurs than just training courses.

The technology ladder concept helps to identify where to start new enterprises, where the earlier ones are prospering; this is why cities and industrial centers grow exponentially.

8. Which Industry do we need most?

Industry is a planned activity concerning production of "wealth" using available resources. It is characterized by planning, cost control, process control, continuous monitoring, consciousness of productivity and long term interests and application of scientific and technological knowledge. Thus, agriculture can be an industry, though it is not one today. Poultry is fast becoming an industry. On the other hand, most of the so-called "village industries" are crafts and not industries in this sense.

The first priority should be to make agriculture an industry in the above sense. This should increase its productivity, but will make some labour surplus for which we need to develop agro-based industries, like the following.

The salient points are:

- Agro-based industries should be number one priority in rural industrialization. They are much bigger in order of magnitude than the conventional industries we consider for rural industrialization.
- The scope for S and T input in these industries, has largely been neglected. Thus green fodder is a very profitable crop for the farmer and can be processed into silage and blended foods for animals. Dry fodder can be chemically and/or microbiologically treated to upgrade nutritional and market value. Biotechnology will bring in further progress. Composting has to be an industrial operation.
- Such broad based industries also have a great potential for ancillaries. The above, for example, will have construction, workshop and transport as key ancillary industries. Key because S and T input in these alone will enable the final cost to be brought down, low enough to exploit the full potential market. There will also be backward and forward linkages.
- The value addition will be mainly in the rural area and has scope for dissemination to landless people.
- The products have nation wide markets and marketing will

therefore be simpler, if technology keeps the prices down. The figures are the shortfalls and not production figures.

- The products will directly lead to rise in standards of living and health. There will be additional employment generation, not only from these industries, but also because the products increase the size of the client industries.
- Compared to any other "industry" the turnover potential in order of magnitude is higher.
- The need is not of so much new technology but application of current technology with the industry approach. Here, human resource development will be the key action point.
- In starting a new enterprise, one should not look only at the technology package, but the total operational package, particularly the marketing of the product. In this, the agro -based industries will have a great advantage.
- Any subsidy on cost in a new technology should be avoided. Government may bear the cost of development (overheads, wastage and excess labour cost in development stage). The government should insist on having cost projections for the post-development stage assuming the process development is successful.

9. Types of Industry

For the purpose of exploring potential, we shall classify industry as agricultural production, manufacturing and service industry.

The agro-production industry will include forestry, faming, horticulture, dairy, poultry, feeds, etc.

The manufacturing industry will include consumer goods, machinery, gadgets etc.

The service industry includes repairs, small fabrications, transport, supply, education, entertainment, health service, retail trade, restaurants etc.

The agro-production industry in our country is generally characterized by a less skilled work force, more dependence on weather and natural forces.

The manufacturing industry is generally characterized by bigger scale of operations, competition, sophisticated marketing and management requirements.

The service sector is characterized by the key role of the human element. It is also characterized by automatic growth of the total sector with development and consequent increase in the complexity of life.

The industry can also be classified according to the materials on which it is based or the products it makes. Thus, we can have foods, beverages, textiles, furniture, paper products, leather products, personal products, rubber goods, petroleum products, chemicals, drugs, electrical and electronic goods, plastics, machinery and capital goods, crafts etc.

It will not be useful to discuss the characteristics and scope for new enterprises in each. Apart from the effort needed to collect such exhaustive and up-to-date information, the validity of the information will last, only for a short time. It is best therefore to describe, the methodology suggested for identifying opportunities for new enterprise.

However, the following information regarding some industries will serve to illustrate the points. The figures given indicate value added and not net value. Value added is the total output value less the input value. Thus, value added indicates the value of skill and technology input.

Agriculture	Rs	70,000 crores
Food and Beverages		2,700 crores
Textiles		3,600 crores;
Paper, leather, rubber etc.		3,000 crores;
Chemicals		4,000 crores,
Steel and other metals		4,000 crores;
Machinery		5,000 crores;
Transport equipment		2,300 crores;
Miscellaneous		1,500 crores.

(ref : Statistical Outline of India Figures rounded and grouped.}

The point to note is that agro- based industry should be our number one priority.

10. Why Profit?

Any body who runs an enterprise is faced with the question of how much profit each operation should earn. Those who get wages also bother about the fair wages for a job. The open market system leaves the answer to market forces. But basically, why is profit desirable? A short story from a school-book gives a beautiful moral.

A colony of 100 lives on a hill. Everyone had to spend 1 hour per day to bring his own water requirement. One enterprising person spent his own time and labour and built a system to bring the water to a tank in the locality. he offered to give the water to anyone in exchange for 10 minutes wages. He does gain 99x10 minutes wages every day for his enterprise. Every one took the water from him and saved 50 minutes wages every day. So the community saved 99x50 minutes wages. Everybody was happy with the labour save and encouraged by the experience, every one thought of new way to save labour for every one. There were many enterprises and the community prospered.

Moral : An enterprise that helps every one has a sustainable long term basis.

We should not be profiteering but a just profit is what propels development.

How can we spot an opportunity?
One generally looks for statistics to find out where the need is most. But there is a danger. the figures may be not accurate. they may have changed drastically even during the time, it takes to collect, and publish. they may give a static picture not a dynamic. If you want to fire a rocket at an enemy aeroplane, you don't aim at the plane. You judge its speed and aim at where the plane would be when the rocket reaches that distance. So you need to know the trends and their "speed". This you will not get in most statistics. So how many factories of a kind are in your area, does not tell you whether they are doing well and growing or whether they are becoming sick. You should go and find out how they are, and what they need. This is how you should use survey information. Another way is to use logic. If there are 20 mopeds in your village, they must be needing repairs and servicing. Is the facility available?

So use the survey report. All districts have surveys made. Contact your District Industrial Center for your survey needs, as a base to make your own survey. Write down all the information you gather.
An enterprise is built not on the motivation of profit, but of service- helping somebody to live a little more comfortably. All inventions that have given successful enterprises have made life more comfortable; all innovations have helped some one and got paid for the help. Look around you. Are there no groups, who need be a trial and error method. But it is a system of education based on real life situation; it can't go wrong. Don't start with more sophisticated jobs than you can confidently manage. Remember the Technology Ladder. Once you get on to it you keep moving up.
Remember the advice given by Mahatma Gandhi. The customer is the cause for which your enterprise exists.

18/7/87

चन्द्रकान्त कुण्डलिक हळदे
मुंबई

Awarded Prize of Rs 50=00

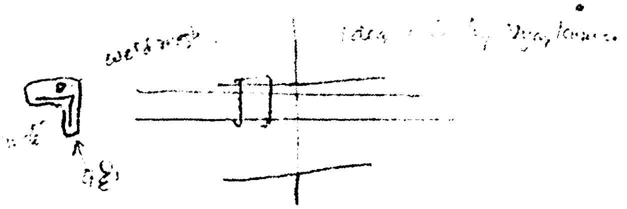
संचालक,
विज्ञान आश्रम, पाबळ.

आदरणीय संचालक कळविण्यास,

विज्ञान आश्रम मध्ये रविवारच आयडिया बक्षीस साठी ~~आमी~~ आम्ही खालील प्रमाणे आयडिया दिली।

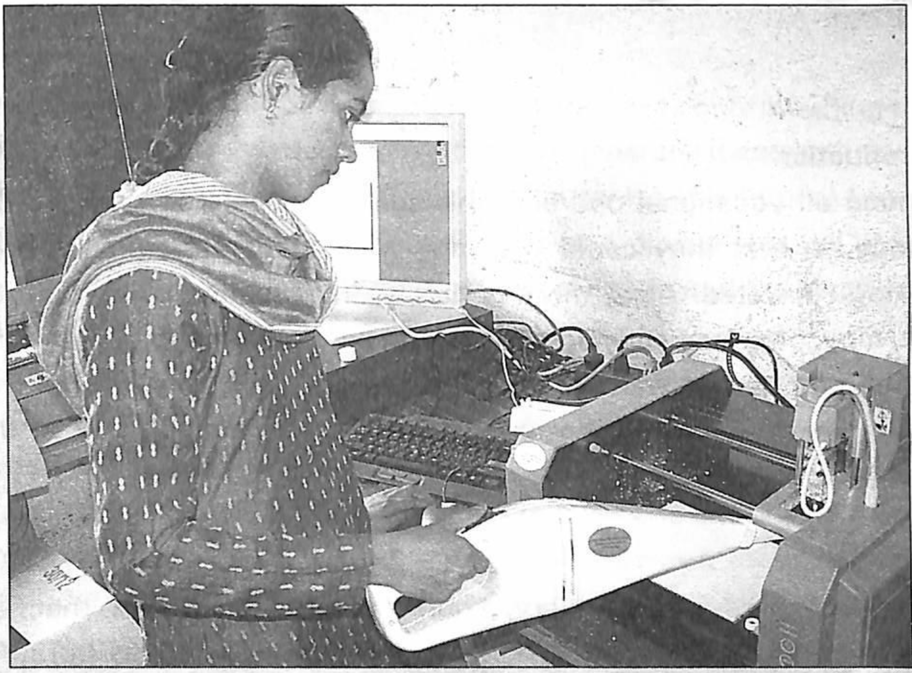
अडचणी : ड्रमवर वेल्ड मेडा ~~…~~ बसविणे ड्रम ऐस तार वापरल्यानंतर, नंतर पहर ~~…~~ नसवायला अडचणी ठरतात.

आयडिया : तार वडुन २४ गेजचा पत्र्याचा तुकडा कापुन, आंगकवर मुडपल्यानंतर, अक्रम आणि वरिल अडचणी दूर होतील.



आपला विश्वासु

चंद्रकांत पुंडलिक हुळेर



Vocational courses should not consider their job as only teaching the technology. They have to show how to generate income.

SELF-EMPLOYMENT AND AGRICULTURE - RANDOM EXPERIENCES AND THOUGHTS

Introduction

Among all vocational courses, the agriculture-related courses are unique, in that they could take any number of students without getting saturated. Also, there is hardly any problem of marketing. Yet, most people already practicing the vocation want to quit and the rural youth do not want to take it up. Why? Unless we solve this riddle, we will have neither good agriculture nor a solution to the unemployment problem of the rural areas.

The Problem

Agriculture is seen as drudgery, a non-profitable occupation that has to be avoided if one can. The farmers generally see it as purely a matter of fate and would like to see their children saved from this fate. At best, they see the farm as something that keeps them alive. No profession can grow if this is the perception of most of the practitioners.

If agriculture is shown to be profitable, the cream of youth will want to get into it. The objective should be for the vocational courses to demonstrate that one can make money in agriculture. The agriculture-related vocational courses, as presently given, are unable to do this. Yet agriculture is the mainstay of the nation and increasingly even the industrial class thinks of getting into agriculture as an industry.

Vocational courses should not consider their job as only teaching the technology. They have to show how to generate income.

Agriculture can be made profitable and has immense opportunities but the vocational courses are not able to demonstrate this to their students. If this is done, not only will it start a rush for agriculture-related courses but also, most of them will opt for self-employment.

Vocational courses should not consider their job as only teaching the technology. They have to show how to generate income through whatever they are teaching. This will involve a whole package of skills, including technical, management and entrepreneurial skills. And often, it is these areas that are lacking, not the technical knowledge.

The Industrial Culture

Unless agriculture becomes an "industry", it will not be profitable. What I mean is that, the industrial culture must come into agricultural practice. This industrial culture consists of having clear specifications for the inputs, the process and the outputs. There must also be financial discipline and cost consciousness, planning and rational decision-making and finally an awareness of performance indices. One must compare one's performance with industry standards and strive to better them. This industrial culture has to be absorbed by practice, not just through the classroom.

Pre-requisites

In teaching this culture the first obstacle is the aversion for arithmetic and generally a tendency to avoid quantitative aspects. This aversion comes from a dislike for all mathematics that is bred in our primary schools. We have to remove this phobia and show that it is not difficult and that, with some practice, it can be mastered. A simple calculator is a great aid in this. People, who have a problem doing sums, can use the calculator and remove the drudgery. They must know and understand however, the operations they need to do on the calculator. I would even suggest that calculators must be made cheap so that every adult has one and uses it.

Equally important is the familiarity with measurement-weights, lengths, area, and volumes, temperatures, etc. Concepts like rate, ratios come later and through practice. Thus, simple arithmetic has to be a part of every vocational course. Assuming that the students have already done it in the primary school does not help. In fact, majority of the students in the vocational course will be poor in this skill.

Finance is an important part of any vocation. Yet, it is a pity that even a majority of the commerce students do not know how to make any bank transactions, nor are they able to keep even simple accounts. It is a very simple operation if taught in a simplified way. Accounts should be a part of the vocational course.

Tabulation of data and its interpretation is also another intellectual skill that is lacking and should be made part of the curriculum. Often graphs are more expressive than tabulation. This cannot be taught except through constant use. Recording of all data in a proper format and its review is the best method for this.

Data has to be collected. Are there facilities? What does collection of this data involve? Often, we ask for data that takes a long time and effort to collect and the use of it does not justify the effort. We must therefore, designate the data that is essential for the health of the operation.

In my opinion, performance indices, accounts, including stock and inventory, profit and loss are the essential data. Yet, we ignore this basic lack of facility. How does one weigh the fodder in bulk, by bundles or by weight? Weighing is such an important part of industry. It is an equally important part of agriculture, but the facilities are lacking on every farm. It is a pre-requisite for our development process.

Rural Business Centre

Information is another scarce resource in the rural setting. We are talking of the coming electronic age as the Information Technology age. In the beginning, land was the main resource; this gave rise to landlordism, land being the source of power. Then, with the industrial revolution, capital became the key resource. Capitalism gave power to those owning the capital. In the coming years, information technology, access to information and skills in using it, will be the key. We have to give the rural section access to the world of information, otherwise the backwardness will continue.

We have talked about arithmetic, accounting and result-organising skills; but these can be used effectively only when you have access to your own as well as external data and information. We must have access to the world of commerce. The rural society must be able to communicate. They must have telecommunication facilities, trade journals and secretarial services. If secretarial services are important to company executives, because their time is valuable, they are important to the rural farmer as well, because he does not have the skills to write and express and so needs help in form filling, letter writing and documentation work.

With the present level of education, where many farmers cannot write at all, where even those who can write; cannot write and express properly and the writing is often illegible, secretarial services are a must. A Rural Business Centre, located in a school and using the skill of their staff and students will be an ideal solution. Not only will the farmers get the services, but the school will be serving the community and through this, make its education more relevant. A computer, STD/Fax or electronic mail for both the giver and user, I expect, will be self-sufficient. Availability of daily market rates before booking agri-produce to the Mandai will be welcome to all. If the cost is distributed over the whole farmer community, it will not amount to much.

Operations like a milk collection centre, have to keep daily records of the milk collection of each account holder (producer), its fat and SNF/or lactometer reading. Spreadsheet application will not only make this easy and fast but will also be able to generate reports about their interpretation and plans for the future. An average centre can have over 500 account holders and an average of 10 litres one milk per account. Therefore, an average dairy will net Rs. 30,000 per day (@ Rs. 6/ litre) and will pay the Business Centre Rs. 60 per day for all the entries. This itself may use about 4-6 hours of time per day.

Most farmers have no record of their farm operations. Even when they do the same crop again and again, they have no data for comparison of their own earlier experience, leave alone that of others. If we make a separate data-base for each farmer, he will be able to learn from his own experience and that of others. Unlike the dairy records, which are maintained now, farm records will be a new activity, but first we shall have to convince the farmers of the usefulness of the same. But this is part of the industrial culture; that only through analysis of your performance data, can you control costs and improve performance. In the absence of the requisite skills with the farmer, the Rural Business Centre can do it for him.

The rural business centre should also help him with commercial information, the prices in the various markets, and the costs of selling there. The rural business centre, if equipped with the proper communication facility, particularly fax or E-mail, could tell him about his options. The whole marketing system might undergo a change.

Apart from benefiting the farmer, the dairyman, the small traders, etc., the operation will create a new set of opportunities. While it is difficult to quantify these benefits, it is certain to change the complexion, just as modern management techniques have done for industry.

Staff Selection

If we want the vocational courses to be courses that promote entrepreneurship, then we must have a staff that believes in it. It also means, at some stage, the staff should want to resign and start their own enterprises rather than just teach. The staff that looks for security will not be able to do this job. We should therefore, see how we could attract potential entrepreneurs to the teaching job. I suggest this could be done by offering the farm and the working capital of the course to the teachers. This would give them the opportunity to demonstrate their knowledge. Also, they could keep a share or most of the profits. This would attract as teachers, only those who are keen on self-employment in the agriculture sector and would like to gain experience before they launch themselves in their own enterprises. Thus, the teacher's post becomes a stepping-stone for the entrepreneur. Then we can hope to make the vocational courses popular and effective.

Scope for Self-Employment in Agriculture Operations

We have seen how managerial skills can open up opportunities for service industry in the agricultural sector. There are also opportunities for the new vocational graduate through the practice of technology. Most of this technology already exists but has to be demonstrated and shown to be profitable. There would be many more such areas. We shall see one as an example.

A) Cattle Fodder/Feed

The deficits for the following cattle feeds have been noted by ICAR.

		Value (Rs.)
Green Fodder	388 million tonnes	31,000 crores
Crop Residues	639 million tonnes	64,000 crores
Concentrates	82 million tonnes	24,600 crores

Total value of the deficit in cattle feeds 120,000 crores

This means there is an almost unlimited scope for the production of cattle feed, if it can be produced at commercially viable costs. As a farm product, it should be profitable to the farmer. And as a cattle-feed it should be attractive to the dairyman. We shall first see the prices of some commercial feeds (Table A).

TABLE: A

PRICES OF SOME COMMERCIAL FEEDS

Item	Market price Price (Rs./Kg)
Jowar REs.	2.16
Lucerne	5.30
Silage, maize	1.75
Concentrate	4.20

This shows the relative cost of maize fodder in relation to other feeds. While Lucerne is the most expensive, because of its superior quality, it still finds a constant share of the green fodder use. Considering from the farmer's point of view, the following yields and costs are informative.

Crop	Yield/acre	Expenses	Market price (Rs.)	Profit acre (In 3-4 months)
Jowar grain	1006	2684	3.50	1438
fodder	600		1.0	
Bajra grain	1050	2385	3.0	1568
fodder	800		1.0	
Maize fodder	19555	2572	0.4	5250
Groundnuts	815	4580	8.0	1940
Lucerne	14581	6116	0.8	5549

These figures indicate that maize and Lucerne are indeed very profitable for the farmer and also economical for the dairyman.

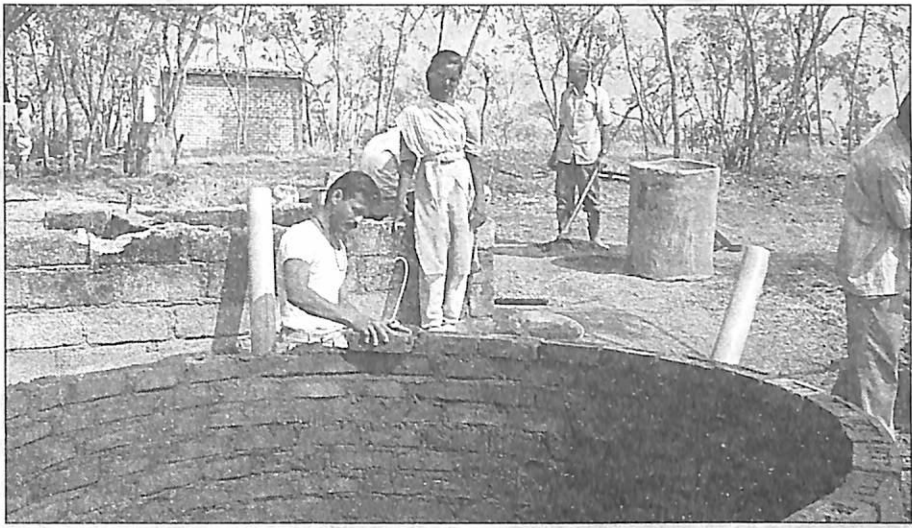
Considering all the above, it seems that cattle feed could be the basis of self- employment for a large number of youth. Maize can be made into silage. The dried crop residues could be blended and made/extruded into blocks for feeding. There are a large number of possibilities when the market deficit alone is Rs. 120,000 crores.

Apart from fodder crops, the fruit and vegetable industry is booming. Food processing, for bulk production, appears to be growing very fast. The poultry broilers business is growing around 20% per year. The value added by dressing is substantial. Dried chicken appears to have some market. Milk products are growing.

All in all, the agriculture is likely to be a very profitable operation. When agriculture catches on, the mechanical, civil, electrical/electronic industries will grow to meet the needs of the agriculture production.

All this growth will need support from the technical and management experts. Consultancy will be more in demand.

Entrepreneurship is not just self-employment. It implies innovation and uncovering new opportunities. I see agriculture as a fertile ground for entrepreneurs. Our vocational programme will produce them, only if we operate it in the real life situation and show how it can make profits.



There is an unlimited scope for innovation in the construction industry in rural areas.

CONSTRUCTION ALTERNATIVES

1. In our effort to choose construction alternatives for low cost rural applications, we considered following parameters:
1) Cost 2) Capital cost 3) Suitability for training of unskilled boys 4) Amenability for quality check and standardisation. 5) Adequate labour component.

The different alternatives were to be evaluated on the above criteria, after in-use experience had proved their usefulness. Most of the alternatives are still in the development /in test stage and only broad indications are available.

2. Soil based Products:
Soil–Block: Soil blocks of 300x140x100 mm. by compacting with ASTRAM have been tried. Productivity as also quality was not as per-target (175-200 for 3M/8 hrs). Cost needs to he brought down by avoiding transport of clay.

Soil-cement blocks: Soil cement blocks with 5% cement were prepared by using hand moulding process. About 6000 blocks of 300x200x100 have been used. Quality control was difficult. Compacting machine is to be tried.

There is an unlimited scope for innovation in the construction industry in rural areas

Soil Cement concrete: Cement (1 part) Soil (7 parts) and gravel (8 parts) has been used as a concrete and was found very useful and better than soil cement blocks of the same cement usage. We have cast walls of 100-200mm thickness and 150-200 mm. which appear adequate for strength, rigidity and insulation properties. We have used this for steps on the outside and they seem to stand well.

3. Fibre based products:

Cotton–cement: This has been found extremely useful and interesting. It is very hard, sets well, stands water, and can be used for plugging large holes, without shuttering. Balling of the cotton makes it difficult to handle large quantities.

Paper-cement mortars: Dry paper pulp (1 part by weight) with cement (6 parts by weight) gives an easy to apply mortar, which cures well, because the paper releases the water slowly. This gives ferrocrete panels, with a good sheen, which do not crack easily, nor heat up in the sun. These panels have stood well in sun and rain for one year. They do not burn at lower paper proportions than 1:1, but get discoloured by charring, when a flame is applied continuously. They may be suitable for window and door shutters if fixed in an iron frame.

Paper-coir-cement: Cast in the form of beams which are rigid but not strong enough. Can be drilled or sawed. Need to be developed as wood substitute.

Paper-cement-soil: (1:1:8) was used for making insulating panels for indoor use. Shrinkage is the major problem. Good workability and applicability.

Coarse woven jute + cements: Has been used to make trays for poultry cages, (for corrosion resistance) and is now in test use. May be suitable for moulded products like WC pans, wash basins etc. perhaps with a water proofing resin finish.

4. Ferrocrete:

We have made 1x 0.5 m. ferrocrete panels with XPM reinforcement, nominal 10 mm. thickness using 183 mortar. They were prepared on plastic sheet and covered with jute bagging, wet for three days and then immersed in curing tank for 1 week. They develop micro cracks, through which damp can be noticed. They have been drilled and bolted on angle iron frame and the joints plastered, for low cost housing, coated with waterprooing cement paint (1 part Assoproof; 2 parts cement) to stop seepage of water.

These have been satisfactory for walls but not for ceiling. Curved panels have been tried but satisfactory shape has not been achieved.

Ferrocrete water tanks have been made and used in house units. Also we have made and used WC pans, wash basins, sinks and kitchen table top, bio-gas plant, drainage channels, etc.,

5. Asphalt Sheets:

Made of paper pulp sheets, impregnated with asphalt, these are light, tough, and flexible. Do not heat as much as A.C. sheets are self-sealing and cost only Rs.2.5/sq. ft. If properly anchored with J-hooks they stand weather very well. They might be improved if chicken mesh reinforcement could be embedded. We now purchase these sheets but we have also made small samples for development work.

6. Plastics:

We feel plastics have good potential in rural areas. We have made only a few random attempts to use urea- formaldehyde and phenolformaldehyde and polyester resins. We are interested in using paper pulp and urea- formaldehyde resins for corrugated roofing sheets. Cotton matting with polyester resins for moulded articles (FRP analogs) has been attempted.

7. Angle iron frame houses:

With a small workshop with only Rs. 7500 investment, one can easily build modular frames that can be assembled to make a house in 3-4 days. The wall frames are made from 30x30x30mm. angles and corners with 40x40x5 mm. Each frame is 1x2.5m. and has three segments for ventilators, windows and for brick wall with sill at the bottom. Roofing is also angle iron frame with trusses, rafters and purlins. The grid of 20x20x3mm. with 30x30x3mm. rafters gives good rigidity to the structure. Rigidity ofWalls; is increased by brick walls up to 1 m height.

8. Doors & Windows:

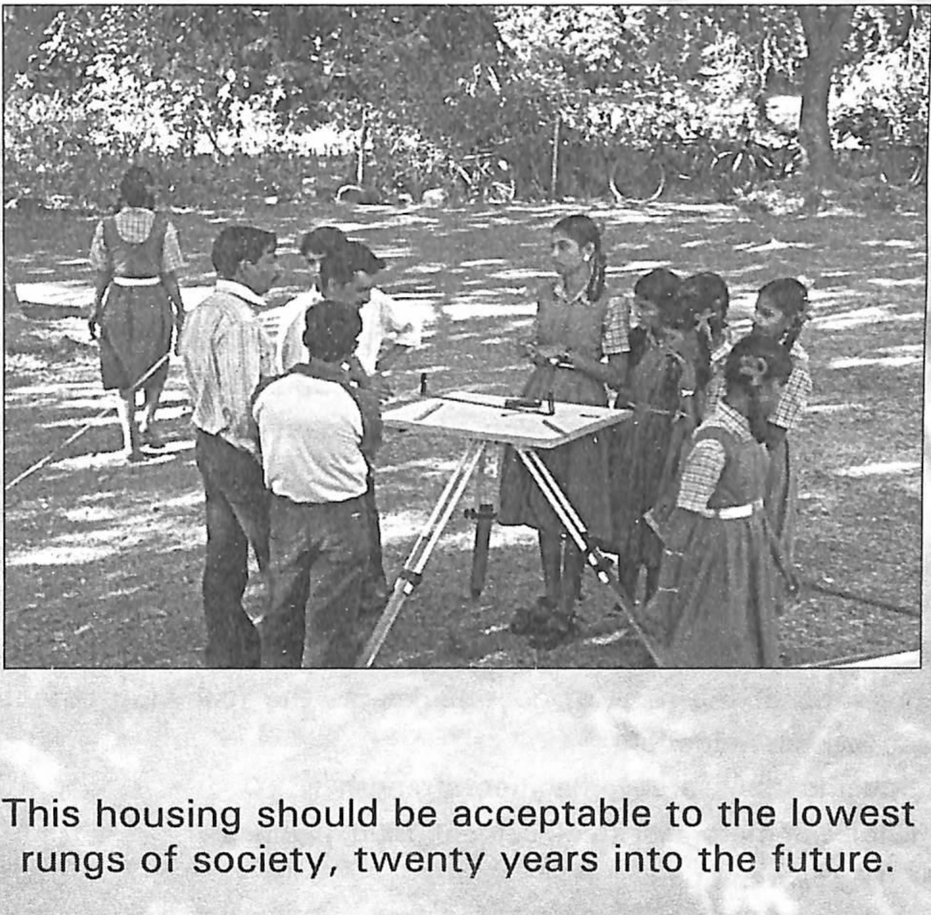
These are still presenting a problem. Panel doors and window shutters, are not only expensive, but also unsatisfactory because of excessive shrinkage, expansion and warping. The labour cost is also more. Block board has been easier to use, is light, looks neat and is entirely satisfactory for indoor use. We are testing outdoor use with protective coats. Painting of plywood and block board consumes more paint and there is scope for treatment of these for standing weathering (urea- formaldehyde resins)

We have tried angle iron frames with paper cement panels for WC/bath doors. They are not very rigid, tend to twist, but are otherwise satisfactory.

9. Geodesic Domes:

Geodesic domes of angle iron frames with chicken mesh skin and mortared after centering from inside, may be an approach for reducing cost still further.

This brief account should be enough to convince that, there is an unlimited scope for innovation in the construction industry in rural areas.



This housing should be acceptable to the lowest rungs of society, twenty years into the future.

LOW
COST
HOUSING –
VIGYAN ASHRAM APPROACH

At present, the types of housing vary from the "nearly zero cost zopadpatti" built out of scrap, to very expensive urban housing. In this context, what do we mean by Low Cost Housing?

We aim at minimizing the cost of housing that would be acceptable to the lower middle class urban and rural population, who normally lead the society in the adoption of new ideas and products. This housing should be acceptable to the lowest rungs of society, twenty years into the future. Today it should be better than what the poorer sections can afford, in existing designs.

The Approach

A break-up of the housing costs indicates the following potential areas for cost reduction:

a. Specifications: area, amenities, strength
b. Choice of materials: steel, cement, mud, plastics
c. Design parameters
d. Productivity
e. Factors of Ignorance
f. Contractors' excessive profits

Our approach may be called the "Ford T" approach and is as follows:

This housing should be acceptable to the lowest rungs of society, twenty years into the future.

a) Specifications: We have chosen an area of 253 sq. feet as the minimum, an Indian family at the end of the century, should have. The amenities should include sanitation and plumbing.

b) Materials: After trying mud/cement combinations, we settled for the Ferro cement concept but the choice is open for other materials.

c) Design Parameters: We found a lot of scope for reducing material consumption by changing design parameters. The use of the strongest 3-D shape, the sphere, and the strongest 2-D -shape, the triangle, led us to the Geodesic Dome structures. We have still more ideas on rectangular structures to be explored.

d) Productivity: A major cost arises from low productivity of the labour utilised. Modular designs, prefabricated components are possible solutions. There are many ideas we are trying out to improve productivity. This is inevitably going to affect the labour-materials ratio.

e) Factor of Ignorance: Urban housing in RCC has often excessively heavy columns and beams - yet disasters occur. We believe the proper choice of design parameters can save costs.

f) Contractors' margins: A contractor has a useful role to play. But because of lack of competition, contractors extract excessive margins. The best way to counter this and bring down costs is to demystify all knowledge and make the skills widely available.

The Geodesic Dome

We can illustrate the above points with respect to the dome houses. Geodesic is the great circle or an "equator line". It is the shortest distance between two points on the surface of a sphere. In 1885, a Chinese Dowager Empress built a palace that had a geodesic dome. In 1922, Carl Zeiss Glass Works commissioned Dr Walter Bauers

Field to build a planetarium dome. He built a 40-m. lightweight dome in Ferro cement using the icosahedra shape.

Buckminster Fuller gave the name Geodesic and made it popular in the USA. By 1941, an equivalent of $10,000 domes of 6-m. diameter were constructed in USA.

The inherent strength of the sphere allows considerable reduction in steel without sacrificing strength. B. Fuller claims that for a conventional wall and roof, the structural weight required to shelter 1 sq. ft. is about 50 lbs. whereas for his geodesic designs, it is a mere 0.78 lbs. Thus, the two well-known domes in Italy - the dome of St Peters and the Pantheon were both about 150 ft in dia. and weigh about 30,000 tons. In contrast, Fuller's geodesic dome of 150 ft dia. weighs only 30 tons, 1/1000 th in weight. In an earthquake, both the heavy domes would fall, but Fuller's will remain standing. Because of the small surface area for the volume enclosed, the heating and cooling effects are minimal, so also wind and cyclone effects.

After getting some experience of building and living in a dome house, we designed a kit that is:
Modular - common components for all sizes
Easy to assemble - colour code and nut-bolt assembly
Core gives the strength - assured strength
Potential to generate employment in rural areas; whosoever the client is.

The 280-sq.ft. domes require a maximum of 85 man-days to erect the steel and cement shell on a firm foundation, and another 40 man-days for the "finish" to make it attractive. We believe there is scope for reducing this to 50 and 30 respectively. The kit production is economical to rural areas and brings to the village new skills that could be used in other fields.

The construction is simple enough to train local boys in a few weeks. It can also be built through self-instruction. There is scope for local boys to emerge as contractors.

Future Scope: We hope to be able to adopt the franchise system. That is, we can give a standard production system for producing these kits anywhere, with a minimum of training. There is ample scope for local initiative in the use of different materials as also use of the dome. We hope to be able to give a kit for the interior also, on a modular basis. We hope to considerably reduce the time for completion of the dome by improving the productivity. Simultaneously, this will demystify the skills. Finally, we would like to find alternate methods of applying the mortar so that centering is avoided or simplified.

Break up of the Cost of a 280-sq ft-dome house

Steel etc	3491
Labour	2505
Meshes	1470
Cement	2960
Sand	605
Rock	300
Misc.	897
	9731

This includes steel doors and windows with steel shutters, a ventilator, oil paint, enamel for the steel work, and cement paint from outside and water bound distemper from within.

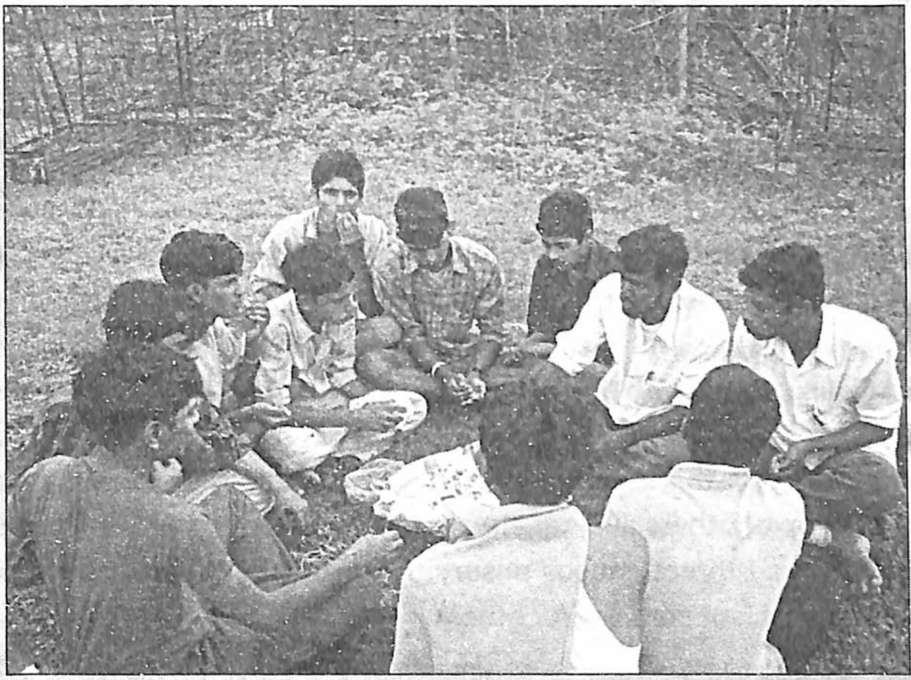
The flooring is 4" mass concrete finished with 1:3 mortar.

The cost in Sept 1988 is Rs 43.7 / usable sq ft. or 41.1/sq ft of plinth area.

Rectangular Structures

We have also tried prefabricated RCC columns and Ferro cement channels, with built-in windows, to build walls, a steel truss with asphalt/cement sheet roofing. We built a workshop shed of 800 sq ft (72 sq meters) at a cost of Rs. 27,000. It has gone through the last monsoon very well. The cost break up is as follows:

Steel bars, angles etc.	7923.9
Water, electricity	992.5
Meshes	1330.0
Labour	3065.13
Cement	5051.25
Sand and gravel	785.0
Bricks	1530.0
Roofing sheets	5315.0
Misc (nuts, wire, weld)	1468.0
Rs.	27,460.00



India needs a complete reconstruction of the moral, religious (?), social, educational, political and economic fabric.

WHY INDIA NEEDS VIPASSANA

What India needs

A complete reconstruction of the moral, religious (?), social, educational, political and economic fabric.

Root Cause of the Problem

Every one feels threatened by others, and in the rat race wants to climb on top of others and get ahead, by any means and at any cost. The perceived threat causes misery, hypertension, greed, jealousy, hatred and lack of concern for others.

The solution lies in removing this state of mind and bringing tranquility and goodwill for others.

Vipassana is the only hope.
This kind of reconstruction cannot be done by armed revolutions: we have seen that armed revolutions have replaced old tyrants by new ones but not changed anything fundamentally.

India needs a complete reconstruction of the moral, religious (?), social, educational, political and economic fabric.

We have to go back in our history. India has done this kind of revolution in the minds of the people and that is why we have the Ashoka Chakra and the Stupa as our national symbols. We shall use the same technique Ashoka used, namely, Vipassana.

It does not need funds, does not provoke resistance. It spreads goodwill and will be self-sustaining in the growth phase.

Misery

Nobody can change the laws of nature. Therefore, nutrition, hard work, good health cannot be avoided. We have to work to get them. But in working to remove the physical causes of poverty and misery, we come across great obstacles in the form of attitudes, like lack of concern for fellow beings, greed, corruption, hatred, violence etc.

These are the real causes of misery in this world; if the causes that lie in the minds are taken care of, the physical causes can be removed faster.

Ultimately misery is a state of mind arising from our not getting what we want or having to bear what we do not want.

A miserable mind causes suffering not only to itself but also creates a bad environment for others.

Gandhiji said, there is enough for everybody's need but not for everybody's greed.

A need is stable over time or increases very slowly, e.g. our food and shelter needs. Greed (greed for sumptuous food, more good things of life, easy money etc.) feeds on itself and increases very steeply.

What Vipassana Aims to achieve

If misery arises in the mind, it can be removed by treating the mind. Everybody has at least a grain of good in him. If this is nurtured, it can grow and take firm roots. Misery is like a weed. It grows, takes root and then smothers the good nature.

- Remove misery from the lives of human kind by removing its roots in the mind.
- Train each individual to look inside himself and learn from his own experience, how the habit of forming aversions and greed are formed.
- Train him to break this habit, and thereby liberate himself from misery.
- Create an environment of goodwill towards all. A mind bereft of bitterness is very peaceful and creative. This will produce economic and intellectual progress in society

Some concepts of Vipassana

1. All human misery arises from our habits of the mind and therefore can be removed only by changing these habits. These methods are based on the universally applicable laws of nature; Vipassana is one such technique.
2. This technique is therefore applicable to all, irrespective of creed, religion, caste, nationality etc.
3. The Laws of nature are the same inside us and outside us. The basic laws are therefore common to living as also the non-living things around us. It is these laws that were known as

Dharma/dhamma. The meaning of Dharma now has been narrowed and implies sectarian beliefs.

4. True learning comes only from our own experience. Others can guide, help to learn, but final learning comes only from our own effort. Benefits come only from practicing what has been learnt and not from the learning alone. Nothing that is truly beneficial comes without great effort. It cannot come only from praying or asking and getting favours from someone else.
5. Understanding theory is important for the proper practice of any technique. But merely understanding the theory on an intellectual plane cannot bring any benefits. It may help inspire someone to take the next step, but nothing more.
6. There should be no objections from any religion or sect to the technique of Vipassana as it uses only those features, common to all humans, and aims at what every religion and sect preaches as desirable.
7. All things that look different are made up similarly and ultimately from a single entity. All things are continuously changing, forming, ending and again forming and so on endlessly.

Vipassana Concept of how misery is created

- We get information from outside, through our senses - Vigyan
- The information is noted in our system - Sandhya
- This produces certain sensations in the body - Vedana
- We form a habit of reacting to each sensation as pleasant or unpleasant - Sanskar
- We also have the habit of 'dwelling' on old miseries and 'recreating' them
- These sanskar produce misery for our mind. It produces reactions, like weeping, abuse, aggression etc. that spread the misery outside to others also.

- If we stop the habit of 'reacting' to the sensations, the misery is stopped at its source.

Vipassana teaches us the method of

- Breaking the barrier between the outside mind and the inner mind
- Going deep to where the sensations are felt
- Changing the habit of reacting to each sensation
- Thus breaking the chain of creating new sources of misery
- Allowing the old sores to come up and be wiped off.

How will Vipassana help India?

- By reducing misery at the individual level
- By increasing goodwill among people
- By increasing work efficiency by giving a peaceful mind
- By reducing friction between communities and sections.
- By restoring a balance between need and greed
- By reducing corruption by controlling greed
- By reducing the violence in the mind
- By having a new life style that can be distinctly Indian. For every year of work, at least some should spend 10 days, in a Vipassana camp, turning one's gaze inside, to recharge the mental batteries.
- By giving a meaning to our Ashok Chakra in the flag.
- By having something to offer to the world

We have done it before, 2500 years ago. We can do again. Let us try.

Vigyan Ashram began as a laboratory of education, where Dr. Kalbag did various experiments and perfected his design of rural development through education and education through rural development.

Annexture I

EVOLUTION OF RDES AND CURRENT UPDATE

What is Vigyan Ashram?

Vigyan Ashram (VA) is a laboratory for work-centric education.

Vigyan Ashram is a school for dropout students giving them vocational training.

Vigyan Ashram conducts pre-vocational programme in schools.

Vigyan Ashram works for development of rural technologies. It is a rural technology center.

It works on low cost housing, constructs geodesic domes !

Vigyan Ashram manufactures and carries out ground water prospecting using Earth Resistivity Meter.

Vigyan Ashram makes multimedia CDs and software.

Vigyan ashram provides internet services and establishes internet kiosks in villages.

These are the some of common answers. All these descriptions and many more, are true. These activities are part of an integrated programme of 'Rural Development Through Education System (RDES)'.

Dr.Kalbag, founder of Vigyan Ashram, was a scientist. In his corporate career his primary responsibility was to carry out laboratory research, test it on pilot scale and then to implement it in a production environment. He developed VA programme on the similar lines. Vigyan Ashram began as a laboratory of education , where he could do various experiments and perfect his design of rural development through education and education through rural development. Subsequently, a pilot project was initiated in a limited number of schools. Now the VA model of RDES is at a stage where it is ready to take off towards universalisation.

Dr.Kalbag was often asked whether Vigyan Ashram would survive after him. In his peculiar style, he used to ask back whether it was necessary for everything to survive. He belived that one need not keep worrying about such questions. He believed that if the concept is viable, it would survive or may evolve into something else that is useful. At the same time he used to remind people that the students who have started their own enterprises, are success story of their own efforts, my success would be when the system would run without me – he used to say.

On the very next day of his demise, on 30th July 2003, VA started functioning as usual. A team of technicians went to install an internet tower at Singeshwar on 31st July. When the villagers wanted to close their shops to pay respect to Dr.Kalbag, VA volunteers persuaded them against it. During last seven years after Dr.Kalbag, the staff and volunteers at VA have given their best to keep the momentum of Vigyan Ashram. It is necessary for us to give readers an update on the present status of Vigyan Ashram and the RDES concept propounded by Dr. Kalbag, six years after his passing away.

Programs of Vigyan Ashram

'Development through Education and Education through Development' is a motto of Vigyan Ashram (fig.1). We believe that it is necessary to use technology to increase pace of our rural development. We also believe, that technology is needed to increase efficiency and effectiveness of everything we do. To spread the available technology to masses, we need to educate them. Such technology based services can only be made accessible to villagers through small enterprises. Small enterprises will give boost to local economy which in turn helps in real development of villages.

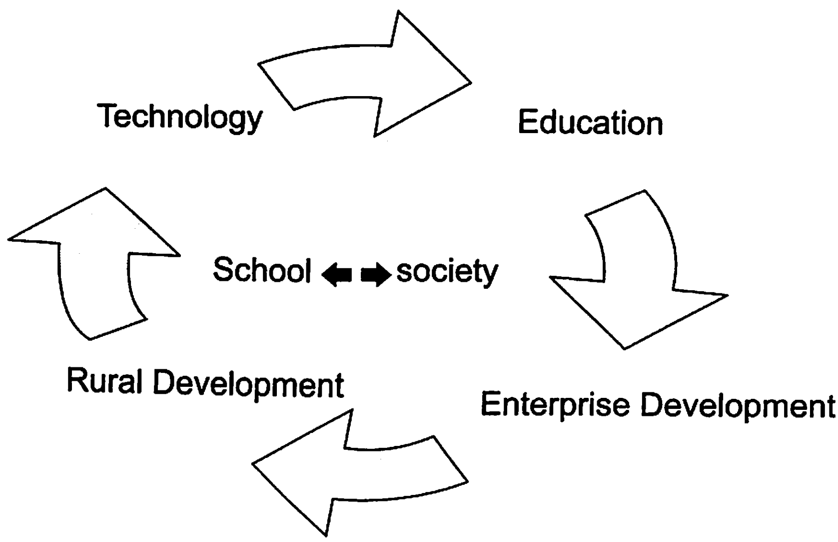


Fig 1. Education through Development

To realize the vision of RDES, VA has following programmes, that are interlinked to each others (fig.2). Education is at the center of the VA's program. Technology development is another area of VA's work. Technology developed will be disseminated through education programme. Students learn by 'Learning while doing' methodology and while doing so they provide services to the community at a modest cost. This gives students experience and confidence to start their own enterprises. Appropriate technologies will get disseminated through these rural enterprises and at the same time large pool of technology-literate will be created through the school programme, who will have scientific temper and work culture imbibed in them.

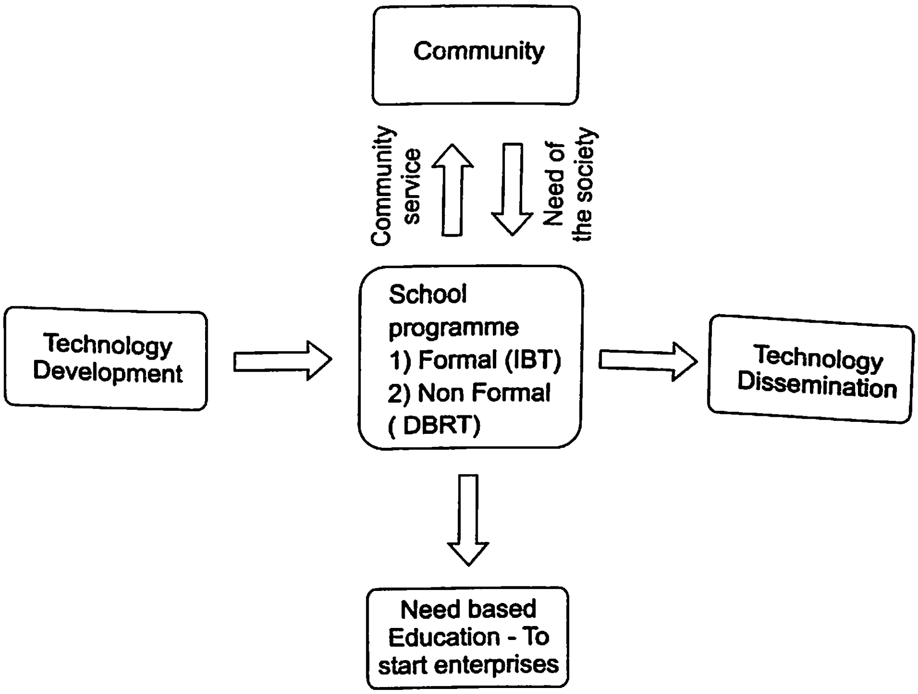


Fig. 2 RDES

Education

VA implements RDES programme in two modes.

1) Non formal mode – the programme is called 'Diploma in Rural Technology (DBRT)'

2) Formal schools – the programme is called 'Introduction to Basic Technology (IBT)'

Diploma in Basic Rural Technology

The programme was started in 1983 as a Rural Technology course. In 2000, National Institute of Open Schooling (NIOS) recognized it as a Diploma. VA want to test its educational methodology by examining how it works on the weakest link. Therefore, to test the merits of this program, VA initially enrolled school dropouts. This is one year residential program at Pabal and any student studied upto 8th standard could get admission on first-come basis. DBRT program staff was supported through DST core support till 2003. Then onwards, Asha for Education – Seatle chapter started supporting salary of DBRT staff.

Number of students enrolled for DBRT course each year at Pabal increased from 19 in 2003 to 36 in 2009. Apart from DBRT, VA conducts various short term courses on poultry, fabrication, wireman, electrical appliances repair, computers etc

Normally NGOs willing to start training on similar lines sponsor candidates for DBRT. Every year we get students from all over India, So far, we have students coming from Madhya Pradesh, Gujrat, Assam, Orissa, Nagaland, Manipur, Uttar Pradesh and of course Maharashtra.

'Learning while doing' approach overcomes language barrier and 'Work becomes the medium of education'. At VA's Pabal campus, teaching and learning takes place in Marathi, Hindi and English. A year long stay at ashram leads to transformation of personality of students and multi-skill training makes them suitable for variety of jobs. Learning in real life gives them confidence to undertake tasks.

Since 2005, we started the practice of placement of DBRT students with our alumni entrepreneurs and other enterprises. Most of the students get placed before they complete their final examination. After getting some experience many students start their own enterprises.

A survey of our alumni of the last 7 years was undertaken with support of Lend-a-hand-India, a US based non-profit organization. It showed that 36% of our alumni started their own business, 48% got into employment and the rest were pursuing further education. It was found that 71% of alumni were doing work related to the skills acquired at VA. In 2006, VA received a Youth-to-Youth award from the World Bank for establishing alumni network. More than 300 alumni were contacted and their profiles were posted on www.renindia.in website. VA also started skills up-gradation programme for its alumni.

In 2008, National Institute Of Open School constituted committee to review syllabus of DBRT. As per the recommendations of the committee the DBRT syllabus was revised and work of writing DBRT books in English is in progress.

VA helped many orgnizations like Loksadhana at Chikhalgaon, Vivekanand Kendra (nasik), Astitva Pratishthan (Veer, Dist. Pune), Symantak (Dist. Singhudurg) to start DBRT programme. VA provides instructor training and technical support to these organizations.

Introduction to Basic Technology (IBT)

In 1987, VA started 'Rural Technology (RT)' programme in 3 schools around Pabal. Students from these schools were coming to VA one day per week, for training. After 3 years of pilot study, Maharashtra State of secondary and Higher Secondary Education Board (SSC) appointed a committee to evaluate the programme. Realizing the usefulness of the programme, even to the urban schools, committee recommended to remove the word 'Rural' and named the programme as 'Introduction to Basic Technology (IBT)' and recognized it as pre-vocational program (V-1). Initially, the programme was supported by DST and CAPART. In 1995, MHRD (Ministry of Human Resource Development) supported the program in 15 schools under its centrally sponsored vocational scheme. Later the scheme was transferred to state government and the funding for the programme was stopped. At that point, complete system of IBT implementation had not yet evolved. The financial constraints meant that, there was a possibility that the program may stop before the results were proved. Hence, Dr.Kalbag sought support of Sir Dorabaji Tata Trust to fund the programme from 1999-2001. The program spread to 23 schools till 2001.

Objectives of IBT program:

The objectives of IBT as a pre-vocational education at the secondary level are –

1. To impart training of simple basic skills to students in class VIII, IX and X.
2. To expose them to the 'world of work'.
3. To develop their personality and enhance their understanding by giving activity to hand.
4. To help them to connect academic education to the daily life.
5. To develop vocational interests, aptitudes and allow self-exploration.
6. To make them enterprising.
7. To facilitate the students in making choice of vocational courses at the higher secondary level.
8. To prepare students for participation in work as a desired dimension of academic education, and
9. To inculcate healthy values related to work culture.

The scheme of implementing IBT programme is as follows (price base year 2010) :-

1. The programme is imparted to students of class VIII to X for one day per week (10 school hours per week).
2. The school provides land, 2 classrooms, and electric connection.
3. Tools and equipment (Approx Rs.1, 00,000/-) are expected to be made available in the school. (By the community)
4. Instructors (preferably entrepreneurs from the community) having demonstrable skills are selected by the school.
5. Recurring expenses for instructor's training, monthly honorarium,

and consumables for practical are to be met through a funding agency for a period of 3 years.

6. The tuition fee charged (approximately Rs. 40 per month) is deposited in separate bank account so that it contributes towards sustainability of the program after 3 years

7. The science/mathematics teacher in the school works as a coordinator and conducts lessons on theory and drawing prescribed under the IBT programmes.

Test for sustainability

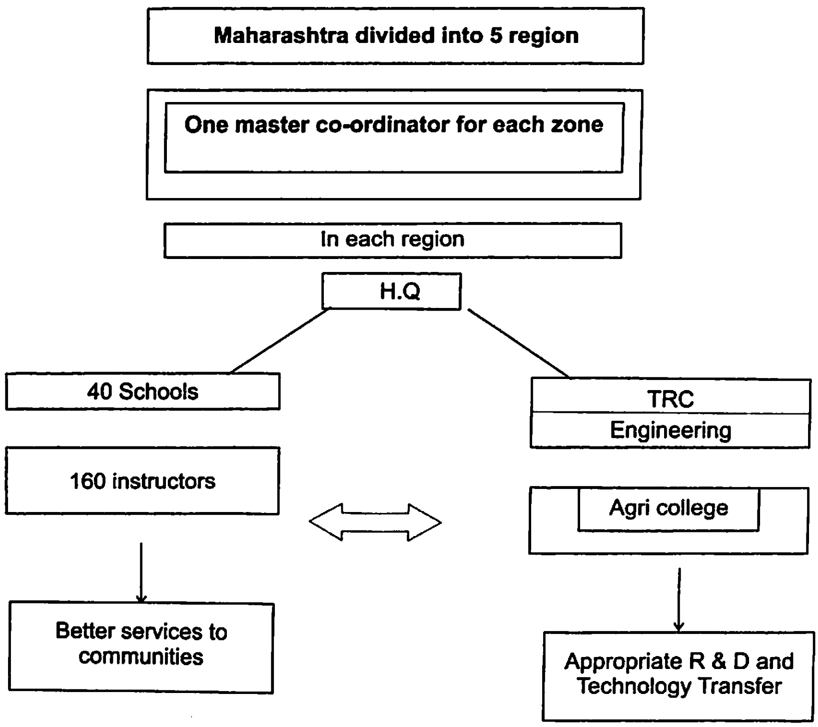
Funding from Sir Dorabaji Tata Trust got over in 2001. The programme was evaluated by Mr.Ramesh Panse of Gram Mangal. The objectives stated for the project such as improvement in learning / school attendance / performance in and after 10th std. / community services etc. were achieved satisfactory. The real question was whether community would come forward to continue the programme.

In 2001, all the schools (where IBT was implemented) were requested to continue the programme on their own resources. By this time these schools had realized importance of IBT and had also experienced its benefits, It was suggested that they continue by charging fees the programme by charging fees to students, by raising money through community services and through the donations from community.

There was practically no support to schools in the period 2002-2005. Dr.Kalbag passed away in July 2003. By 2001, usefulness of IBT was demonstrated, a beginning was made towards replication of the programme but more work was needed to prove it as a fully replicable model.

Few months before his demise ,Dr.Kalbag started developing a plan to replicate IBT on a larger scale - to 1000 schools - with Yogesh Kulkarni, the then Dy.Director of with VA. A proposal was submitted to 'Development Marketplace -World Bank competition' in collaboration with Dnyana Prabodhini, a Pune based non-profit organization, which worked in education sector. Our proposal was not selected for funding. VA received the outcome of the competition on 24th July 2003. Dr.Kalbag sent an e-mail to Yogesh Kulkarni saying that, though we could not make to the final he had not lost zeal for the programme and that it was in fact his life's mission!

Following is the model for replication of IBT in Maharashtra.



IBT program came to a standstill in 2003. VA did not have any staff on IBT project and communication to schools almost stopped.

Replication of IBT is very much important to realize the concept of 'RDES'. Hence, to start communication with school and to revive the project, a proposal was submitted to Asha for Education to support salary of one coordinator to activate the programme. A meeting of all IBT school principals was organized on 23rd April 2004 at Pabal to review the status of IBT. It was found that out of 24 schools, 16 schools continued the programme. All of them reiterated usefulness of the programme and urged for training and monitoring support from VA.

Though schools faced many difficulties in continuing the programme and also made some compromises on the way, it was satisfying to learn that the schools had continued the programme for 4 years after withdrawal of the support. This was a good indication for the usefulness and acceptance of the IBT programme.

PLAN 100

The report of school principals meeting was shared with many well wishers and funding agencies. Ms Sunanda Mane of Lend-A-Hand-India (LAHI) was one of them. Ms. Mane visited VA in November 2004 as she was aware about VA's work over the years and had visited the Ashram few times in early 90s. Ms. Mane showed keen interest in the IBT replication project. She asked for more details and initially sponsored fees of 10 DBRT students. Lend-A-Hand India also decided to sponsor a survey of VA alumni to understand the impact of the DBRT/IBT programme. In 2005, LAHI supported IBT programme in two schools which were part of the Tata supported group of schools and needed financial assistance to continue the programme. From the experiences of these two schools and also taking in to account the past experience, Project PLAN 100 was conceptualized and launched. The idea was to replicate IBT in 100 schools to generate a critical mass of 20,000 IBT students to impact the public opinion and policy. Ms. Sunanda Mane contributed a lot in shaping this project. LAHI not only agreed to support the project financially, but also decided to develope an exhaustive web based monitoring system for the programme which was considered to be critical for success of the programme as well as for universal replication.

In the first phase of PLAN 100 , IBT was launched in 6 schools in 2006-07. Till 2003, IBT was an experiment. Under PLAN 100, the effort is to streamline and package the programme for facilitating its scaling up. Implementation guidelines were published in Marathi. One VA field officer is appointed for every 10 schools. Now field Officers visit the school every month and provide mentoring to the IBT instructors. Regular training programme for IBT instructors were started during summer and winter vacations. Training hall and workshop infrastructure were upgraded with LAHI's support.

Number of schools increased from 16 in 2006 to 28 in 2007 and 55 in 2008. Online monitoring system was made available in 2008 (www.lahi-impact.org). VA also made a website for schools at www.techshala.com

On the government front, the SSC board formed a committee in 2005 to review syllabus of the IBT programme. The new syllabus came into effect from 2006. Teacher's handbooks were also prepared for IX and X standards.

In 2007, Dombaranhally school in Karnataka joined the IBT programme. This is the first school outside Maharashtra to join IBT. In 2008, IBT started in six more schools in Karnataka. IBT started crossing the state boundaries.

Advocacy

1) Government recognition

Government has granted recognition to following three pre-vocational programs.

V1 – Introduction to basic technology

V2 – Elements of mechanical engineering

V3 – Elements of electrical engineering

However, the number of schools offering the pre-vocational courses has remained the same since 1999. Government did not grant fresh permission for opening pre-vocational schools since 1999. When it was decided to launch project PLAN 100, first hurdle was to get permission to run IBT program in new schools.

A proposal was submitted to the Technical Education Ministry and Director of Vocational Education. After much follow-up, the government gave permission to start V1 i.e. IBT program in 100 schools. While doing this, we could persuade the Government to introduce a system of inviting applications from schools for starting the IBT program. From 2007, Directorate of Vocational Education started publishing advertisement in newspapers inviting applications from the interested school for opening of 'pre-vocational' programme. This was first such advertisement after a gap of nearly 8 years. In response to the advertisement, 239 schools got permission to start pre-vocational programme. Out of which 126 schools got permission to start IBT (V1) course. This was an important breakthrough with the government and the bureaucracy.

2) Pre-vocational as a core subject

With the support of 'Purskarit Shikshak Sangathana' (association of teachers who have received special acknowledgement for their work as teachers from the government) led by Mr.Anandrao Patil , an appeal was made to the Government of Maharashtra to make 'pre-vocational' programme a core subject at the secondary school level.

The appeal emphasized the need to make 'work based education' as an integral part of the curriculum. Several meetings of teachers were held and many followup meeting with ministers took place.

The State Minister of Education, Mr.Hassan Mushriff, appointed a committee to study the programme. Accordingly, committee of Director of School Education and Vocational Education and MPSP (Maharashtra Prathamik Shikshan Parishad) visited the VA. They expressed satisfaction over the programme. Since the Government wanted to concentrate only upto 8th grade under Sarva Shiksha Abhiyan (Universalization of education program), they requested VA to design a work- education programme for 5th to 7th std. A proposal was submitted to Government. Accordingly MPSP sanctioned a pilot project for 20 schools in 4 districts (Pune, Amaravati, Sangli, Kohapur). VA published book 'Jeevanopayogi shikshan handbook (For life-skill based education)'. The program was implemented successfully in the year 2006-07. Evaluation done by MPSP expressed satisfaction over the programme. But due to lack of enthusiasm from MPSP and Zillha Parishad, funding was stopped after the first year.

3) A meeting was held in Mantralaya in presence of the Cabinet Minister for Technical Education Mr.Dilip Walse Patil and Education Minister Mr.Vasant Purke on 7th October 08. Another meeting was held on 27th Jan. 09 in the presence of Education Minister Dr.Patangrao Kadam and Technical Education Minister Mr.Rajesh Tope. In principle, they agreed the demand of making pre-vocational programme as part of core subject. They asked SSC board chairman to study syllabus of CBSE and international board and submit a proposal.

4) The VA also made a presentation before focus group on 'Work and Education' by NCERT for Developing 'National curriculum

Framework 2005'.

5) A documentary - 'Vigyan Ashram.... Education through Development'

To help with the advocacy and spread of the message of work-centric education, Avakaash Nirmittee, a Pune based documentary production firm, produced a documentary on Vigyan Ashram in Marathi and English in 2007. Several shows of this documentary were organized in towns and villages. This became a very useful tool to explain the programme and the concept.

Partners

Vigyan Ashram is working with many like minded voluntary organizations to promote the concept of RDES through IBT/DBRT programme. The key partners are Lend-a-hand-India, Suzlon Foundation, Bayer Crop Sciences, Jnana Prabodhini, Asha for Education, YUVA - Bangalore, Prajayatna, Vivekanand Kendra, Astitva Pratishthan, Pragati Pratishthan, Khoj, Lokasadhana, and Syamantak and many more.

Appropriate Technology – innovation and promotion

Experimenting is one of the core activities of VA. VA always looks out for new technology and attempts to implement it at VA.

VA is known for many technology development projects. The present status of technology projects undertaken before 2003 is as follows –

i) Pabal geodesic dome –

VA alumni Mr.Kasim Inamdar produces and markets geodesic dome kits. VA directs all the inquiries to him. There are certain problems like leakages during heavy rains with the dome. With increase in cost of steel, the cost of dome is almost equal to a normal wall bearing construction. VA plans to work on it.

2) MechBull Tractor – VA was advocating low horse power tractor for small farmers in nineties. Mechbull was developed and tested for many years at VA. It was a work horse for VA. VA alumni Mr.Shindade sold many of them. He improved the design at his own initiative. He installed hydraulic system on Mechbull version.3. In 2004, VA manufactured version 3 for its own use.
Now many companies are manufacturing low horse power tractors, hence VA stopped working on its development.

3) Earth Resistivity Meter –
The present machine at VA is able to do water prospecting up to 150 feet. Therefore, VA provides service within the constraint of 150ft. VA has sold more than 55 earth resistivity meters so far. Now with the ground water level going below 150ft. and many digital meters available in the market, we have stopped promoting these machines.

4) Reality learning engine
VA took a loan of Rs.17 lacs from CAPART (Council for Advancement of people's Action and Rural Technology) to develop multimedia Compact discs (CDs). We develop CDs for Computer Technician Training Programme, Basic English Programme, MS Office Tutor, Balwadi etc. Mr.Richard Pipe along with Dr. Kalbag developed an authoring tool 'Reality Learning Engine'. Yogesh Kulkarni worked as a Project leader. After untimely death of Dr.Kalbag, priority for VA changed. Work on 'Basic Engineering', 'Basic Electrical and Basic mathematics CDs remained incomplete. Development of CDs was put on the back burner. VA had a loan outstanding of Rs.10 lacs. All of the revenue went into repaying the loan. For want of suitable project leader and constraint on funds, VA could not continue the work on remaining CDs.

Yogesh kulkarni also conducted a workshop on RLE (Reality Learning Engine) for school teachers in Pune, AISECT (All India Society for Electronics and Computer Technology) members in Bhopal and also in ADRA (Adventist Development and Relief Agency) Educational Conference in UK,

Later Mr.Richard Pipe left his company and our technical backup for the RLE development was stopped.

CTTP (Computer Technician Training Programme and RLE project is a milestone in VA's history. It helped in establishing VA in content development. It also helped in developing 'Learning while doing' pedagogy using multimedia.

VA was able to pay back the loan to CAPART through sales of CDs. VA sold more than 5000 CDs and has distributor network in Maharashtra, M.P and Delhi. VA used print media, advertisement in magazines, exhibitions for promotion of CDs.
VA sees lots of potential in Information Technology and definitely wants to continue work in the area of content development.

5) WLL Internet Project
VA entered into agreement with n-logue communication Pvt Ltd. in 2001. VA invested Rs.12 lacs in the project by taking loan from 'Indian Institute Of Education'. There were many technical and administrative difficulties in the project and the project went live only in 2003.VA established internet kiosks in 36 villages. VA also installed and activated Village public telephones in more than 70 remote villages in Rajgurunagar. Kiosks model could not become sustainable for lack of internet based services and also lukewarm response from the people. Soon other telephone service providers started offering services in nearby towns. Therefore, VA decided to withdraw from the project. VA had a franchisee agreement for 5

years with n-logue. The agreement ended in 2006. VA decided not to renew the agreement with n-logue and handed over the project to n-logue in Jan 2006. A loan from IIE was paid back in 2006-07.

Though the WLL project could not succeed in establishing viable village kiosks, it helped in development of another project aAQUA. It also helped VA in establishing internet connectivity and web culture in VA. This helped in nurturing linkages with MIT , Lend-a-hand-India, Asha for education etc. From 2007 onwards, VA got connectivity from other service providers.

6) DST core support and CAPART's 'Technology Resource Center (TRC)' :

VA got core support from 1992 – 2004 from Dept of Science and Technology (Science and society division). Due to this long term support, VA could carry out many of its development projects.

Similarly, VA got Training and Resource Center status from CAPART. Objective of TRC is to promote rural technology to the people.

Technology Developed after 2003

Dr.Kalbag was a scientist and had a life time experience in industrial research. His demise created a vacuum at VA. To overcome this, VA started collaborating with other institutions. VA also started giving thrust on developing business model and replication in a more focused way. Following are the technology development projects undertaken after 2003.

1] aAQUA (www.aaqua.org)

aAQUA stands for "Almost all questions answered". It is an on line discussion forum for farmers. Here a farmer can post his/her question in Marathi/English language and experts from Krishi Vigyan Kendra (Agri. Science Center) Baramati answer the questions. This is in line with the idea of 'problem referral system' mentioned in articles written by Dr.Kalbag. The forum was developed by Development Informatics Lab at IIT-Powai. It was deployed in rural internet kiosks setup by VA.

aAQUA project has grown up over the years and with the initiative IIT, Mumbai, a company called M/S Agrocom Pvt Ltd. was formed. Vigyan ashram is one of the co-founders of the company.

2] LED lighting solutions for rural areas

A LED light consumes less power compared to other alternatives. They can be charged by various methods. Under DST funded project, Vigyan Ashram developed kits for small scale LED lamp production. Vigyan Ashram with the help of M/S Thrive Energy Pvt Ltd. developed training manuals and kits for LED lighting. The manual is available on Vigyan Ashram website. VA also trained IBT school instructors to manufacture LED lights as part of community service. Many schools take up LED manufacturing activity.

3] Fab Lab Project

Fab Lab at Pabal is setup with the help of Massachusetts Institute Of Technology, (MIT), USA. It started in 2002 with setting up of a few machines to work on electronic projects given to Dr.Neil Greshenfeld by Dr.Kalbag. VA received full Fab Lab in 2005.

Instead of giving readymade solutions, Dr.Kalbag wanted to give tools in the hands of the people to find solutions to their own problems. Fab Lab is a collection of set of computer operated fabrication tools, which empowers one to make almost anything! One can give shape to one's idea using tools in the Fab lab. It is a prototyping lab for innovators.

Pabal fab lab is first Fab Lab in the Fab network and currently there are more than 60 labs across the world.

There are many innovative electronics projects undertaken by VA in the Fab lab. Following equipments are installed at Vigyan Ashram's Fab Lab :

1) Laser cutting Machine
2) Roland Milling Machine, 3 D scanner
3) Vinyl cutting machine
4) Plasma cutting machine
5) Electronic table (Oscilloscope, Soldering equipment etc.)

Through Fab lab, VA is trying to develop expertise in the area of electronics and microcontrollers.

4] Wi - fi robust area network

Internet lease line at Pabal was not reliable. Frequent breakdowns in lease line compelled VA to search for an alternative. In 2005, there was no internet service provider available in Pabal. A project to take broadband connection using wi-fi from Rajgurunagar to Pabal was undertaken with IIT-Powai under PanAsia funding. We were successful in establishing a link between Pabal and Rajgurunagar. However, due to some technology interface issue with n-logue's 'Cor-DECT' system, VA could not use it. Afterwards VA got internet connectivity at Pabal from BSNL. This project helped VA to make its campus wireless. Maintaining Wi-fi has become routine for VA Staff. Our experiences in various internet services viz Cor-Dect, Dial-up, Wi-fi, mobile etc. helped us guide many NGOs in selecting an appropriate internet option.

5] Nomadic Education Project

The project to use Information Communication Technology(ICT) to educate children based nomadic camps was carried out from 2005-07. VA partnered with IIT-Powai and Bhatake Vimukta Vikas Pratishthan (BVVP – Nomadic Tribes Development Organization) in this project. Various issues like charging of laptop, suitable interface for learner, lighting solutions were tried. A successful anchored instructional strategy is developed. A package MEEIT {Marshalling Education through environment using ICT}was developed. The project was funded by Media Lab Asia. There were four papers published on the finding of the project. The findings were shared with organization working in the field of primary education. This project received first prize of Unesco in the use of ICT in non formal education category in 2008.

6] Human power based energy solution

VA along with save Bombay Committee to won "Development Marketplace Award 2007" to develop human power based energy solution. VA modified bicycle and also designed various attachments on it. Now VA is working on reducing cost of the bicycle and devising a proper energy storing unit.

VA is helping a social entrepreneur Mr. Ashish Gawade in commercialization of the solution. He formaed aa Pvt. Ltd. Company M/s Bottom of the Pyramid Energy & Environmental Solutions Pvt. Ltd.

7] Biogas based electricity generation

Dr.Kalbag had taken trials on using non edible oil cakes as feed for biogas. He wrote about feasibility of using dungless biogas for electricity generation. In 2004, VA started working with Gangotri Energy Resources Pvt Ltd. VA did initial trials on biodiesel and biogas. A 15m^3 biogas plant was established by Gangotri at Pragati Pratishthan. It was named as 'Dr.Kalbag biogas project'. VA also constructed 6m^3 biogas plant at Pabal and tried to use petrol engine on it. Petrol engine was modified to run directly on biogas but VA faced problems like overheating and fluctuation in output. Meanwhile-Gangotri proceeded with the research to take the concept to the next level.

8] Students from Higher Technical Institute

VA regularly hosts students from higher technical institutes across the world to undertake projects on rural technologies. Engineers Without Border (EWB) regularly refer their students to VA.

A team of engineering students from Cambridge developed a repository for rural technology projects for engineering students. The projects are available at http://www.engindia.net/

9] Developing Agricultural Services

Poly-house, medicinal plant nursery and seedling nursery were developed in 2008 with support from INDUSA endowments. To overcome the water problem in Pabal, a farm tank of 65lacs litre capacity was constructed in 2009. This will help VA conduct training programmes on various agricultural services at its campus.

DST core support

VA faces a challenge of attracting and retaining appropriate human resorces for it's projects. In 2009, Dept of science and technology (Science and Society Division) revived core support to VA. This support enables VA to appoint four senior people with engineering and science background. VA has identified energy, agricultural services, electronics and ICT based applications as the future thrust areas for core project.

Vision and Way ahead :

Dr.Kalbag spelled out his vision in chapter 1. He also gave a prospective plan for VA. His writing is the guiding light for the VA team. Any big movement has it's origin in the dedication and commitment of an extraordinary individual. Dr.Kalbag did the foundation work. It is the responsibility of his successors and those who believe in the philosophy of work-centric education to institutionalize the system.

To carry forward the vision of Dr. Kalbag, VA has taken steps and reconstituted its management structure. Programme Advisory Committee (PAC) was formed by Board of Trustees of Indian Institute Of Education, the parent body of VA. The Executive Director leads the VA program under guidance of PAC. PAC recommends strategic decisions to the Board of Trustees of IIE (Indian Institute of Education).

In 2008, VA core staff and well wishers met in Rihe village and formulated a vision statement of VA as follows.
'To strive for development oriented society having scientific temper through work based education'.

In March 2009, VA's RDES programme was discussed with Dr.Anil Sadgopal,_(Founder of Hoshangabad Science programme and Chairman of NCERT – National curriculum framework 2005 focus group on 'Work and Education') at Pabal. He suggested a vision statement for VA as follows.

'To become a national resource centre for research, development and training for transformation towards work based education system and related social policies.'

VA is working on 'work based education' for last 25 years. The fundamental principle is the same as that behind 'Basic Education' (Buniyadi Shiksha) propounded by Mahatma Gandhi. VA integrated technology in the concept of 'work based education'. It also demonstrated new areas and ways of providing community services. For VA, real development is the development of the intellect. To develop intellect, the best way is to give training that involves all the five senses of the student.

VA believes that Gandhiji's concept of 'Basic Education' is very much relevant today. It needs to be adapted to the technology of today including the use of computers. VA believes that it is our responsibility to work towards bringing a transformation in the traditional education system - to move from 'Book centric' education to 'Work centric' education.

Following are the three areas, on which VA wants to concentrate in the near future.

A) Education :

Dr Kalbag has spelled out RDES philosophy. IBT and DBRT are the two programmes he devised as a tool to bring RDES into practice. So far, VA's programme was limited to work based activities. There is continuous need to enrich the programme with new tools and techniques. Simultaneously, VA needs to bring other social science subjects into the definition of development.

RDES → DBRT → IBT → Work Centric Education (WCE)

Now, VA wishes to begin working on WCE concepts and go beyond IBT (pre –vocational) course. In work centric education, it is expected that all the academic subject like science, geography, languages, history, mathematic are taught through work based activities. Work will be medium of education. There is a need to develop WCE paradigm.

A widespread confusion exists about work based education . It is generally looked upon as some combination of pre-vocational programmes , socially useful productive work (SUPW) , science project activities and arts and craft activities. Many oppose WCE believing it would promote child labour. VA plans to take up a lead in propagating the WCE philosophy in the right spirit"

VA campus at Pabal is an educational laboratory where VA plans to undertake new initiatives to develop programmes to teach geography, language, culture, arts, history etc. through work based activities.
The rural areas in the country are getting urbanized. With it's rapid pace, it is estimated that by 2050, almost 50% of country's population will live in cities. To propagate WCE philosophy, we need to demonstrate its utility in urban areas as well. Therefore, VA wishes to work on developing work based programme keeping in mind the changing society. .
Web based learning, video conferencing are becoming a reality even in the villages. VA plans to take up new initiatives to provide online education to reach out to students in a much larger number.

B) Technology Development :
The core value of VA is 'Quest for Knowledge'. It is necessary to keep VA programmes dynamic and up-to-date. VA will continuously adapt new technologies and develop business models for dissemination through its students. These would be the businesses based on new technologies and not traditional occupations.
In RDES, Dr Kalbag put forward a concept of building linkages with higher technical institutes, schools and communities. In last six years , we have collaborated with institutions like MIT, IIT, College of Engineering, Pune, KVK etc. VA plans to work towards establishing such linkages even at school level.

Government and policy makers are increasingly looking forwards to education as a tool to meet the demand of skill manpower, generated by the industries. Contrary to that VA is propagating 'work as a medium of education' and mainly to develop intellectual capability of child. Many privet schools and educated parents realized importance of work in overall development of child. They give work exposure to their children through holiday camps and extracurricular activities.

Such facilities are not available to most of the student. they will get benefitted only if Govt. make it a part of educational systems. to make it happen a demand has to be made from every level.

C) Advocacy :

VA cannot remain content with IBT in 100 schools out of more than 18,000 schools in Maharashtra and about 2,200,000 in India. Only Government should and can undertake the task of universalisation. VA would like to promote a movement and network of like minded NGOs. VA wants 'Work centered Education' to become part of the Government programme for quality and useful education.

Some of the VA's plans may appear like a distant dream. There are many challenges on the way. It is easy to work with limited number of schools. Replicating it on a large scale is altogether different challenge. VA needs to involve lot many stakeholders in this mission. It is impossible to fulfill the mission without whole hearted support from people, educationalist, NGOs, bureaucrats, and politicians.

So far, individuals as well as organizations from all sections of the society have firmly stood by VA and we hope to get their continuing support in its mission to make India a developed nation, proud of its equitable and balanced development!

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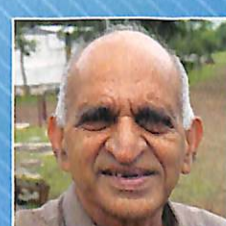
Dr. Shrinath Sheshadri Kalbag is a scientist turned edu-philosopher. Vigyan Ashram, near Pabal, in Pune District is the testimonial of his experimentation based on his conviction. This book depicts his journey about his endeavor to train rural youth into entrepreneurs and technologists. Dr. Kalbag has shared his experience with a child like enthusiasm and honesty.

The emergence of Dr. Kalbag's work during the past two decades as it explored the Gandhian idea afresh. Without claiming as much, Dr. Kalbag quietly but steadily re-interpreted the Gandhian pedagogy of linking work with knowledge in contemporary economical, technological and socio-cultural framework and demonstrated how it could become a powerful means of curricular transformation.



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