Appropriate Technology and Research Projects

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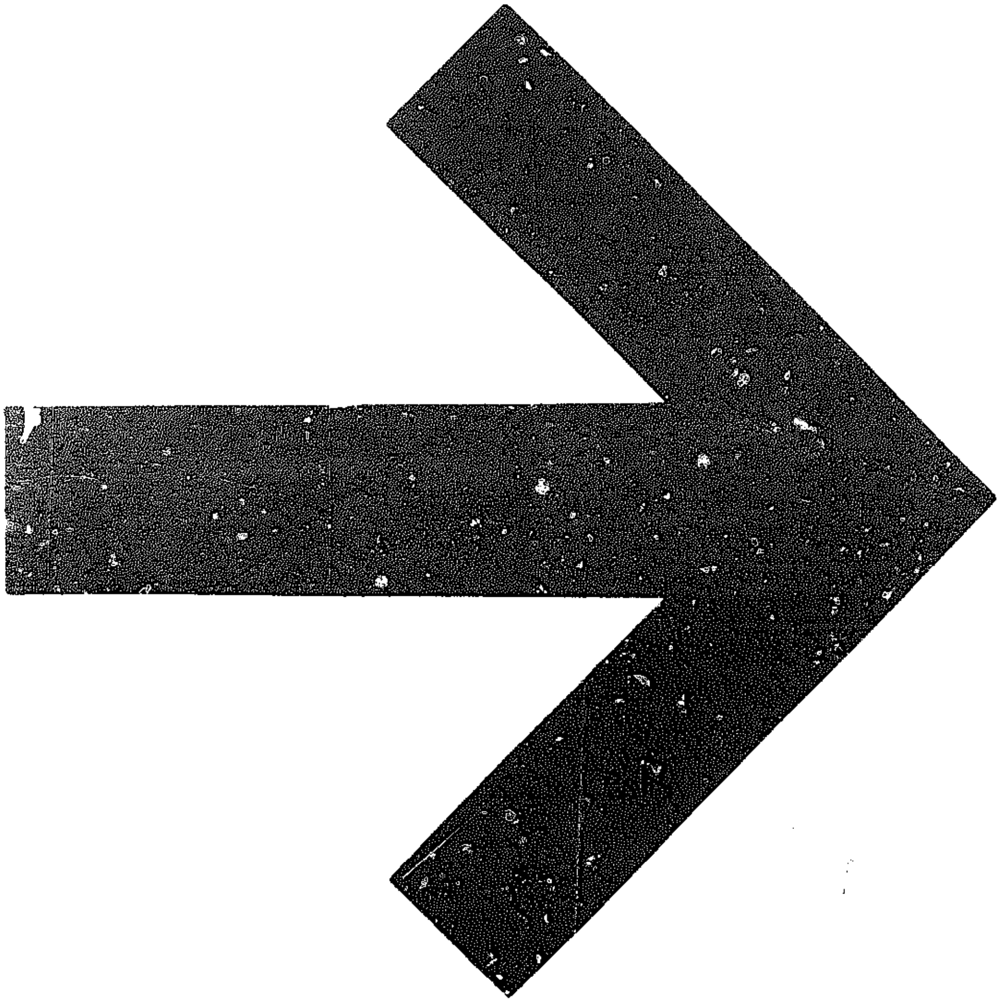

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INTRODUCTION

There is no doubt that since achieving independence, India has shown all round progress. The production of essential items like steel, cement, etc. have gone up. Industrial goods such as radio, television, ships, aircrafts, motor cars are manufactured in the country. The green revolution has also pushed up food production. We have been able to set up huge steel mills, large dams, thermal and nuclear power stations. In short, the Gross National Product has increased considerably and so has the per capita income. However, despite these successes, and in fact, as a result of some of these developments, the lowest strata, the weaker sections, have not achieved much. The life in the rural areas, for the poorer section is ebbing away, resulting in mass migration of the village folk to the towns. It has also given rise to a dual society, dividing the country between 'haves' and 'have nots' the top ten per cent, the metropolitan, industrial and other urban centres enjoying all the fruits of progress, while the bottom ninety per cent, the rural and small town areas, languishing in starvation, filth, poverty and misery.

To a large extent the cause of this malady, is the choice of technology made for development in India which is based entirely on Western and capital intensive technology designed primarily to save labour, produce goods for individual consumption and maximise profit. There is a great demand for the products of the modern industry from the 'haves' or the affluent section, which sustains the seller's market in which this technology flourishes. This has given rise to islands of prosperity in a vast ocean of poverty and misery. It is only the 'haves' or the top ten per cent of Indian society who have access to the goods of modern luxury, for this technology is not capable of transforming the lives of the 'have-nots' or the bottom ninety per cent. It is rather alienating them more and more from the production processes. There is a pressing need therefore, to design a technology to make the bottom ninety per cent population self-reliant.

It has been for this reason that great social workers and pioneers like Tagore, Gandhi and others laid emphasis on rural development and on the improvement of technology of village crafts and industries. Gandhian movement, in particular, gave a new turn to the meaning of industrialisation and machinery. He made charkha, a symbol of tecanology suitable for Indian condition. But, unfortunately, the emphasis changed completely after achieving independence. We made great strides towards rapid industrialisation to achieve the affluence of the western countries in shortest possible time. This appears to be an unrealistic goal now.

Western technology, imported in India is not always the best even in its limited sense of maximising production and profit and is not appropriate to Indian conditions in all cases. The indigenous and traditional technologies like potter's wheel, cobbler's needle and thread are very inefficient and wasteful of skill and time. The modern technology imported from the West is too expensive, complicated and beyond the reach of the most of the Indian people. It is not always utilized to the best of its capacity, and is, therefore, wasteful of resources. A systematic research is therefore needed in India to upgrade and improve the efficiency and productivity of the traditional equipments, so that the fruits of technology are shared by all and the whole of Indian working force joins at the dinner table of production. Although this is a very important problem, which requires the attention of the highest policy makers and planners of the land, this could also be done in a modest way without much expense and investment by diverting a small fraction of money being presently used on students, projects in the universities and other institutions.

This book mainly deals with the aspect as to how students projects at the undergraduate, the post graduate and the Ph.D. levels could be used to solve the technological problems confronting poor people and weaker sections. It requires some imagination to conceive and formulate the problems and introduce them in the institutions. Real life problems should be given to the students rather than theoretical problems, if maximum benefit is sought to be derived from them. Before that can be done, the concept of appropriate technology has to be fully understood to apply its principles for the solutions of the problem. There are many constraints and impediments which seriously restrict the scope of working in a rural surrounding, like absence of electricity, lack of communication, unavailability of materials, servicing and repairs. The designer has to keep all these aspects in mind to design equipment suitable for village use.

Since I was involved in its initial stages as an official of the Intermediate Technology Development Group, London in introducing similar projects in the British universities and instituions, I have been able to include numerous examples from my personal experience. It required long hours of patient discusions with the teaching staff and students, and seminars in many institutions, before the topics became acceptable. At present, there are about 200 projects of intermediate technology, taken up at about 40 British universities. and institutions. Similar movements have also started in other western countries. When the students and teachers of the western countries have joined in a big way to try to solve the problems confronting the rural areas of the developing countries, why not we apply even greater effort at the solution of the problems, which confront a large majority of our own population.

A large number of topics have also been included in the Appendices to serve as examples on which research can be immediately started.

I am indebted to the I. T. D. G. London for including some material from their "Students' Projects Briefing Report", (Mimeo.) in this booklet.

Varanasi, January 1974 **M. M. Hoda**

I

CONCEPT AND EARLY HISTORY

Introduction

When we talk of development in India, we must be clear in our mind, what do we want to achieve and whom do we want to develop. Are we concerned only with increase in per capita income, having favourable balance of payment, and measuring our development in terms of production of steel, cement and electricity ? Or do we want to develop our downtrodden masses, teeming millions living in the five hundred thousand villages of India. There can be no controversy about the fact that the removal and eradication of poverty and misery and the improvement of the lot of the 80% of the country's population living in the villages should be our main concern.

Strangely enough, most of our development plans envisaged and taken up since independence do not reflect this consciousness. They are mainly concentrated in urban areas, because they are more city oriented and urban biased. They appear to have bypassed the rural areas. There are not many effective schemes of employment generation in the villages. No wonder that the life for the weaker sections of the population in the rural areas and small towns is decaying and village structure is breaking up, giving rise to the migration of the village folk to the cities in search of employment. This tends to destroy the civic life of cities, due to overcrowding, insanitation and disease, whereas the cities destroy the village life by competing out the rural industries and crafts and promoting large scale migration. The villages and the cities are thus working against each other instead of mutually helping and strengthening each other.

This has also given rise to a dual society in India, one is the modern westernised sector with all its factory produced glittering luxury goods, and the other is the rural society including small towns which is languishing more and more because intelligent and competent persons are leaving it striving to join the westernised sector. The phenomenon of brain drain starts right from the interior villages of India and ends up in England, U. S. A. and Canada. What is worse, all our best brains, educated and intelligent persons, scientists and technologists are being mobilised for solving the problems of modern industries and rich societies. It is quite understandable that the scientists and technologists of the rich countries are engaged in solving the problems of the society to which they belong; but it is regrettable to see that the scientists and technologists of the poor countries like India are also engaged on the problems of the rich socieites. This phenomenon affects our country in two ways. In the first place, highly educated and trained Indians migrate to the western countries and all the money spent on their education and training is lost to the nation and the tax payers. The fault in this situation lies with the kind of training and education which they are given, for it makes them rather misfit for the home country. Secondly, even if they do not migrate and remain at home they are engaged in a highly sophisticated research work which help only the rich societies, the western industrialised sector of India, and does not help the poor sections, which constitute the 90% (including urban and rural) of the population. It is for this reason that development of the broad masses of the people is not taking place. Development means helping people to help themselves by the use of better technologies, to be devised by our scientists and technologists. But they are engaged on the technologies which help only those who are already rich and powerful and tend to ignore those who are poor and weak.

It is therefore quite obvious that any development plan, worth its name, must concentrate entirely on the activities of the poor people who live in the villages and small towns; and must try to re-vitalise the dying industries and crafts, providing employment and additional income to the people to relieve pressure from agriculture. Cities should act only as service centres for these activities. It was for this reason, perhaps, that the early pioneers, who had the country's real interest at heart, concentrated more on rural developments.

Early History and Some Examples

One of the earliest experiments in rural development work was carried out in Baroda where Maharaja Sayajirao Gaekwad III and his prime minister Raja Sir T. Madhav Rao conducted their great experiment to help people come out from the stationary conditions (Kavoori 1967). They felt unhappy about the disappearance from the Indian scene of the little self-governing village republics which every village in India was supposed to have been. They introduced subsidiary occupations like kitchen gardening, weaving, poultry farming, eria silk, bee keeping, etc., so that every agriculturist family derived supplementary income. The great emphasis was on education, with a view to make school a recognised centre of work for the welfare of the whole community. The students, almost all of whom came from rural areas and were educated and trained in village occupations and management, went back to the villages year after year equipped with better methods of cultivation and other skills. The early workers also realised the importance of research and introduction of new technology, which was evident in the systematic programme of experimental farms, agricultural chemistry, seed supply, and plant pathology, etc.

Tagore was another stalwart, who recalled that the village artisans in India had once upon a time sent their wares far and wide and earned immense wealth thereby. In course of time, neglect and disorganisation led to gradual deterioration in the technique and skill of production, and made their produce out of use in the markets of the rich. Tagore recognised this fact earlier than many others and set up at Sriniketan a 'Shilpa Bhavana' to revitalise the cottage industries by introducing new technology which he obtained from inside and outside the country. He trained local artisans and villagers in these crafts so that they could make use of the new innovations (Dasgupta 1962). Sriniketan type of leather work and other handicrafts became very popular in India and abroad.

It is striking that both these pioneering efforts at rural development recognised the basic fact that agriculture in India could no longer support her growing population without mobilising other alternative sources of employment. The need of education, research and extension was also fully realised.

It is unfortunate that these experiments remained confined to their own areas and could not become wide-spread due to the limited scale on which they were carried out and the fact that they were not backed up by the developed modern research institutions of the country, which remained beholden towards the sophisticated and modern technologies.

Gandhi's Experiments

It was left to Gandhi to take the issue of saving the village of India on a larger scale and to build a nation-wide movement for it. He made it the first mission of his life to work for the upliftment of the villages and its downtrodden and neglected masses and declared "if the villages perish, India perishes too." He made Charkha* not only the symbol of freedom, but a symbol of technology which was suited to India. He organised All India Spinner's Association and All India Village Industries Association and injected into these all the ingenuities of his trusted colleagues to bring vitality to the village crafts by introducing improved technologies. In his speech in one of the famous institutions of the country, he said that the real purpose of education and research should be to help the poor and the downtrodden (Appendix V). He repeatedly warned that the production by masses

***Spinning wheel**

should not be allowed to suffer at the hands of mass production. He felt strongly that the system of industrialization was based on exploitation. 'What is industrialization', he asked, 'but a control of the majority by a small minority. But whether for good or bad, why must India become industrial in the western sense. The western civilization is urban. Small countries like England or Italy may afford to urbanize their system. A big country, with a teeming population, with an ancient rural tradition which has hitherto answered its purpose, need not, must not copy the western model".

"I would prize every invention of science made for the benefit of all.........I can have no consideration for machinery which is meant either to enrich the few at the expense of the many or without cause displace the useful labour of many".

It is due to his pioneering efforts that the promotion of the village industries and crafts became a movement. Men like J. C. Kumarappa (Kumarappa, 1958) and Dr. Gadgil (Gadgil, 1964) became known as Gandhian economists. They elaborated his ideas further and gave them concrete shape.

Acharya Vinoba Bhave and Sri Jayaprakash Narayan provided the leadership for the work of village development through the Sarvodaya movement.

It was in the Sarvodaya Plan (Shankarrao Deo, 1956) that a comprehensive village plan was prepared in detail. This plan emphasised improved technique, tools and machines, which may be used for increasing efficiency and eliminating drudgery but should not lead to centralisation or unemployment and underemployment. Such machines should be capable of being easily manufactured or fabricated in the villages and repaired in the region.

II

THE WORLD MOVEMENT

Dr. Schumacher and Intermediate Technology

Dr. E. F. Schumacher, a German born naturalised British economist and former Economic Advisor to the British National Coal Board, was independently thinking on similar lines after visiting a number of developing countries on U. N. assignments. He felt that modern Western sophisticated technology was incapable of solving the problems of poverty in the developing countries, and a simple and more appropriate technology, labour intensive and capital saving should be systematically devised (Schumacher, 1965). In the year 1963, he was invited by the Indian Planning Commission on the suggestion of Sri Jayaprakash Narayan to advise on rural industrialization. He made a deeper study of Gandhi's idea on industrialization and had discussions with many Gandhian thinkers and economists including Dr. Gadgil. He developed the concept of 'intermediate technology' and later made it a world wide movement. Dr. Gadgil laid down three alternatives for intermediate technology, viz; to *upgrade existing technology*, to *simplify the modern technology by taking out labour saving processes*, and to *start afresh and invent something new* (Gadgil, 1964).

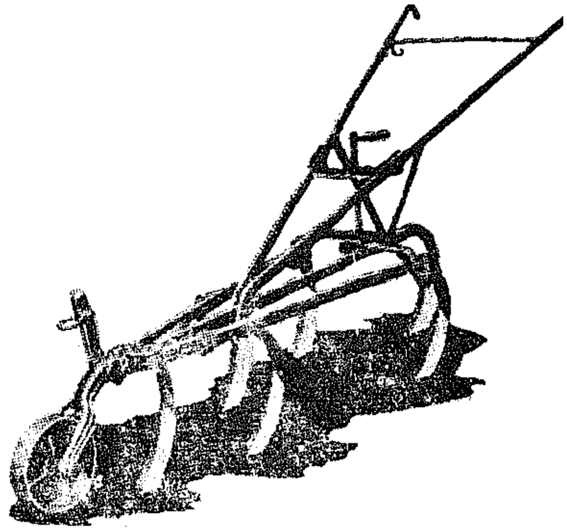
Dr. Schumacher saw in a village in India, traditional pottery equipment hardly worth 50 rupees, and the potter's skill being practically wasted on the inefficient equipment. On the other hand, an effort at improving his technology landed the potter on an imported rupees 50,000 ceramic plant, on which he was being trained. After his training, there was no chance of his setting himself up in business in a village, but he would certainly have been driven to the town in search of employment. This wide gap between the two technologies struck his imagination. He started a search for Rs. 1000—5000 technology, which was intermediate between Rs. 50, indigenous but inefficient technology and Rs. 50,000, imported and highly capitalised technology.

Dr. Schumacher, after being convinced of the validity of his approach, formed a group, Intermediate Technology Development Group Ltd. in London, in the year 1966, with other like-minded persons. This was the first organisation of its kind in developed western countries which advocated for cheap, inexpensive and labour-intensive machines and equipments for the developing countries, instead of modern and automatic equipments which were more profitable to the Western traders. The first work the Group did was to compile a directory of intermediate technology equipments which were available in the U. K. This directory was named 'Tools for Progress'. (Plates I, II, III & IV)

The Group is concerned with techniques and technologies appropriate to the needs of developing countries. It concentrates mainly on rural areas and poor societies of the developing countries which are being left further and further behind by the technological gap. The Group does not deny the importance of large, capital intensive infrastructural schemes, but is more interested in demonstrating that a choice exists and that the most modern is not always the best. It also illustrates the different levels of capital investment that are possible and can be used in different situations. Its main areas of interest are : firstly, the systematization and documentation of data on efficient labour intensive techniques, whether they are in use today, adopted from past practice, or developed anew; secondly, the dissemination of such data; and thirdly, assistance with special projects in developing countries. It consists of a central directing and executive agency linked with a number of specialis groups and panels who examine the scope and applicability of intermediate technology in specific areas. The basic idea of the panel is that between them they should cover the main requirements of rural development—agricultural equipment, building, water

SOME EXAMPLES OF THE INTERMEDIATE TECHNOLOGY EQUIPMENT SHOWN IN 'TOOLS FOR PROGRESS'

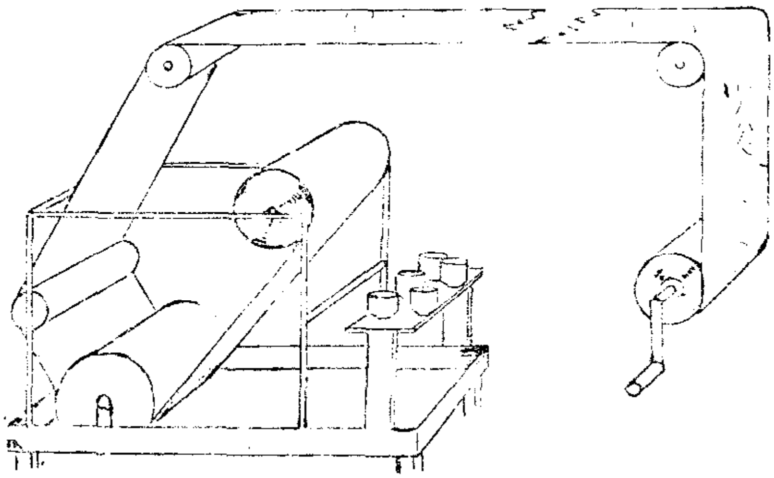
Plate I



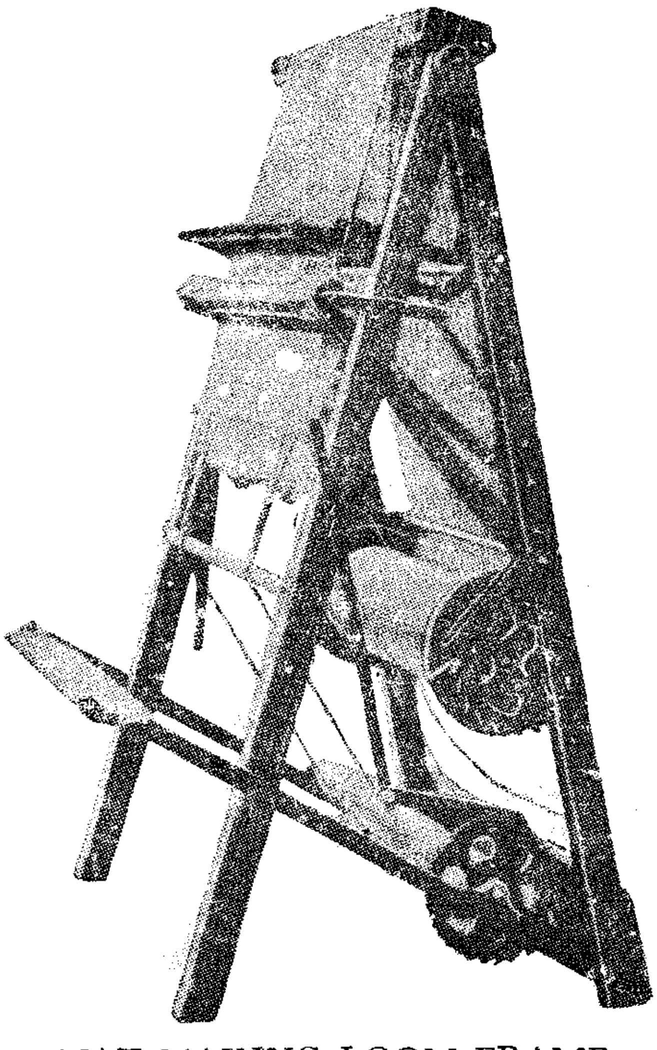
ANIMAL DRAWN HOE

WALKING TRACTOR

Plate II

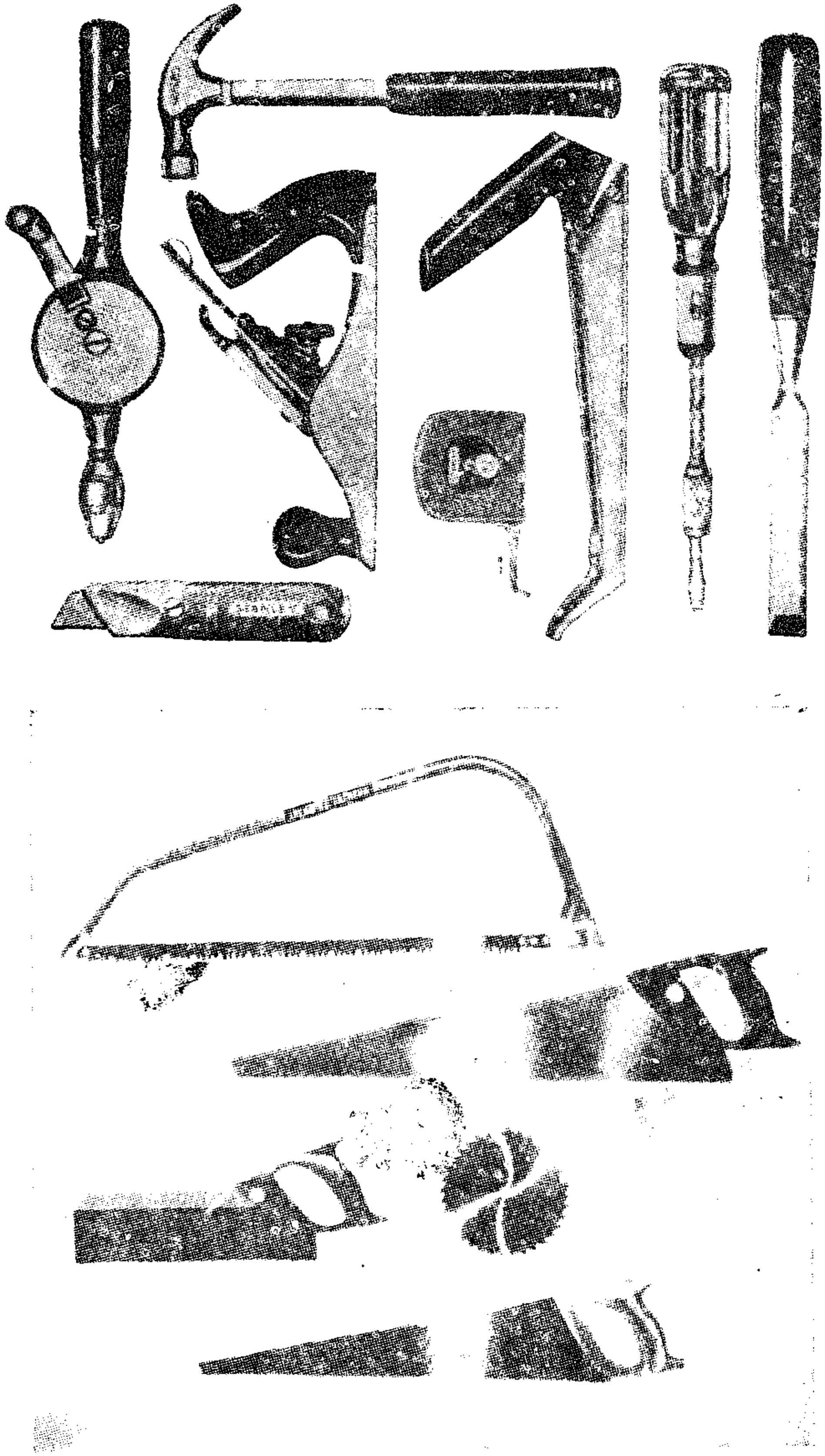


MULTI COLOUR COATING PROCESS



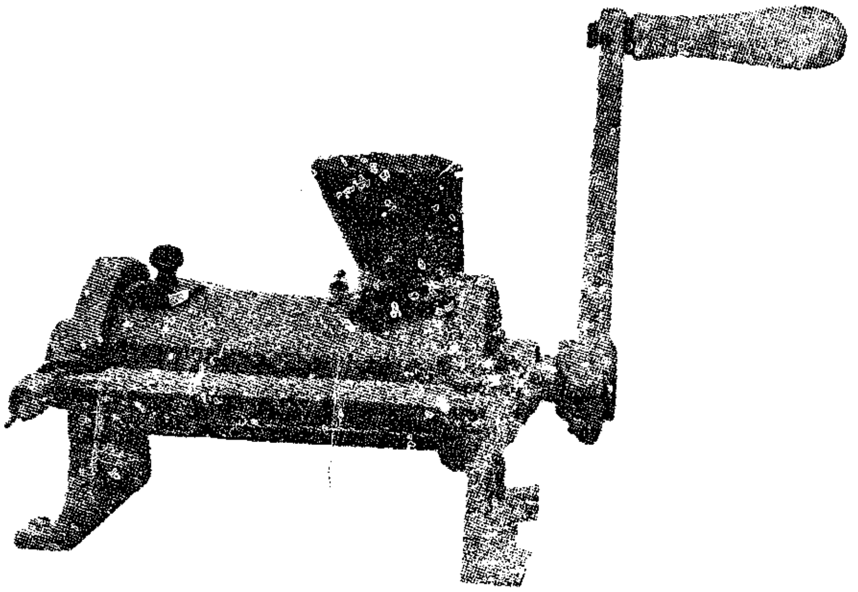
MAT MAKING LOOM FRAME

Plate III



HAND TOOLS FOR WOOD WORKING

Plate IV



HAND OPERATED RICE HULLER

PORTABLE MAN OPERATED HOISTING MACHINE

and food technology, rural health, power, education and training, women's activities, small industry, and cooperatives. It also runs an Industrial Liaison Unit, to establish working relationships with industry, and to provide technical enquiry and Inter-Tech services—a consultancy service in rural development.

Intermediate Technology Development Group of London first tackled the problem of building, because it was thought that building was the first and foremost capital saving industry and unless a country had its own lively and efficient building industries, they would have to be constructed by far away contractors, situated in foreign countries or a few metropolitan areas. So a panel of experts was set up by the London Group to identify the problems of building industry in Nigeria. It was found that the local contractor was the forgotten man. Academic institutions were producing architects, quantity surveyors, civil engineers, etc. etc., and training establishments were training brick layers, carpenters, plumbers, etc. but the key-person, who brought them together was the forgotten man. On the recommendations of the panel, a very extensive scheme for training the building contractors was started in Nigeria. Since then it has spread from Nigeria to several other countries and the materials of training produced by the London Group are being used.

The second panel of the study group was on water. This panel produced a new technology which was suitable for the villagers to construct underground rain water catchment tanks, where water remains fully protected against contamination. (Fig. 1). This was done with the help of the most modern knowledge. The villagers can construct such tanks by their own labour and reduce the outgoing expenditure to the minimum. These tanks were first constructed and tested in Botswana and later travelled all over Africa. The water panel is also studying a particular type of pump, the Humphery pump, which was invented 150 years ago and was surprisingly bypassed by the development of the modern technology. It is possible to manufacture this pump, without

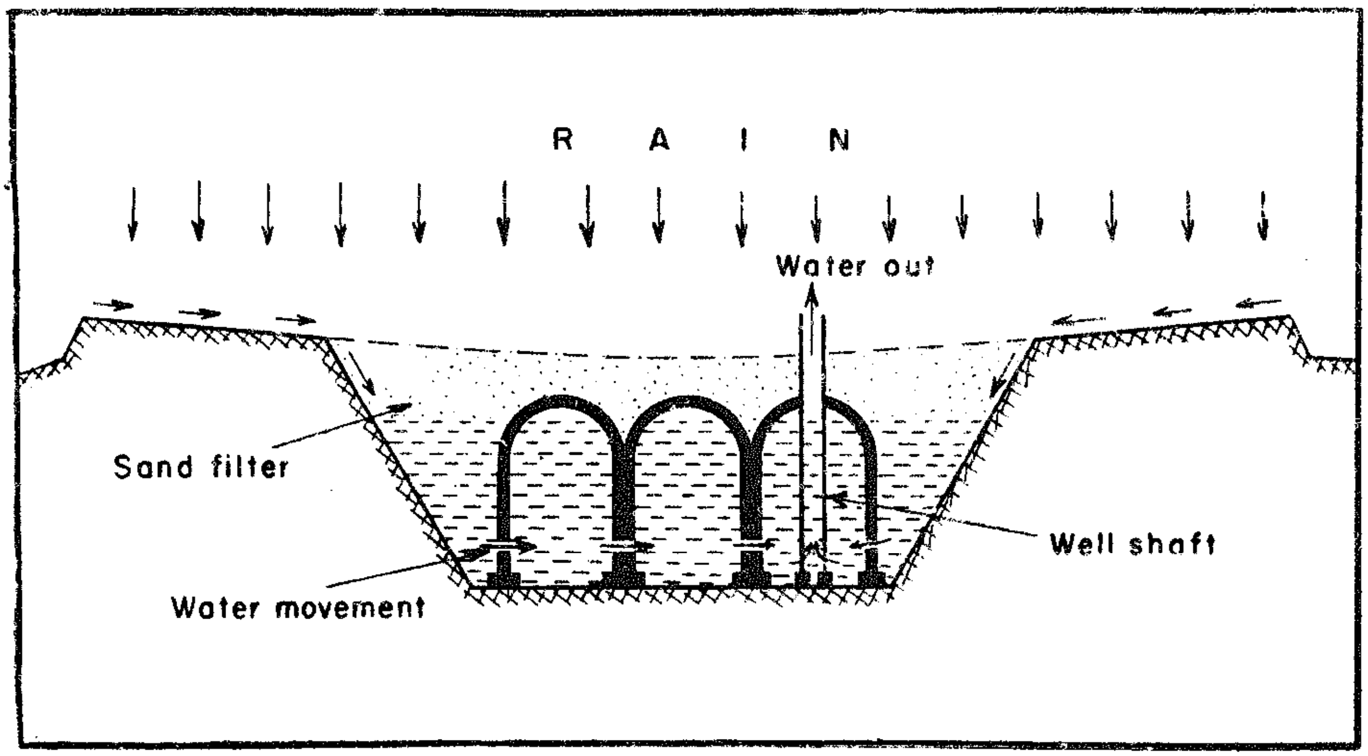


Fig. 1
RAIN WATER CATCHMENT TANK

any precision engineering. This can be produced easily by a village black-smith. It is now being investigated at the University of Reading, U. K. with the help of computers, mathematicians and instrumentations to determine the most ideal and perfect design of such a pump. Once this design is settled anybody could make it.

A number of such study groups on food processing, agricultural equipment, and cooperatives have been started to tackle problems at these levels. One of the most important work of the London Group was to set up an University Liaison Unit, which fed specific problems of the rural areas of the developing countries to the British universities and institutions. The professors were delighted due to this and the students were highly responsive. A list of students projects which have been taken up in the British universities is given in Appendix IV. These projects are similar to other research projects which are meant for a diploma, degree or a Ph. D.

III

PRESENT INDIAN SITUATION

Needs in India

As we have seen the traditional village industries declined mainly due to inferior level of technology in comparison with advanced technology adopted by the modern organised sector. Hence there is an imperative need for improving the level of technology in traditonal industries. The village industries and industries and crafts of small towns have not benefited so far from the Research and Development (R & D) work, already done in the country. We have to give R & D a new orientation to identify the village industries based on local raw materials and skill and for the supply of improved tools, equipment and machines on one hand and adoption of improved techniques of production on the other. The basic approach towards the adoption of improved technology would be evolution of more labour-intensive technology which can enable the village artisans to have fuller employment with improved earnings, which will prevent them from migrating to towns and joining the ranks of the unemployed. The main question is : can we utilize science and technology to this end ? Can we ask our scientists and technologists to use their great knowledge and ingenuity not to make production unit still bigger—hunting after the so-called economies of scale—but to develop mini-plants, so that small people living in small communities can again become productive, without having to wait for people already rich and powerful to provide job-opportunities for them ?

Let no one carry the impression that we wish to go back to something medieval. We want on the other hand to use modern knowledge in a new direction, to reorient-

R and D (Research and Development) in the country, so that it helps the small people. The already rich and powerful people can always help themselves. If science and technology do nothing for little people, how can they help themselves ?

In thousands of places simple, self-help labour-intensive technologies exist, but there is no inter-communication. However, we see that at the level of high technology, there is an excellent system of communication. Whether it is textiles, ceramics, power generation, steel making or air transport, the whole world uses the same technology and as soon as anybody has got upon an improvement, every one else gets it immediately. If one goes to a village and finds that some one has made an innovation and is doing something absolutely first class, the chances are that twenty miles away no one knows about it. It is useless for village level workers to re-invent the wheel, when the wheel has already been invented. We only need a communication system with 'knowledge centre'.

Schumacher's movement of intermediate technology has revitalized this concept, and as was to be expected the Gandhian movement has welcomed the idea as part of its own programme. The Gandhian Institute of Studies, Varanasi organised a high level seminar in 1967 on 'Problems and Prospects of Intermediate Technology'. This seminar recommended the establishment of a National Institute for Improvement of Indigenous Technology to pool information on intermediate technologies, develop, promote and spread new practices. As a result of pressure brought about by the seminar and other movements, the Government of India set up an Appropriate Technology Cell in the Ministry of Industrial Development. Meanwhile, the Gandhian Institute pursued this idea further and took initiative to set up Appropriate Technology Development Unit in the voluntary sector. The proposal was eventually realized when an international seminar on 'Appropriate Technology—for a Nonviolent Society' was held in February 1973, in which Dr. E. F.

Schumacher was the main invitee. He delivered the Fourth Gandhi Memorial Lecture also on that occasion. This coincided with the establishment of Appropriate Technology Development Unit at the Institute.

Appropriate Technology Development Unit, Varanasi

The Unit has been set up with the aim to develop and to crystallise "appropriate technologies" that will really solve the problems of the poor societies in India. The message has now reached in many quarters that development means helping people to help themselves and it requires the input of brain power. One has to identify the problems of poverty and find suitable solutions. Our modern technology has now reached a limit, where the establishment of an average work place in industrial production would cost about Rs. 50,000 to a lakh of rupees. Even in services like hotel industry, the five star hotels invest a capital of Rs. one lakh per person employed. If each job to be established costs from 50,000 to a lakh of rupees, we cannot get many jobs established with the meagre resources in India. If the cost of establishing a job can be reduced to a level of 2 thousand rupees, 25 to 50 jobs can be established for the same amount of money which is required for one job with the help of modern technology. To illustrate, a moto[illegible] symbol of modern technology, costs rupees 25,000 whereas a good bicycle costs rupees 250 only; thus for the price of one motor car 100 bicycles can be purchased and 100 persons helped instead of one. Bicycle is a good example of appropriate technology, because it costs less, it is easy to maintain, and runs without any expense. (Fig. 2)

The Unit proposes to become a 'knowledge centre' where information on such techniques and technologies could be pooled and farmed out to those who require them and research, design and development could be promoted. One of its first priorities is to motivate the scientists and the technologists, the students and the teachers of the universities, engineering institutions, polytechnics, I. I. Ts and other research and scientific institutions to carry out the research work for appropriate technologies to help the poor societies, small

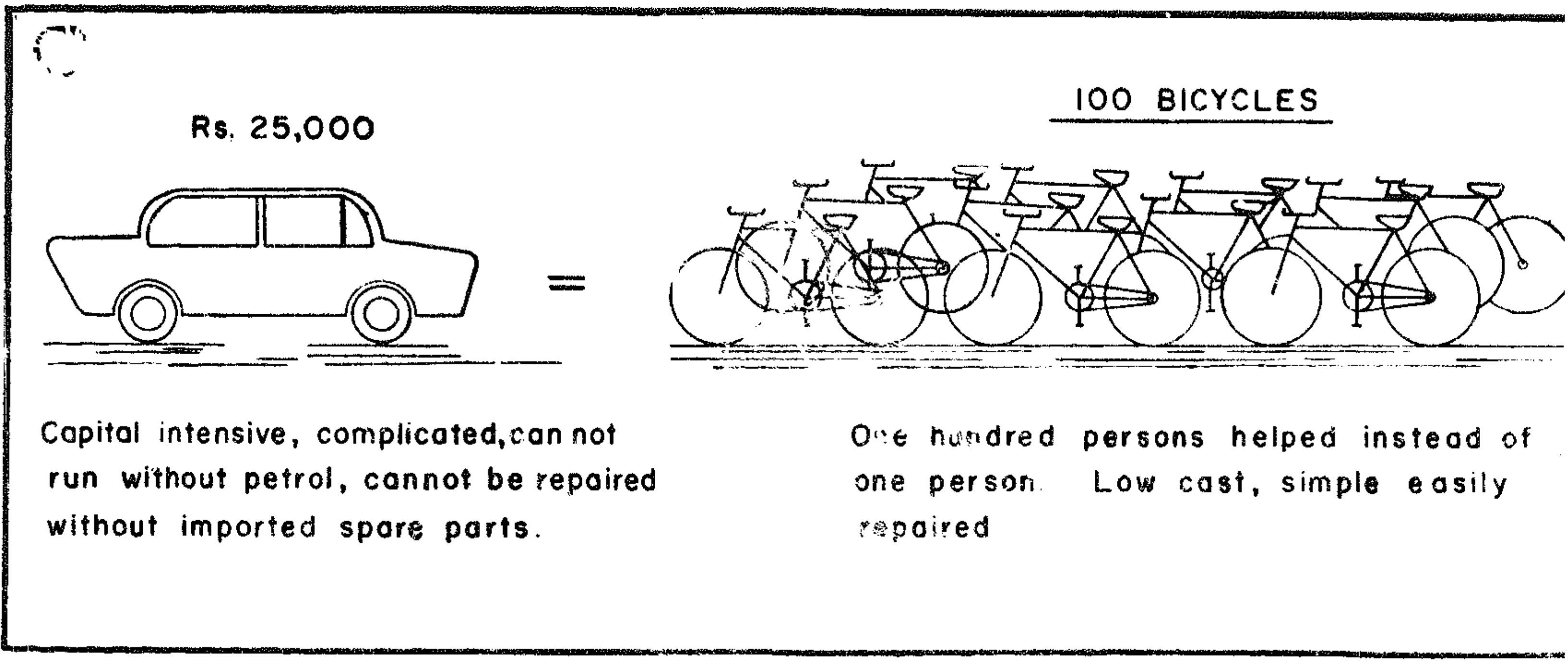

Rs. 25,000
100 BICYCLES
=
Capital intensive, complicated, can not run without petrol, cannot be repaired without imported spare parts.
One hundred persons helped instead of one person. Low cast, simple easily repaired

Fig. 2

communities and the weak and the poor in India. It may also benefit other poor countries of the world, because India is in a unique position, having a highly developed academic system, a highly developed modern industry, enjoying all the resources of research but facing at the same time the biggest problem of poverty.

The Unit also intends to set u. .. university liasion unit, which will inculde besides universities, all technical institutions, polytechnics and research institutes. We had a great expansion of the number of students since independence and particularly in the technical departments. Teaching staff has to dream up new original subjects to serve as topics of students projects. If the topics are purely theoretical and of little practical relevance the students would not react very kindly to them. The project will not be of any use to the country. The Unit with its contacts in the actual field may be able to give them very interesting and valuable subjects that are directly related to real problems of India and other poor countries of the world.

With the active help of the Intermediate Technology Group in London, this type of work is being done increasingly on an international scale and the Unit at Varanasi will be a link in the chain communicating with other centres of the world trying to obtain the most recent knowledge gained in this sphere and bringing it to the notice of the Indian people. To be a useful link in the international chain, it will ensure that the work is done in India so that it influences research in the country and the technologists and the scientists of India do not work primarily on the problem of rich societies.

IV

APPROPRIATE TECHNOLOGY

Technological Choice for Developing Countries

The technological choice facing the developing countries today is generally polarised between :

(a) western technology, which is capital intensive, labour saving and 'sophisticated' in that, it depends on an urban society and an industrial economy,

and

(b) traditional indigenous which is primitive inefficient not systematised and wasteful of resources and skill.

Intermediate or appropriate technology, is a technology appropriate to the factor endowment, skill, technical standards and size of the markets of the developing countries and lies between the two alternatives given above. The essential definition of such a technology can be in terms of capital cost per work place already briefly explained. The indigenous technology of a typical developing country is symbolically speaking a 50 rupees technology, while that of the developed countries could be called rupees 50,000 technology. The gap between these two technologies is so enormous that a transition from one to the other naturally and organically is simply impossible If there is no harvesting equipment between the traditional and inefficient sickle and the expensive and modern combine harvester, it will be necessary to invent it (Fig. 3). In fact, the current attempt to import and introduce rupees 50,000 technology inevitably kills off the rupees 50 technology at an alarming rate, destroying traditional work places without providing for alternative employment to thousands who lose their livelihood. If effective help is to be brought to those who need it most, systematic work on a technology is required which would

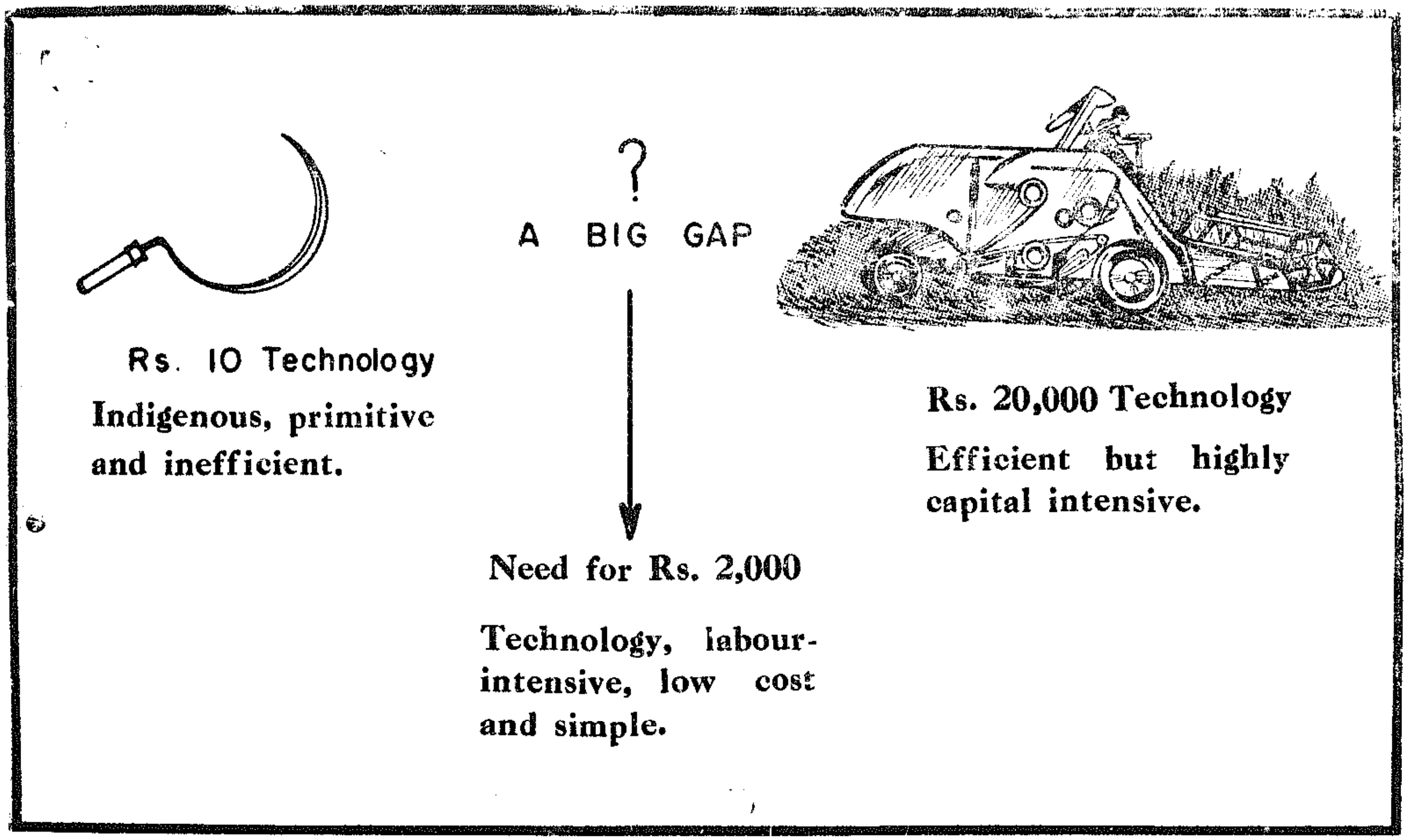

?
A BIG GAP
Rs. 10 Technology
Indigenous, primitive and inefficient.
Rs. 20,000 Technology
Efficient but highly capital intensive.
Need for Rs. 2,000
Technology, labour-intensive, low cost and simple.

Fig. 3

lie in some intermediate position between rupees 50 technology and rupees 50,000 technology. This may be called again symbolically speaking a rupees 2,000 or rupees 5,000 technology. Such a technology would be more productive than the indigenous technology but it would also be cheaper than the sophisticated highly capital intensive technology of modern industry. At such a level of capitalization very large number of work places could be created with existing capital resources and such work places would be within reach for most of the poor people, not only in financial terms, but also in terms of their education, aptitude, organising skill, etc. The workers can put up such work places with the help of their own savings, which is impossible in case of Rs. 50,000 western technology. Indian worker employed even in westernized sector can never save such a huge amount in his life time. This type of technology, therefore, cannot grow naturally and organically. In West, each worker can easily obtain Rs. 50,000 worth of capital equipment for creating his own job, but India and other developing countries have little capital, even less foreign exchange, to buy costly equipment. These countries have a large number of unemployed labour, even if that labour is untrained and unskilled for a modern industry. So another definition of intermediate technology might centre round the notion of job creation, while western technology contributes to job destruction.

Appropriate and Inappropriate Technologies

The following examples have been taken from I. L. O. (Marsden, 1965) case studies on small industries and other sources to illustrate the difference between appropriate and inappropriate technologies for the developing countries.

(a) One country imported two plastic injection moulding machines costing rupees eight million with moulds. Working three shifts and with a total labour force of 40 workers the factory produced one and a half million pairs of footwears a year, sufficient for the need of the population. They were cheapper than the shoes produced by local shoe-makers. But 5,000 artisan shoe-makers lost their livelihood as a result of this and in turn reduced the markets for the suppliers and makers of leather, hand tools, cotton threads, tacks, glues, wax and polish, eyelets, fabric linings, laces, wooden lasts, etc., none of which was required for plastic footwears. As all the machinery and material (PVC) for the plastic fortwears had to be imported, while the leather footwear was based largely on indigenous materials and industries, the net result was a decline in both employment and real income within the country.

(b) One example of appropriate technology in action is the instrument workshop of a hospital in Nigeria. The hospital equipment from wheel chair to saline solutions, is being made from local materials with the help of local labour designed for local conditions—rough concrete floors, high temperatures. It performs far more satisfactorily than imported equipment and by eliminating the spare part problems the useful life is extended. But, most important, the cost is reduced to less than half of the imported equivalent and more Nigerians are in useful employment.

(c) An automatic plant bakery with pneumatic flour handling, continuous mixing, kneading, a travelling oven and conveyer feed wrapping machine, costing 30 million rupees and employing 100 men could supply all the bread for a town of 100,000 people. Thus the whole of town's savings went into the new bakery leaving nothing for other trades and industry. Demands also fell because of the reduced incomes of the redundant bakery workers. The total output and employment in the town declined. If on the other hand, the existing small bakers were supplied with simple dough kneaders (more hygienic also) to replace hand mixing at a total capital of rupees eighty thousand, average labour productivity in the bakery industry could have been raised by 10% and there would be sufficient savings left over in the community to finance further investment in other sectors, where marginal increases in productivity could be achieved too. This growth would be balanced and mutually self supporting.

(d) A ceramic factory making floor and wall tiles formerly imported its hand operated press. In cooperation with small engineering workshops in its locality, it was able to have replacement presses made locally, using castings moulded from scrap metals in small foundries and machines on general purpose lathes and drilling machines. The tiles themselves were made from indigenous clay deposit and fired in kilns composed mostly of local refractory bricks. Thus the output, income and employment were all stimulated in a number of other industries and trades, e. g. scrap metal, foundry, carbon, refractory engineering, clay mining, etc.

In India, examples of inappropriate technologies can be shown in fields where small workers are made to suffer to make provisions for large industries. In Madhya Pradesh, a paper mill has been established with highly sophisticated automatic machines, which is using up the bamboo forest at an alarming rate. Previously, bamboos,—the most important local raw material—were sustaining a large number of handicrafts, and also the house building industries. The new bamboo forests being planted now-a-days are the quick growing type, which can be used only for pulp making, and thus the raw materials being used for centuries for the local craft and industry have been taken away for large scale paper industry. Another instance of how small industry was suppressed for the benefit of capital intensive industry is the use of D. I. R. in 1963 in Punjab, prohibiting manufacture of *Khandsari* (unrefined sugar made by cottage industry) so that big sugar mills could be supplied with huge quantities of sugar cane. The prohibitory order under the D. I. R. could be withdrawn only when a powerful agitation was carried out aganist it.

Similarly the technology of big dams for irrigation purposes involves the use of monstrously large machines, like bulldozers, earth removers, etc. Villagers have to be displaced from the area forcibly who always view the monster with obvious hostility which displaced them for ever from their ancestoral homes. Appropriate technology method would have been to design some contrivance of catching water, where it falls, using the best of intelligence and modern scientific knowledge, enthuse and organise the villagers and with their participation dig as many tanks as required. If these tanks are able to provide water to the villagers, they would always love these dear little reservoirs which would blend with the whole environment beautifully.

The same principle applies to all agricultural and non-agricultural activities of the village. Let us take the example of the two of the most ancient village crafts, pottery and shoe-making. It is surprising to see the village potter still using his centuries old wheel. No attempt has been made to improve this equipment which can increase his efficiency and productivity and at the same time improve the quality of his product. Modern technology tries to solve this problem by importing and setting up electronically operated continuous klins in towns, which drives the village potters out of business. Similarly, the village cobbler is using his meagre equipment which for many centuries has comprised of an iron last needle thread, a lump of wax, hammer and a box of nails. Modern technology is not bothered about him at all. It allows the shoe magnets to import injection moulding plants and set up shoe-making factories all over producing cheap foot-wears, ousting the small shoe-makers. Appropriate technology methods will try to design a machine and equipment which the same village cobbler can buy and use to improve the quality of his shoes and also increase the quantity turned out per day.

The Khadi and Village Industries Commission is probably the only organization in India, which is tackling this problem in an organized way. Although it has solved many research problems at this level and has created viable village industries for grain processing, paper making, oil pressing, soap making, match making, poultry, fruit preservation and tanneries, etc., its most remarkable achievement is in the production of methane gas for fuel from cow-dung, popularly known as 'gobar gas plant.' (Fig 4). It tends to solve the centuries old practice of burning cow-dung which

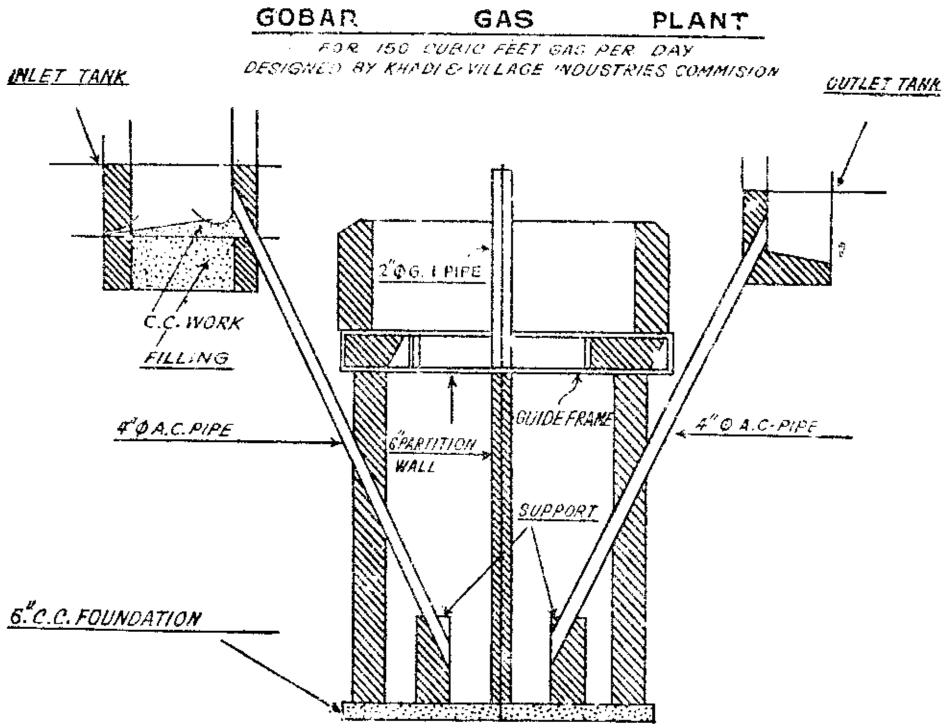
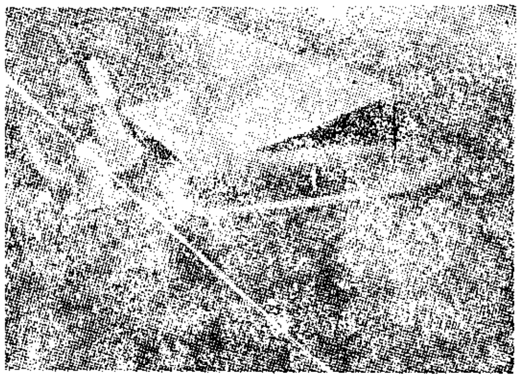


Fig. 4

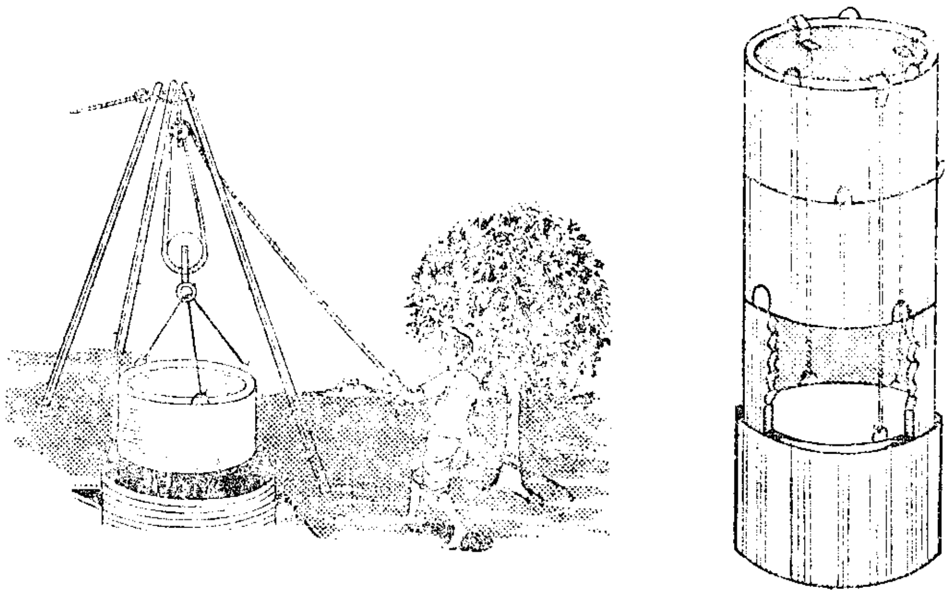
is the food of the soil. This excellent contrivance solves the problem of fuel, manures and sanitation in the villages at one stroke. Now this device requires perfection for being socially acceptable. An effort should be made for its introduction in the villages on a massive scale to save the precious cow dung so that the methane gas generated could be used as a fuel and the rest as high quality manure. Similarly many other Indian organisations in their modest way are carrying out research and development work in various other fields like building, transport, water, irrigation and utilisation of waste resources, but these efforts are not even a drop in the ocean of such a vast humanity. In this connection the names of Friends Rural Cente, Rasoolia, Krishi Yantralaya, Bardoli, Uruli Kanchan Farm, Poona, Planning Research and Action Institute (PRAI), Lucknow and Textool, Coimbatore are worth mentioning, who have done useful work in the field of well-diging, Agricultural-implements, cattle breeding, mini sugar mill and multi-spindle charkhas. (Plate V)

Plate IV

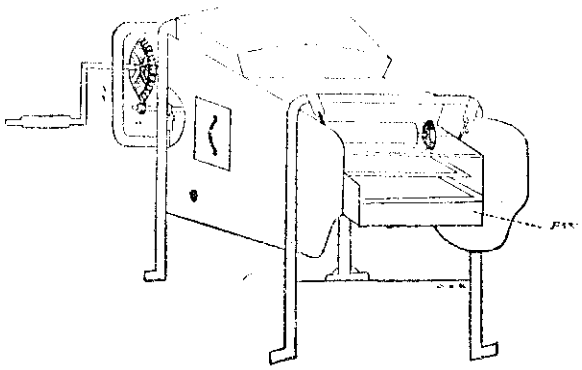
A FEW EQUIPMENT DESIGNED BY FREINDS
RURAL CENTRE RASOOLIA
Dist : HOSHANGABAD M. P.



MOULDS FOR SANITARY LATRINE



RING WELL



HAND OPERATED WINNOWER

Thus when we talk about appropriate technology, we are talking basically about a technology, which makes possible the mobilisation of labour power in the developing countries for productive use. This implies that it must be relatively cheap, relatively labour intensive and makes maximum use of indigenous material. It is 'intermediate' because it will be more efficient and productive than that which the poor are using now, but less expensive and complicated than the machinery currently employed in the highly industrialized countries. The ultimate objective is that a wide range of self-help techniques, which would start a process of progressive improvement in India, founded upon the skill of the people and natural resources available to them. For this purpose technology goes beyond hardware, and includes social institutions and techniques—ways in which people collaborate to achieve certain ends; that is, it includes appropriate form of education and training, provision for health, research and development and indeed public administration as a whole.

A pertinent question asked in this connection is regarding the cut-off point as we go up the technology scale : when does something cease to be an appropriate technology ? There is no theoretical answer to this, it depends on what a community can afford, manage, maintain, reproduce and multiply to the extent necessary from its own resources. Obviously an average equipment cost per work place of Rs. 20,000 to Rs. 50,000 would not be a typical appropriate technology for India, but one costing Rs. 2,000 to Rs. 5,000 is much more likely to be suitable. But there may be exceptions even to this.

V

METHODOLOGY FOR SOLVING PROBLEMS

The Technical Approach

So far we have dealt, briefly, with the economic and social arguments concerning appropriate technology (AT). Now let us consider some of the technical implications.

First of all, it ought to be clear that we are not advocating any really new technology, it is just a new approach to choosing that technology and the way in which it is used. So we are really only talking about a special case of the more general argument relating to appropriate technology.

For a developing country, with its particular economic and social constraints, the technical problems are not yet capable of any close definition. One difficulty of implementing the idea of appropriate technology is the lack of articulation of real needs from the field level. One of the reasons for this is that until people are aware that there is a range of technological choice, problems are bound to be defined in terms of such western equipment as is familiar and available. Hence the desire of the A. T. D. U.* to demonstrate the technological spectrum.

In the limit most technical problems can be solved provided that the design constraints are closely enough defined. But in AT the problem areas are precisely those of definition and implementation of the proposed solution. It is here that social factors have a great influence.

The technical approach to the appropriate technology must be based on the asking of fundamental questions. 'What

* Appropriate Technology Development Unit

tasks are we really trying to do ?' 'What are the real needs of the community ?' 'What are the obstacles that prevent solution of these problems ?' What, then, is the most appropriate way of acting ?' These questions are far easier to ask than to find complete answers to, but this is, after all, the approach of the Industrial Designer. The result should not be a second best, nor an outmoded technology simply transferred, but a solution, that fits the local requirements.

How it can be devised

There can be considered to be four ways of arriving at intermediate or appropriate technology solution and a successful introduction would probably have elements of all the four of them. They are :

(a) Reviving an old technology
(b) Adapting a current one
(c) Inventing a new one
(d) Improving the traditional indigenous technology

(*a*) *Reviving*

On the surface this is an attractive approach. Harking back to the great days of the Victorian engineers, when labour was plentiful and when industrial development of the western world was taking place seems to some to suit the needs of India. But of course, the conditions and requirements are changing fast. So the requirements in India are not the same as those of western countries at any past stage of their development.

Engineering and science have progressed. No engineer today would use the lavishly heavy castings of the Victorians. We have learnt the systematic approach. It is reflected for instance in the science of materials, in the new techniques of working the materials and in the new methods of management and training. Why should not these be used in India with suitable modifications if they are appropriate ? Some of these are marvellous technologies, even from modern standards but were bypassed by the modern development of technologies.

Bypassed technologies can make a contribution by showing an unusual way of solving a problem (water wheels are a good example). But the greatest contribution is to be found in the attitude of those who were not daunted by technical problems and who designed for the conditions of the time, e. g. the comparative simplicity of servicing and repair. It will be desirable to go for the simplistic general approach of the 19th century engineers without blindly copying their technology.

(*b*) *Adapting*

Does one convert a current product to appropriate technology by just removing the labour saving elements (an electric motor, conveyor belt or hydraulic system) ? In part, of course, one does, and this underlines one of the real points about appropriate technology. Substituting a hand lever for an electric motor represents not just a financial saving but also a useful employment opportunity. It also extends the application of the equipment to unelectrified areas and considerably simplifies the problem of maintenance. But all too often this approach will not work, simply because the scale of western equipment is altogether too large for the developing countries.

So the appropriate technology answer is not to be found exclusively even in small scale industry, although this might appear at the upper end of our spectrum. Current western equipment is generally just not available in the sizes suitable for a family or small community. There are too many examples of failure of large scale mechanisation programmes. The reason for failure are not simply the logistic ones (lack of spare parts), but its inappropriateness to the whole technical infrastucture.

(*c*) *Inventing*

There is considerable scope here for both new research and the blending of past and present techniques to evolve a new design approach. The definition of the problem and statement of needs will have to come from the rural areas itself but the solution can come from engineering institutions and research organizations. This approach would direct the best of modern scientific knowledge available, for the benefit of the rural areas, where 80% of the Indians live. This might be information on new materials or the techniques of working them or the way in which that work is organised.

(*d*) *Improving the indigenous technology*

This approach will be most productive in Indian situation. All the crafts and industries existing at the village and small town level may be studied systematically and organised effort made for their improvement in efficiency and productivity. Help and assistance of the most modern research institutes and the best instruments with the modern scientific knowledge, computer, etc. should be available to carry out research on these. In case it is found that certain machines and equipment were incapable of improvement, then effort could be made for inventing something new.

VI

THE PROJECTS

What is a project and what should it do?

In Appendix II is given a list of items round which projects can be based, which are some of the more important problems confronting rural areas. A short note has been included on some of the items (Appendix III). In other words, it will be quite difficult for this Unit to write a project specification for every item. Rather, they should be treated as ideas to form the subject of a project, and the concept of A T as the theme on which a solution will be worked out. Ideally, we would like to leave it open to individual students (or groups) to work out the details of their own projects, taking into account their own capabilities, the time and money allowable and the other facilities available to them.

Whilst each item can be taken as an indication that there is a need for more information on these topics, that information can take many forms. The project could aim to produce a piece of hardware. That is, it could try to rationalise or simplify an existing design. Then, if the design was promising, field tests could be arranged, the design might be published and the designed equipment might be manufactured.

On the other hand, the output could be 'software'. This would include the investigation of a process or technique and discovering what are its essential elements, analysing the historical development of a device, a bibliographic search or simply locating the manufacturers and distributors of equipment, or any combination of these.

Any work done along these lines would be of use. But ideally, infromation should contribute more directly to one or other of the range of A.T.

The case for Appropriate Technology Projects

The most obvious attraction of projects of this nature is their relevance to people. Students will find them interesting because they are worthwhile. Interest breeds involvement and these two things are a vital part of education.

The wide range of choice is an important factor. The projects can be either hardware or software. That is, they can concentrate on designing and building a piece of equipment or trying to rationalise an existing design, or analysing it historically, or simply locating manufacturers and distributors or equipment, or investigating and writing up a process or technique, or a combination of these. They can stretch across several disciplines, so they can be either multidisciplinary or can lead an engineering student into fields such as economics, sociology, finance and work study.

They can be tackled at any level—school, undergraduate or post-graduate. Since Appropriate Technology Development Unit is trying to build up profiles from 'do it yourself' to small scale industry, even the simplest investigation has potential value, and individual projects can be scaled to individual students' capabilities.

Appropriate Technology is not inferior or a second best, as some people accuse it to be but is the most appropriate to the local conditions. This approach should be an important facet of any educational process and it demands an intellectual disciplines of the highest order. Above all Appropriate Technology demands fundamental thinking. Although a reasonably precise definition of the technical boundary condition could enable appropriate design to be made, the most significant contributions will come from those who can ask basic questions about the purpose of a technology and the way in which it should be used. The fundamentalist approach demands that a student has a thorough understanding of a current process from which he can distill the essential components. Then comes the time for original thinking and appropriate designs. Working in an unusual context is stimulating enough to the engineer or scientist, but Appropriate Technology projects have the added advantage of requiring the students to explore the current ways of doing things before trying to transfer the essential elements to a new application.

As usual with project work, there are the benefits of group working, of task allocation and of defining the aims and objectives. There should be something in each project to extend the talents and develop the self-esteem of every student. The opportunity for professional contact is important. So is the possibility of designing, building and testing low-cost 'proof of principle' models. Each project can, in the time available, be brought to the conclusion of a phase, although this would not necessarily be the final one. There is then the possibility of handing on projects from year to year.

Against this must be set the difficulties. It will be nearly impossible for A. T. D. U. to give a really detailed specification of what is needed. Often this has not yet been articulated, let alone defined. This means, however, that there is considerable latitude for exploration of topics. In many cases, there is not yet any identifiable or quantifiable market. This is a particular problem when thinking of manufacturing quantities. And finally, there is the likelihood that even the best solutions may not be put to immediate use.

The definitions adopted for the Unit's technical publications are a useful guide to the sort of 'market' we are talking about. They are given for guidance only. There can be no hard and fast rules; there is no one appropriate technology and no one level at which it is aimed.

Technical publications will be aimed at the three levels of home industry, village industry and small industry which can be defined in terms of the following eight categories:

(a) Potential users of the information
(b) Methods of communicating technical information to them

(c) Materials available locally
(d) Equipment available locally
(e) Workers available locally
(f) Financial requirements
(g) Product types
(h) Potential markets

Thus :

(i) Home industry—a 'family' operation characterised by:

(a) Generally self employed, limited formal education
(b) Simple non-technical Hindi and English capable of translation into the regional languages, but more pictorial, illustrated by sketches and diagrams
(c) Local resources
(d) Hand tools
(e) Family members
(f) Approximately Rs. 400 per workplace
(g) Hand-made articles generally for use in
(h) The local community

(ii) Village industry—

A 'community' operation characterised by:

(a) Small entrepreneurs, government extension workers, cooperative managers, etc.
(b) Simple English using basic technical terms capable of translation into regional languages, preferably illustrated
(c) Local raw materials and metal locally purchased
(d) Hand and simple machinery
(e) Craftsmen
(f) Approximately up to Rs 2,000 per workplace
(g) Production in small quantities for local consumption
(h) Surrounding communities, local, small town

(iii) Small industry (already being looked after very well in India)

(a) Government officials, bigger cooperatives and local companies

(b) Normal technical terminology
(c) Indigenous or imported materials
(d) Powered machinery
(e) Skilled
(f) Approximately up to Rs 10,000 per workplace
(g) Machined products for export from district in quantity
(h) Urban, national markets.

Later, when a lot of research material is available, the Unit may consider the following technical publications :

(i) Technical profiles

An investment guide covering the range of technological choice in terms of intermediate technologies. Aimed at departments of industry, government planners and international agencies, they will give an outline of the inputs and operations necessary for any technological process over the three (arbitrary) ranges shown above, illustrating the technical choices available for each.

(ii) Instruction manuals

These will contain the detailed information (including drawings etc.) necessary to put into practice the technical choices presented above.

(iii) Directories

Catalogues of equipment suitable for AT application with an introduction in simple language explaining the level at which the catalogued information is used. Each piece of equipment should have a simple explanation of its use, scope and modification to particular circumstances. The Unit's first publication will be a directory of appropriate technology, documenting tools, machines, equipment, plant and processes, already being successfully used in India to serve as a guide for field workers.

(iv) Annotated bibliographies

It should be the aim of most of the student projects to produce results that could at some possibly later stage be included in one or other of these series.

Appendix I

Design Constraints

(Although it is expected that most of the students having some link with the rural areas, are quite aware of the conditions there, however, it may be useful to list all the possible constraints, which will act as a reminder).

The three levels of the Unit's publications show the sectors for which information is being prepared. A few more details might give a picture of the conditions in which appropriate technology can be made use of. It is a quite arbitrary list; local materials and facilities really only become important when considering a specific installation. It concerns the physical inputs available in a typical rural area.

Obviously, one ought to question why certain things are not available. It might be a great help in developing a region if, say, fibre glass was available. Should it be bought from a large city ? Or can it be made locally ? Or is it really necessary ?

(a) The Village

500–1,000 inhabitants
'Home' or 'village' industry is what is wanted.
Nearly all the people work on the land, although there are other skills.
It is about 5 miles over a dirt track to the metalled road, and 10 miles in all to the town.

(b) The town

A market town of 5,000–10,000 people who are farmers traders, artisans, unskilled labour, government officials etc. Some of the (bigger) farmers from the village visit once a week. 'Village' or 'Small' industry would be appropriate.

There are motor and agricultural machinery shops.
There's also a scrapyard.
Trains run infrequently to other market towns and to the district town which is about 50 miles away.

(c) *The District town*

This has about 50,000–200,000 people.
We are not here much concerned with the district town, because it is not much concerned with the rural areas. It does have some 'modern' light industry which attracts many people hoping for jobs. It has a rail head, and also the hope of many planners who see it as the key to the development of the region, but unemployment continues to grow, prices are high and still rising and what ever industrialisation has taken place seems to have had little effect.
However, 'small' industry might well be tried with success.

Note : T Available in Town
V Available in Village (most of the material and equipment available in villages are also available in towns)

AVAILABLE IN

TOWN VILLAGE

(d) *The people*

If there were factories they would be unreliable for

—attendance, on some days only 10 out of 50 might turn up.
—regular maintenance of machines
—consistent monitoring of operation or machine watching
—sequence operations (wrong sequences)

Skilled mechanics in the town (motor and agricultural mechanics

	TOWN	VILLAGE
and electricians)	T	
No skilled operatives in the village (for local crafts see traditional skills)		
Builders and contractors working mostly with local materials	T	
Houses etc. in the village built by the people who want them		V
(*e*) *Education*		
Hardly any in the village—a few of the children are literate		
Primary and secondary schools in the town	T	
Industrial Training Institutes in the district town		
University, with a very modern engineering department usually disinterested in the rural areas, in the state capitals or other important towns		
(*f*) *Climate*		
Tropical—high temperature —high humidity —occasional very heavy rain —dust and sand storms		
Some of the hilly areas or valleys have severely cold weather in winter		
(*g*) *Energy and water sources*		
Intermittent electricity supply	T	
Infrequent petrol and diesel oil supplies (also greases and oil)	T	
Ready supply of paraffin (Kerosine oil)		V
Muscle power-men (used to bicycles)		V

	TOWN	VILLAGE
—animal (oxen, donkeys, camles, *not* horses)		V
Winds (variable mainly strong, not measured)		V
Slow rivers, fast streams		V
Strong sunlight		V
Low grade fuel (wood, coal, dung, organic waste)		V
Piped water which sometimes fails in the summer	T	
Not piped water in the village		
Streams in the rainy season		V
Wells which fail in drought (little expertise in the village in locating or constructing)		V

(*h*) *Transport*

	TOWN	VILLAGE
Jeeps and trucks	T	
Bicycles and bullockcarts in some cases		V

(*i*) *Equipment and Materials*

	TOWN	VILLAGE
Power tools	T	
Lathes	T	
Oxy-Acetylene welding	T	
Blacksmith facilities		V
Nuts and bolts	T	
Motor and agricultural machinery parts (e. g. bearings)	T	
Bicycle parts (e. g. chains)	T	
Galvanised iron pipe	T	
Corrugated and plain galvanised sheet	T	
Carpenters		V
Hide and skin		V
Mild steel bars, angles etc.	T	
Plastic pipe	T	
Polythene sheet	T	

	TOWN	VILLAGE
Cement	T	in some V
Sand	T	in some V
Stones		in some V
Wood (both hard and soft)		V
Brick		V
Tiles (not glazed)		V
Glues (animal type not epoxy type)	T	
Natural products (animal fats etc.)		V
Natural resources (minerals etc.)		V
Artificial fertilisers	T	
Rope	T	V
Salt	T	V
Manures		V
The recovery or re-utilisation of waste could be extremely important		

(j) Traditional Skills

Pot making	V
Sandal making	
Leather tanning	V
Mud and thatched house construction	V
Animal draught (by some farmers for efficient ploughing)	V
Hand threshing	V
Grain storage (inefficient, much	V
loss)	V
Soap making	V
Oil expelling	V
Not Rope making	
Not food preservation	

Appendix II

Project Topics

Below is a list of more than a hundred items which appear to be comparatively more important problems of rural areas and small towns. They are selected from actual inquiries made from the developing countries.

Some of the items have been elaborated further.
[Appendix III]

A. AGRICULTURAL

Animal drawn harvester
Mouldboard ploughs
Multi row seeding attachment
Cotton seed drill
Green manure trampler
Chaff cutters, manually operated
Paddy threshers (pedal operated)
Seed and fertiliser drill
Portable corn grinding machinery
Grain drying equipment
Sugar beet crusher
Sugar cane crusher

B. POWER

Kerosine or butane refrigerators
Capabilities of draught animals, training equipment and harness.
Windmill operated generator
Solar or wind powered generator
Pedal operated electric generator
Water powered 2 or 3 kw lighting plant
Small portable steam engine using low grade fuel

Solar cookers
Solar heaters
Non-transport uses for bicycle mechanism
Methane gas from cow dung, human excreta and other waste material

C. CHEMICAL/RUBBER ARTICLES

Hand operated plastics machinery
Home sized chemical equipment, particularly tabletting machinery and gelatine capsule making machinery
Vegetable oil processing
Plant to manufacture fuses and explosives
Small petro-chemical project based on refinery by-products
Urea mineral and molasses block as supplementary feed to livestock
Refining used lubricating oils
Vegetable dyes, equipment and materials
Purifying sheep lanolin for shampoo or cream

D. FOOD INDUSTRIES

Oil expelling machinery
- for oilseed crops
- for groundnuts
- for sunflower seeds

Canning machinery
- for fruits and juices
- for pineapples

Vegetable processing unit
Storage of vegetables
Drying of vegetables
Sun drying of vegetables and fruits
Tomato canning machinery
Groundnut roasting machinery
Bakery equipment
Manufacture of glucose from tapioca starch
Tobacco curing

E. BUILDING, WOOD AND PACKING

Brush and broom making equipment
Saw milling and woodworking equipment
Timber seasoning
Furniture
Radio cabinets
Tea chests and other packing cases
Building fittings
Chip, particles and sawdust boards
Hardboard making machinery
Fibre board from groundnut husk
Craft papers and building boards from papyrus
Hessian sack manufacturing
Paper bags for cement
Paper pulp from kenaf
Blotting paper for schools
Corrugated cardboard packing box machinery
Fibre waste utilisation to make useful products
Light weight sheet from maize stalks, sugar cane waste etc.
Building materials for rural housing
Small scale cement plant

F. TEXTILES

Garment making
Tent making
Cotton ginning and processing
Cordage, ropes, twines, etc.
Hosiery
Improvement of spinning wheels
Improvemet of manually operated looms
Waste cotton utilisation
Manufacture of surgical cotton
Technique to improve weaving quality

Technique to improve printing quality of textile

G. POULTRY

Incubators, kerosine or methane operated
Sterilizers
Bird crates
Wire netting and other equipment for fowl runs
Poultry weighing scales
Poultry feed made from oilseed cakes, vegetable leaf protein or other locally available material
Egg trays
Processing and packing feathers

H. OTHERS

Pottery making equipment
Zip fastener machinery
Electroplating equipment
Oil filter for vehicles
Dish washing machine
Utensil washing machine
Cloth washing machine
Glass and ceramics
Iron smelting
Ironmongery
Reconditioning of car batteries
Wire working
Book matches from waste paper
Filling tyre cases with foam plastic for ox carts
Pencil making machinery
Soap manufacture
Polish manufacture
Candle making

This is merely an illustrative rather than exhaustive list. One could as well add problems from one's own experience.

Appendix III

Project Descriptions

Some of the topics in the list have been expanded and elaborated as examples. These are not meant to be an authoritative definitions of the work that needs doing, but they illustrate the typical factors that ought to be considered when a project is being conceived and set up.

A—Mechanical

(1) *Paddy Threshers* : Investigate the characteristics of a portable thresher for paddy, powered by an animal or by man foot operated or hand operated .

The requirement is for a simple piece of equipment capable of local manufacture from local materials (wood and iron) by local carpenters or blacksmiths, that can be carried to the fields and operated there while harvesting is in progress.

(2) *Foot Operated Lathe* : In village, where there is no electricity the process of diameter reduction of metal rods becomes very difficult. If a treadle lathe could be designed using wheels, ropes, pullies and gears capable of being operated by treadle and capable of giving high speed to metallic rods mounted on wooden chuck, it would be very useful.

(3) *Zip fastener machinery* : The project could investigate the ways in which zip fasteners are made, and noting all the unavoidable inputs and processes, it could suggest ways by which either currently available or yet-to-be designed machinery could be utilised to manufacture zips on a small scale. The final project report, could be a profile that gives all the details of how to set up a small factory, including heading for costs (both capital and labour) and also a suitable layout for the workshop.

The project could adopt a more basic approach and compare as many different systems as possible of fastening, and attempt to classify them in some way. Suggestions could perhaps then be made for alternatives to making zips.

Alternatively, if a survey of the industry suggest that current equipment is not suited for a small scale manufacture, the project could set out to design, build and test more appropriate machinery.

(This could very well be a work for Ph. D.thesis)

(4) *Wire bending* :

Given various sort of wire stock, what can be made useful for village use and how. Design of various jigs, tools, fixtures and equipment for wire bending (chicken wire fencing, nets, table lamp-shed's skeleton, toys skeleton, rat traps, etc).

(5) *Bearings* :

The characteristics of bearings and transmission system in a slow-running machinery. This may involve some experimental work on friction and heat in bearings made from unconventional materials like hard wood, and using uncoventional lubricants.

(6) *Engines* :

Conversion of a petrol engine to run on steam engine and designing of a boiler to produce steam for the same engine.

(7) *Humphery Pump* :

Reviving of an old technology for pumping water by methane gas, no piston, water column works as a piston.

B. Electrical and power

(*1*) *Wind Mill* : Except for small lighting or battery charging applications, wind mills are not recommended for electricity generation. The size of the wind mill and the speed and voltage control problems all impose prohibitive technical limitation. Wind mills that can be made locally and used directly for pumping water or grinding grain, etc. are more useful.

There are some possibilities of new experiments like comparison of various kinds of wind mills like one with large sails, with a small sail and a funnel. Mechanism to produce vertical oscillations from wind power to get direct to and fro motion instead of converting rotary motion to reciprocating motions.

(*2*) *Utilization of solar energy* : Solar energy can be used for a variety of work, namely

(1) Heating
(2) Cooking, ovens
(3) Refrigeration and freezing
(4) Desalination, design of stills, solar ponds, etc.
(5) Electricity generating
Project can be started on all these items.

(*3*) *Refrigeration* : Cooling and food preservation is important in India, not only domestically, but commercially, e. g., fish farming. One approach to the project, however, would be to ask for which requirement refrigeration is a suitable solution. A quantitative comparison could be made between different methods of preservation, drying, smoking, chilling, salting, etc.

If it is decided to pursue the idea of refrigeration, the aim should be to produce a simple and cheaper unit than is currently available. Units on the market are expensive and come fully built up, complete with cabinets and interior fittings.

Since electricity is not available in most of the villages, it would be immensely useful if kerosine oil or methane gas can be used for running the refrigerators. The project could study the methods of freezing mechanism, run on kerosine or methane gas. Only freezing units could be manufactured and cabinets, interior fittings and insulating materials could be built locally.

C—Chemical

(1) Rubber articles : Describe the processes by which rubber articles are made. Information on raw materials, preparation processing and equipment necessary to produce simple articles, rubbers, washers, suggestions for new products (e. g. cart spring, hosepipe) which could be produced at a later stage, would be useful.

(2) Plastic articles : Similar projects on plastics.

(3) Refining used lubricating oil :

In many areas fresh lubricating oils are difficult and expensive to obtain. The benefits of recycling are obvious. The project would set out to answer some of these questions :

1. Is refining technically possible ?
2. Is it a case of refining or simply filtering ?
3. Is a useable product obtainable with simple equipment at low cost (comparable with new oil) ?
4. Does not process degenerate the lubricating properties ?
5. How many times can the process be carried out ?
6. Are there any residue ? How can they be used ? Would they be suitable for the wooden bearing of a bullock-cart where scoring is not critical ?

The project should aim at providing information on technique and equipment suitable for a small garage or workshop. The quantity involved might be, say, 20 gallons a month. Since 5 gallon tins are readily available the project might concentrate on small batches of 5 gallons.

If proved viable, a whole field of waste reclamation can be started with oil refining as nucleus.

D—Production Engineering

Method, Motion and Time Studies of the following village crafts and industries

(i) Oil expellers and ghannis
(ii) Paddy husking and wheat grinding
(iii) Potteries and tile making
(iv) Skin flaying and tanning of hides
(v) Shoe-making
(vi) Basket making and bamboo crafts
(vii) Spinning and weaving
(viii) Carpet weaving
(ix) Banarsi sari weaving
(x) Wood working and wood-craft
(xi) Iron mongery and blacksmith
(xii) Agricultural operations
(xiii) House building
(xiv) Brick kilns

E. Agriculture

(1) Ploughs : The share is the part of the plough that causes the greatest difficulty. Shares need to be made of hardened steel but factories that produce them are expensive.

There are many designs of animal drawn plough, some better suited to particular soil types than others. The real requirement is for information on the local production of the share-making, sharpening and hardening them. Can this be done on a small scale level—improving the skill and technology of village blacksmith ? How can worn out and broken plough share be reclaimed and used ?

Minimum tillage involves tilling only the strip of land, where the crop will grow—trash and residues from the previous harvests cover the rest. This system can minimise soil erosion and help moisture conservation. Mould board ploughs invert the soil and bury weeds.

Can the project find whether there has been any work to ascertain whether soil conditions, bacteria, etc. are significantly different in areas where animal drawn equipment is proposed. In addition to possibly breaking down humus and encouraging loss of moisture, mould board plough requires large tractive effort and are not suitable for animal draught, because small oxen are only good for about 250 watts or 1/3rd of an H. P.

Can the project collect information on, or produce a design of other forms of improved ploughs suitable for animal draught. These might include chisel disc and vibrating plough.

(2) *Seeders* :

In general each crop needs a different type of seeding device. The National Institute of Agricultural Engineering, Silsoe, Bedfordshire, U. K. have successfully produced a groundnut planter on the notched disc principle. International Rice Research Institute, Phillipines also have good designs. However, it needs further development both to suit different types of nuts and grain seeds and for local manufacture. Reeves type of seeders has an inclined rotating plate with a hole that picks up one seed at a time.

Generally with seeders and planters the problem area is the mechanical distribution of seeds going through metering devices, which are normally relatively complex. Can the project make any innovation here ?

Soft roll seeders are another type. The rolls could be made of wood, covered with, say, sponge foam, which transports the seeds from a hopper to the soil with minimum damage to the seed and minimum disturbance of the soil.

Maize and millet, etc. do not plant very well in the precision planters. In the U. S. A. some farmers are using metering devices like fluted roll of a wheat drill. If one only gets 70% germination any way, there is not too much need to be precise in planting. The general requirement is not one seed every 12 inches, but rather 5 seeds in more or less every 60 inches.

There is an Indian Standards design for a cotton seed drill (I. S. 3310 of 1065)

(3) Green Manure Trampler :

This project would entail collecting as much information as possible on existing designs and collating them into one report and evaluation or into one design.

The relevant Indian Standard is IS 3301 of 1965.

(4) Chaff Cutter :

The project would again collect and collate as much information as possible on simple chaff cutter, obsolete or current design theoretical and descriptive information, etc. A prototype machine, perhaps based on existing machinery should be attempted. This must be capable of local construction by a blacksmith or a carpenter.

(5) Paddy Thresher :

The starting points for this design are a VITA design and Indian Standard, I. S. 3327 of 1965 and a South American pedal powered design. Friends Rural Centre, Rasoolia, Dist. Hoshangabad, M. P., has also got a good design. There are also a few Japanese designs, being used at various places.

(6) Small Grinding Machine :

If a little more attention is given on agricultural processing techniques and machine, a lot of food being wasted could be saved. A considerable improvement in nutrition could also be made with the food that is already being grown and eaten. For instance upto 40% of the available nitrogen in some food is lost by pounding them rather than grinding them. In addition, it is possible that, some labour blockages could be removed by the introduction of grinding at critical times in the agricultural calendar.

There are a number of hand operated mills on the market. The British design has a fairly large fly wheel and a double handed handle on a radius of about 12 inches. Its capacity is approximately 2 kilos an hour and with an average family of 6 people, 10 families would keep it in use for 4 to 5 hours. Comparative studies of the various designs can be made.

The project may also investigate the feasibility of fabricating such a mill. This could be 'value engineering' of the large castings and machine parts. Would it be possible to make the grinding plates out of hard wood. What about broken hacksaw blades embedded in a disc ? Or cement ? Or stone ? Would particles worn from the plates be a health risk ?

What about other similar equipments like grain dehuller ?

(7) Crop Drying :

The increased use of irrigation means that harvesting can now often take place in the wet season and this increases the importance of crop drying which can now become a factor of limiting output.

There has been a considerable amount of work in this area but it has not been attempted systematically to cover the subject.

Important references are :

(a) Samaru Research Bulletin No. 47 1965. It describes wood burning equipment

(b) Various papers by the Brace Research Institute McGill University, Montreal, Canada. These deal with solar energy

(c) Sun drying of fruits and vegetables, F. A. O. Rome. This describes open sun drying only.

(d) Tropical Products Institute, London has many references.

(e) Indian Council of Agricultural Research, New Delhi has also many useful references.

The project would essentially be a literature search for practical techniques. If this could be extended across to cover a wide variety of crops and techniques it would be even more useful. A 'profile' on drying, showing many different methods and level of complexity, could also be prepared.

(*8*) *Sugar Production* :

There is much information already available. Study the mini sugar mill designed by the Planning Research and Action Institute (PRAI), Kalakankar House Lucknow.

Designs for simple equipment—the crusher and the boiler, which could be locally made—is needed.

A 'profile' on sugar and khandsari production from the simplest hand operated and open fire equipment right up to the scale to a small factory, may be prepared. We need information on principles of designs and practical information on equipment and technique. Do you need different equipment for sugar cane and sugar beet ? Or can it be adapted from one to the other ?

What can one do with the residual molasses ? Can it be fermented to produce yeast for an animal protein supplement ?

(*9*) *Oil Expelling* :

Most of the non-commercial processing is inefficient. The demand for locally processed oil, like that available from Khadi and Village Industries, is high. There are many people who would welcome information on how to construct and operate simple locally made equipment. The project should first look for other commercially available units, preferably in the range of 250 kg. capacity.

The Japanese used to make a small hand operated press, but now the cheapest they make is a small screw press. Could a design be made of a small screw press or some suitable alternative (a very simple hydraulic press, but not solvent extraction) or improvement upon oil ghannies ?

Currently, all oil seed crops are grown for their oil, but the residue is a very good potential source of protein. What is known about using the residue for this purpose. Incaparina is a food mix containing cotton seed protein, used in South America.

In the conventional process, the oil seed is put into the press and cooked. This and the temperature rise in the pressing process destroy the protein. What is the temperature rise in the process ? Is there a method of extracting oil with minimal heat damage ?

(*10*) *Canning* :

Canning of vegetables and fruits can be a very dangerous process. Particularly when carried out on a small scale, there is a very real risk of botulynum poisoning. Produce which is low in acid are especially risky.

Since a constant supply of steam as well as clean water is needed, it is possible that the process could never be economical on a small scale. Nevertheless if the project could develop a reliable hand seamer and either locate or design appropriate ancillary equipment, it is possible that, with skilled supervision, an area producing a sufficient quantity of uniform quality produce could develop its mark at the same time as making nutritious and palatable food available in the off-season.

Investigations on suitable containers for canning is also very important.

F. Note on completed projects in the Imperial College of Science & Technology, London

(*i*) *Wire bending :* There are great skills in the rural areas of developing countries in handicraft; for instance, in making lamp shades. They can make the outside covering but the wire contraption inside has to be bought from the town. So it was said it will be nice if these people could make the wire case themselves. Thus the problem was posed how do you bend the wire accurately and precisely if you do not have a big machine and a student of the Imperial College of Science and Technology in London who carried out the research has completed a doctor's dissertation on the question of how to bend wires. His job was not only to study the principles of bending wires but also to develop the cheapest possible set of jigs and tools.

(ii) Re-inforcing bitumin with natural fibre:

Another example was to develop a material to be used in the rain water catchment tank for holding water. The matecial developed for rain water catchment tanks was a bit of cement and some polythene tubes and sheets but it was a very laborious job and it took a lot of time. Now one of the by-products of the oil refineries is a very heavy sticky residue called bitumen which is in surplus. This can be used to insulate the water tank but by itself it does not help unless reinforced. Anybody can tell that it can be reinforced with glassfibre but that glass fibre costs rupees 2000 a ton whereas natural fibres which are in surplus such as sisal, coconut fibres and aloe leaves cost rupees 200 a ton or less. The students were set to study systematically and by the best methods of modern science, the possibility of reinforcing bitumen by natural fibres. This extremely valuable thesis is complete.

Appendix IV

A list of Student's Projects currently in hand in British and other Universities

Key-
staff=departmenat research
u. g.=undergraduate
p. g.=postgraduate

AHMADU BELLO UNIVERSITY, NIGERIA

Salt production using solar pond	
Solar ovens	u. g.
Solar water pumps	u. g.
Solar fridge	u. g.

ARCHITECTURAL ASSOCIATION

Disaster shelter :	Investigating minimal structure for use in e. g. Bengal	u. g.
Methane gas :	Recirculating of waste and energy to be used in conjunction with hydroponic scheme	u. g.
Building in Ghana :	Maurice Mitchell worked in Ghana as an architect. Hopes to return next year. Helpful in giving other students inspiration	u. g.

BIRMINGHAM POLYTECHNIC

Survival :	Six separtate projects on the minimal requirements to sustain life—water, food, housing, transport etc.	u. g.
I. T. methodology :	Andrew Hurst doing project on methodology of AT, e. g. : how a layman can record local needs and resources for remote process and	

for appropriate recommendation to be made. At the moment in Swaziland. p. g.

BIRMINGHAM UNIVERSITY

Composting : Agricultural implications of composting. Could well link up with methane gas projects. [staff]

CAMBRIDGE UNIVERSITY

Animal nutrition : No further details

CITY UNIVERSITY

Solar energy: 2 or 3 projects on water heating and utilisation of solar energy u. g.

EDINBURGH UNIVERSITY

Technology Consultancy Unit Kumasi University, Ghana being organised by Harry Dickinson, who is also responsible for Alex Weir's and other IT projects including :

Wind power : Extraction of power from one square metre of wind u. g.

Solar power : A rival project to see if more power can be extracted from 1 sq. metre of solar radiation u. g.

GLASGOW UNIVERSITY

Solar distillation : Design of a solar still and state-of-the-art review of recent developments p. g.

HATFIELD POLYTECHNIC

Water power : 3 projects will probably include a 'profile' of ways of extracting power from water. Design and test of a Mitchell turbine. Profile on dams and civil engineering for water power sites. u. g.

IMPERIAL COLLEGE

Fridges: Methods of lowering temperature u. g.

Wire bending: Given various sorts of wire stock, what can be made and how u. g.

Cheap transport: No further details u. g.

Windmills: Comparison of a windmill with large sails with one with small sail and a funnel u. g.

Windmills: Mechanism to produce vertical oscillations from wind power u. g.

Chicken wire fencing: Design of and equipment to produce it u. g.

Waterproof materials: Investigating the possibility of using asphalt to line water catchment tanks and usefulness of natural fibre like jute as a crack stopper u. g.

Groundnut roasting: No further details

Electricity generation: From windpower u. g.

LIVERPOOL UNIVERSITY

Steam Egnine: Conversion of a petrol engine to run on steam u. g.

Boiler: Design of a boiler to produce steam for above engine u. g.

MANCHESTER UMIST

Water pumping: In conjunction with I. T.D. G. water panel, David Farrar continues on his project to try to classify man and animal powered water pumps and improve them and, in general, how a socially appropriate water policy is decided. He plans to visit Swaziland shortly p. g.

Pump: Analysis of costs and performence of a range of simple pumps u. g.

Bearings: The characteristics of bearings and transmission systems in slow running machinery. This may involve someexperimental work on friction and wear in bearings made from uncoventional materials and using unconventional lubricants u. g.

NORTH EAST LONDON POLYTECHNIC is trying to build up an area design for developing countries based on AT—as part of its multi-disciplinary post graduate studies in design.

PORTSMOUTH COLLEGE OF TECHNOLOGY

Survival: Review of basic requirements—techniques and technologies for simple survival. Aimed at 'alternative' communes u. g.

READING UNIVERSITY

Humphery Pump: Nalim Walpita is working full time investigating this attract-

Note : The above 2 projects are being supervised by Arnold Pacey and are designed to produce result to help to David Farrar's work.

ively simple internal combustion pump. Trying to determine if it can be made reliable and on a small scale and if so, how p. g.

Solar Pump: Investigating and test of solar powered Savery pump u. g.

Steam Engine: Renovation of antique blacksmith made steam engine for the Museum of Ruarl life. Compare and contrast with design of one that could be made today using modern knowlege and materials. u. g.

Agricultural economics: 2 projects possibly going to look at farmer-level surveys taking Mike Collison's work at starting point u. g.

Water Power : · Review of different methods of extracting power from water. Design of simple vertical axis water wheel for Tibetan Farm School and also design of simple (wooden) water turbines [staff]

Lighting: Profile of all different methods of providing light not including gas and electricity [staff]

ROYAL COLLEGE OF ART

Water Power: Profile of water power devices, Design of simple vertical axis water wheel for Tibetan Farm School u. g.

Electro-plating: Profile of methods and equipment for plating. Design of equipment not easily and cheaply available. u. g

Solar pump:	Review of methods of raising water suitable for solar energy. Design of one type	u. g.
Agricultural machinery :	No further details.	u. g.
Washing Machine:	No further details.	u. g.
Wind Power:	No further details.	u. g.
Furniture design:	No further details.	u. g.

POLYTECHNIC OF THE SOUTH BANK,

Low cost fridge	Review of methods of lowering temperature. Investigation of required characteristics for fridges. Design of a unit (preferably gas powered).	p. g.
Chicken rearing equipment:	Investigation of equipment needed for rearing of chickens. Possible 'profile' on equipment needed and how to use it. Possible designs of unified range of equipment.	p. g.
Fixing:	Review and evaluation of all known methods of joining wood (lashing, nails, glues, corrugated fasteners, etc.) Details of how to make them (e. g. production of nails).	

Appendix V

The True Object of Industrial Research

(Originally appeared in the columns of "Weekly Letter" by M. D. under the caption "At the Science Institute")

The next day Gandhiji visted the Science Institute. The Doctor showed him over the different departments, electrical, chemical and bio-chemical—on which money has been poured like water. He looked quite absorbed in thought as he mechanically listened to the professors who were explaining the different things, possibly thinking of the Frankenstein's monsters that the boys were learning to create, of the tax-payer who had not even the remotest hope to get a return for the money he was paying for the costly experiment and possibly of the great donor who had given his three millions for the welfare of the motherland. When the students gathered together to present him the purse of Rs. 325/-—he had probably decided to say nothing more than a word of thanks. But he could not contain himself, once he opened his lips. For a few minutes the students stood spell-bound listening to that outpouring of the heart, severe, yet suave.

"I was wondering where do I come in?" he exclaimed with a sigh. There is no place here for a rustic like me who has to stand speechless in awe and wonderment. I am not in a mood to say much. All I can say is, that all these huge laboratories and electrical apparatus you see here are due to the labour—unwilling and forced—of millions. For Tata's thirty lacs did not come from outside, nor does the Mysore contribution come from anywhere else but this beggar world. If we are to meet the villagers and to explain to them how we are utilizing their money on buildings and plants which will never benefit them, but might perhaps benefit their posterity, they will not understand it. They will turn a cold shoulder. But we never take them into confidence, we take it as a matter of right and forget, that the rule of 'no taxation without repesentation' applied to them too. If you really apply it to them, and realize your responsibility to render them an account, you will see that there is another side to all these appointments. You will then find not a little but a big corner in your heart for them, and if you will keep it in a good nice condition, you will utilize your knowledge for the benefit of the millions on whose labour your education depends. I shall utilize the purse you have given me for Daridranarayan. The real Daridranarayan even I have not seen, but know only through my imagination. Even the spinners who will get this money are not the real Daridranarayan who live in remote corners of distant villages which have yet to be explored. I was told by your professor, that the properties of some of the chemicals will take years of experiments to explore. But who will try to explore these villages ? Just as some of the experiments in your laboratories go on for all the twenty-four hours, let the big corner in your heart remain perpetually warm for the benefit of the poor millions.

"I expect far more from you than from the ordinary man in the street. Don't be satisfied with having given the little you have done, and say 'we have done what we could, let us now play tennis and billiards'. I tell you, in the billiard room and on the tennis court think of the big debt that is piled against you from day to day. But beggars cannot be choosers. I thank you for what you have given me. Think of the prayer, I have made and translate it into action. Don't be afraid of wearing the cloth the poor women make for you. Don't be afraid of your employers showing you the door if you wear Khadi. I would like you to be men, and stand up before the world firm in you convictions. Let your zeal for the dumb millions be not stifled in the search for wealth. I tell you, you can devise a far greater wireless instrument which does not require external research, but internal and all research will be useless if it is not allied to internal research—which can link your hearts with those of the millions. Unless all the discoveries that you make have the welfare of the poor as the end in view, all your workshops will be really no better than Satan's workshops, as Rajagopalachari said in joke. Well, I have given you enough food for thought, if you are in a reflective mood, as all research students ought to be."

Young India, 21-7-27, p. 235

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