THE IN-SERVICE TRAINING OF SCIENTIFIC TECHNICIANS FOR SCIENTIFIC AND TECHNICAL RESEARCH AND ITS APPLICATION

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CONTENT

We shall consider, both in general terms and from specific examples, how working scientific technicians can specialize, be better trained and become better adapted to their occupation. Before doing so, however, it would be appropriate to try and define their role and to describe what qualities they should possess and what knowledge they need in order to fulfil that role properly.

They occupy a fundamental place in the immense and extremely complex operation - underlying any development - which ranges from knowledge of, and due regard for, the human environment to its utilization by man.

I. INTRODUCTION

For m an to achieve fulfilment, both individually and collectively, he must be capable of bringing about his own integrated and rational development, immediately and in the long term, within his environment, the improvement of which is naturally a basic consideration.

For this environment to be improved, it must first be known, but account must also be taken of changes and developments in it as a result of the various possible human activities, and an attempt must be made to ascertain the reactions that such changes may prompt in people. Scientific study of this environment is essential and must take account not only of the environment's present ecosystems but the socio-economic setting as well, and their potential for change as a result of human activities. It is equally essential to assess the effect of these abrupt or gradual changes on man himself and on the use he may make of his living environment, both immediately and in the near or the more distant future.

There are three complementary facets to such a study :

- investigation of the characteristics and properties of that environment in order to know it and ascertain man's place in it and to pinpoint the possible overall trend;

- knowledge, gained through observation and experimentation of the scope it offers for development and use by man, and of the consequent modifications it will undergo regarding its balance or further development;

- communication to those who are to be responsible for carrying out the successive operations involved in this "management", of the findings of such research, studies, works, observations and experiments so that they can assume effective control of such changes for the benefit of the people in question.

Researchers and teachers are the people for this work, but there are never enough of them. It is also very often true that some aspects of the work call for qualities of accuracy in execution and repetition and of perserverance and regularity in continuing, which researchers and teachers do not always possess to a sufficient degree but which are highly developed in certain of their colleagues, the technicians.

It can therefore be confidently stated that though the eagerly sought development of countries requires the labours of scientists - in the broadest sense of the word - whether they are engaged in research or in teaching, it calls just as much for those of their associates, the technicians.

II. THE ROLE OF TECHNICIANS IN PREPARING AND ACHIEVING THE "DEVELOPMENT" OF COUNTRIES

As I have been working with technicians for nearly half a century in agronomy-oriented research to prepare and to assist in carrying out overall physical planning, I shall mainly adopt this standpoint in the pages ahead for considering the fundamental role and the essential qualities of technicians and what I see as the best methods of providing them with the most suitable training.

A. Role of technicians in laboratory research services in universities and in other bodies such as scientific research centres and laboratories.

(1) Their first assignment is the preparation of samples. This looks very simple at first sight, and perhaps it sometimes is. In many cases, however, this operation is very complicated and in the 1935-1945 period, when I had no specialized technician to help me, I always personally took on the job of preparing a great many particularly difficult soil samples (e.g. calcareous soils and soils with ferro-manganese concretions) taken in the course of preparation of the soil map of France or for certain detailed studies of saline soils in Algeria.

In any case, and especially if he uses such machines as crushers for the operation, which save him time and energy, the technician must have a thorough knowledge of the nature of the material on which he is initiating the study and know exactly why the study is being made. Each sample has something individual about it and this affects its preparation for a particular study, as well as the aim of and the method used in the study.

Apart from the preparation of rock, water, soil and plant samples referred to above, there may be plants to grow or animals to look after. The technician is generally responsible for this, which calls for special qualities.

(2) The technician is also responsible for carrying out routine operations involving chemical, physical, biological and other analyses, which make demands on him in terms of qualities and knowledge. Broadly speaking, he carries them out perfectly well and most efficiently, and better indeed than would most of the researchers with whom he works. One problem often presents itself in the case of soil analysis, for instance, namely whether it is preferable to ask a technician always to carry out the same measurements on all laboratory samples or whether each technician should be expected to conduct all the analyses required for a particular group of samples. In the former case, the technician gains in rapidity, accuracy and efficiency; in the latter, he is sure to find his work more interesting. In practice, each laboratory headmakes a choice depending on the requirements of the researchers and technicians as a body, and a compromise solution is often adopted.

(3) The technician is frequently asked to "make a start" on studying the samples he has prepared. This is so when it comes to analysing small soil or rock specimens, and perhaps cross-sections of plants, animal organs, bacterial cultures and the like. He often has a real knack of recognising on the microscope slide the noteworthy point which, with more searching observation, will yield important conclusions.

(4) Then in many cases, in a laboratory, the technician is required to assemble, with the advice and usually the participation of the researcher the framework and apparatus needed for the experiment in view. This assembly work and its checking may take days or weeks, the experiment itself a few hours, and the readings a few minutes. The skill and dexterity of the technician can do wonders in all this.

(5) Equipment maintenance is also an important item in his work.

B Role of technicians in station research services (e.g. experimental agricultural stations)

As previously, the technician is responsible for :

(1) Preparation of samples subjected to or used for experimentation: preparation of the soil of the experimental plots or of the fertilizers or seeds used, etc.

(2) Plant-growing or looking after zoological speciments, including routine care.

(3) Maintenance of measuring equipment, where applicable, e.g. for gauging the humidity, temperature or ventilation of the environment under investigation.

But he also has to see to :

(4) Setting up the whole experiment, which requires of him a good deal of care and accuracy in the operations to be carried out and, in many cases, sound knowledge for certain practical work.

(5) The accurate and detailed observations that are essential as the development of cultures or of zoological specimens progresses. They must be repeated frequently not to say continuously.

(6) survey ~~Classification~~ of plants, grown etc., soil description, gauging of discharges, and the like, an essential item in his work and of paramount importance; it determines a number of the qualities he needs.

C Role of technicians in field research or research application operations

(1) This role is similar to that set out above.

(2) Experiments are generally carried out on a markedly larger scale. There is often a change-over, for instance, from the plot of a few square metres to the field of at least a few hundred square metres. The technicians responsible for this operaion should also possess a certain sense of the "lie of the land", so as to be able to adapt the procedure laid down to the site used.

(3) The technician must also, in this case, be able to take on responsibility for plant and zoological specimens, kept whatever the condition at the time when care has to be provided or observations carried out.

(4) The field technician is also expected to get his team out of any practical difficulty whatsoever - such as lack of water or food, and vehicle breakdown or transport failure - and, in the first place, to be capable of foreseeing and avoiding such incidents or at least, should the worst come to the worst, of "pulling through".

D Role of technicians in technical services - chiefly those of government departments - in applying scientific research findings

There is little left to add to what has already been stated. It should perhaps be pointed out, however, that the role of such technicians depends to a large extent on whether or not they are in contact with the local population. In some cases, the technician has virtually no such contact or only very occasionally. In that case his role is as explained above and he is usually responsible for "close-up action" involving demonstration and advice. His role is then more essential than ever. Success depends on the quality and effectiveness of the findings to be applied but, to at the least the same extent, on his own qualities and in particular on his ability to mix with people.

III. REQUISITE QUALITIES AND PROFICIENCY FOR TECHNICIANS

To be fit for such a variety of roles, scientific technicians definitely need to possess a great many qualities and a high standard of proficiency.

A Human qualities

(I). Generally speaking, and especially when he works in a developing country where he will often be more isolated than in a more industrialized country, the technician must be intelligent and possess complete intellectual honesty. The researcher, teacher or engineer working with him cannot constantly be checking the findings or readings supplied to him by the technician. Some checks are necessary at times but it must be possible to place the utmost confidence in his data.

The technician must also be capable of promptly understanding the aim or the reason for carrying out the work. The real and practical concept of the development of a country and its population, that of integrated physical planning, should usually be perfectly familiar to him. In addition, he needs the ability to work in a team and a precise idea of his place in it. Relations between technician and researcher or engineer are sometimes very easy and flexible, but this is unfortunately not always so, and then the team collapses. We have had several instances of this with field pedology teams.

(2) Other qualities should be sought after in varying degrees according to the exact role of each technician.

(a) For the laboratory technician, associated with biology, chemistry, or physics studies, accuracy and manual dexterity are all-important, as are a degree of adroitness and real rapidity of execution.

If, in particular, he is going to be carrying out routine work, he must also be orderly and have a thorough grasp of work organization, in accordance with the space and equipment available.

(b) For the station technician and particularly the field technician, resourcefulness and the fact of being used to open-air living become very important, other requirements being stamina and tolerance of adverse weather conditions. The soil scientist must be able to carry on despite very high temperatures, and the hydrologist even in torrential rain.

The technician very often has to take charge of a small team of labourers, which calls for still further qualities of authority and leadership and a sense of responsibility.

(c) The technician who, like a farm foreman or an agricultural instructor, or a forestry or irrigation supervisor, is constantly working with people either to teach them new methods or to co-ordinate their work, must possess considerable psychological qualities and natural authority as well as a sound feeling for human contacts and human relations.

B Technical qualities and proficiency

(I) The technician must have a firm grasp of the purpose of the study, which ~~often requires an effort, and a very necessary one,~~ on the part of the person over him, i.e. the engineer, researcher or teacher. He must also grasp the nature, characteristics and properties of the object studied. This may be somewhat secondary when it comes to routine laboratory tasks although, as I see it, it greatly adds to the interest he takes in his work. It is essential for all field work.

How can a prospecting pedologist, geologist or hydrologist be effective if he lacks that sense of the "lie of the land" which gives him a more or less instinctive understanding of its orientation, the arrangement of its contours and the possible tie-up between all the components? An understanding of water as regards its origin movement and destination is one of the basic ingredients that makes a hydrometrist so valuable.

The same goes for the biologist, who must have an inherent feeling for the plant or animal concerned, and for its growth and development.

The human sciences investigator, for his part, must possess a sense of human relations and a knowledge of the psychology of the people among whom he works. Such qualities and knowledge should not be lacking in all those who, in development operations, for instance, engage in "close-up" extension work.

All this may be more or less innate, which is always preferable. These qualities and this knowledge may nevertheless be gradually acquired in the work context; at the least, they develop on the job.

(2) The technician must possess quite a thorough knowledge of the object of his study.

(a) In the first place, the requirement is for fundamental knowledge. This may be fairly specialized but it must be sufficiently detailed and precise. The technician does not generally need to know the entire function or mechanism of the object, though he must have a grasp of essentials and of the basic factors involved in its development. He must be able to recognize the most important characteristics and those of the various stages in that development.

This knowledge must nevertheless be broad enough for the training of the technician to remain truly human and to allow, where necessary, a change of assignment which is often needed after ten to fifteen years of work, particularly in the case of field technicians like prospectors and hydrometrists.

(b) The technician should also, of course, be thoroughly familiar with all the practical operations involved in his work, and with the reasons for them.

Furth ermore, he must really know his equipment and be able to service it. If he cannot always carry out repairs, it is helpful if he can trace the cause of the breakdown and remove the part needing alteration or replacement. This is particularly necessary in the case of equipment from abroad. These observations apply not only to laboratory apparatus but to field equipment as well, particularly vehicles. This quality is all the more essential for the field technician, who so often works in great isolation far from any back-up.

IV TRAINING OF SCIENTIFIC TECHNICIANS

A Choice of candidates

There seem to be three issues here : should men or women be considered for recruitment? At what age ? With what training?

(1) As a rule, technicians may be selected from among both male and female candidates. The fact nevertheless remains that it will be better to recruit men for some types of work and women for others. Thus field work, geological or pedological prospection, hydrological observations and measurements, and in many cases even agricultural surveys will be more suitable for men and there are even countries where it would still be unheard of to entrust such work to women. On the other hand, meticulous, precise and routine laboratory work is generally perfectly well performed by women, though men can also be put on it.

It is true, even nowadays, that women are more concerned than men with the day-to-day running of homes and the care of children. Various technical assignments particularly in the field, would do nothing to facilitate that task for them.

A somewhat special case is that of technical instructors (in agriculture, foresty, etc.) Women sometimes do very well in this work although very often it is better to employ men on it. It should be emphasized that all this may depend not only on the actual qualities of the people concerned but even more so on the customs of individual countries.

(2) The age at which to select trainees also depends on the areas of specialization contemplated.

In the case of laboratory work this is of no great importance so long as concentration, manual precision and keeness of sight are already sufficiently developed and have not declined. On the other hand, in the case of field work, it is better to have the technician specialize fairly early on, in practice as soon as he has acquired the necessary basic knowledge and practical experien ce, provided he can already project a certain authority. The extension worker, on the other hand, will probably do better if he is not too young and can display the genuine maturity and that thoughtfulness which is essential if he is to be able to adapt to the wide range of situations with which he will be confronted.

We shall consider below the type of training the technician should possess at the outset. It must be emphasized straight away, however, that technicians with the most rudimentary backgrounds but with at least two or three years of activity at this level behind them may be excellent material for specialized training which will allow them promotion to a higher level and more important duties.

B Basic training

What is often required is a perfectly ordinary secondary education but with more emphasis on subjects like mathematics, physics and chemistry and, if possible, natural science. The education given in France for various technical or agricultural "baccalaureats" is entirely suitable. Some technical schools procide very suitable courses from both the practical and the theoretical points of view. They generally last two to four years, depending on the initial education of the trainees and the level (operational engineer, senior technician, technician) at which they may be aiming.

There are even schools that provide the entire course of instruction required, and students completing the course can, almost immediately or after a probationary period of six months to a year, fill a technical post satisfactorily and be given an established position. There are many well-known schools of this kind for chemistry and biology but fewer for other disciplines, although the agricultural colleges at various levels, can nevertheless provide the necessary instruction in them. Caremust be taken to ensure that sufficient emphasis is placed on technical and practical training.

This type of school is becoming increasingly common in all countries, both developing and industrialized, cases in point being Algeria, Tunisia, Mali, Upper Volta, Kenya, Colombia and others.

In some parts of tropical Africa, these practical schools, of different kinds according to the subjects taught, are located in neighbouring countries and use the same language.

C Specialization of technicians

(I) Specialization in technical schools

(a) As just pointed out, there have been a great many technical schools in the industrialized countries, thought as yet they are not numerous enough to train all the technicians needed. In the developing countries, the number of technical schools is constantly on the increase and in both groups of countries, schools are coming into being for new or older subjects for which, as in the case of geological prospection in France, no schools existed just a few years back. They often cater for an entire region.

(b) They provide training at two levels at least, generally that of assistant or operational engineer and that of technician proper, and sometimes at three levels. The academic background of the student usually corresponds to the secondary leaving certificate or the like, and the course lasts two years or three to four years, according to the target level.

Some schools even admit students at a slightly lower level corresponding to three or four years of secondary schooling instead of the usual six. Others, as in various countries of northern or tropical Africa, may accept students who have left school earlier but have already had at least two or three years of work experience in the discipline concerned, or in a related discipline.

The course generally includes a sizeable academic component (often two-thirds of the time) but the practical side is not overlooked, whether in the form of laboratory or field work. The proportion varies considerably according to country and school, and according to year and standard attained.

There is a good deal of documentation on them, some published at the instigation of Unesco and often in conjunction with other United Nations Specialized Agencies. It therefore seems more interesting to discuss the other forms of technician training and more particularly, training for technicians at work.

2. Training in technical schools has its counterpart in training acquired day by day in the work team itself, in the laboratory or in the field, in contact with the teacher, researcher, engineer or senior technician in charge.

(a) Such training is constantly guided by the senior-level specialist, who explains the operations and says what has to be done again, what must be looked up and learned in books or what is to be found in documents. It is a form of training that is possible in certain areas such as geological, pedological, hydrological and phytogeographical prospecting. Here again, this method which is very sound in many respects, does not seem adequate on its own in the case of human science investigators or agricultural instructors, for instance.

(b) It offers a good many advantages since it is easy to provide, so long as each teacher or researcher works with only one or two technicians. It is purpose-oriented and this makes it easier to avoid any waste of time and needless effort. It means that the technician is taken off his usual job only for the minimum amount of time necessary.

On the other hand, it obliges the specialist to devote a proportion, and a very variable proportion, of his time to it especially as with each new type of work demanded of the technician, a fresh start has to be made in this new context, on the educational activity previously undertaken. Such training is fundamentally over-specialized.

Furthermore, though the people in charge of university laboratories are normally very willing and suited to this role, and thought the same can usually be said of researchers, this is not always so in the case of engineers and those at the head of the various technical departments.

3. <u>Special training by means of courses or workshops (or technical seminars)</u>

(a) Between the two extreme types of training we have considered, there exists another which consists in putting the technician on a medium length or short training course specializing in the branch of knowledge concerned.

It is preferable to keep these refresher - and sometimes restraining - courses for technicians with sufficient working experience, say two or three years, in the field or in a laboratory. They then feel more concerned by the instruction given them, both theoretical and practical, they are familiar with certain difficulties already encountered and they may have tried out various ways of overcoming them. When such matters are dealt with on the course the trainees will be quite at home with them, and will get far more out of the course than if they were taking it immediately after recruitment.

Without setting out to instruct the trainees in all the general theories and facts of the disciipline in question, one can give them a comprehensive outline even at their level of training, with real emphasis only on the material that is likely to be of use to them in their work. Thus pedology technicians who are going to be prospecting essentially in tropical regions need to be familiar mainly with immature hydromorphic, natron-containing, lateritic, ferruginous and similar tropical soils, and only in a more general manner with insohumic, browned or podzolized soils.

Such workshops and courses offer many advantages. The participants, being of the same standard and confronted with the same practical problems in their working lives, will soon get to know one another and compare notes. The reactions of each student to the teaching can be very instructive to the others, especially if the teaching methods used are sufficiently active.

The people in charge of these courses are usually researchers or assistants to the teacher. They take an active part in research work and their experience is very broad and very diversified. They would perhaps not be very good at formal lecturing, but they are usually perfectly suited to this type of technician training which employs a much more "personal" form of instruction.

Such forms of training are entirely suitable for technical laboratory staff in universities and scientific, agronomic and other research centres, and for field personnel. They are less appropriate for technicians engaged on survey or extension work, and can provide only one side of the necessary instruction.

It must be recognized however, that there are drawbacks to such courses and workshops. The main one is that for a certain period the best technicians - and there are often too few of them as it is - have to be taken off their jobs. There is a partial remedy for this, as we shall see further on, when the operation is carried out at the place where most of the participants are already at work. This is not so when it is organized regionally - although this alleviates other difficulties - and still less so if the course is held in a fairly distant country. Each country can then only send a few of its technicians, often just one or two and this complicates organization.

In addition, it is not always a simple matter to gather together at the same time all the teaching staff desired and the essential demonstration material. This is particularly difficult if the course is held, as is preferable, in a developing country. It is then often necessary to bring in specialists from abroad.

Nevertheless the fact of holding courses in such a country often facilitates any "Field"components.

To overcome some of the above difficulties, courses may be organized regionally for countries using the same languages in a given ecological zone. On the other hand, this unfortunately gives rise occasionally to other difficulties due to certain misunderstandings between enighbouring countries over boundary demarcations, migration and the like.

There are still other problems to be overcome that we shall consider further on, particularly that of the diploma to be awarded to every satisfactory participant and the question of how it should help him in his career.

(b) Holding of courses

Several methods have been proposed and used for providing such training. Some can be applied on the spot or, at least, have been tested with this in view.

The first case is that in which the department itself comprises a fairly large number of young technicians to be given specialist training or can play host to those from other departments geographically very close. Formal lectures and laboratory work can be organized in them, taking up to two hours at the end of the day (one hour out of working time and one hour after work) on every working day or three or four days a week. The instructors are, in this case, those in charge of the work of this department, teachers, researchers and heads of laboratory, or their opposite numbers in neighbouring departments.

Training of this kind was provided for several years at the soil laboratory (physics and chemistry) of the Division d'Etude du Milieu Naturel et des Resources Hydrauliques, at Bir Mandreiss, Algiers.

Other similar trials have been carried out, and always successfully, in research centres oruniversities in various countries. The writer knows of other examples concerning soil prospectors at the Adiopodoume Research Centre (ORSTOM) in Ivory Coast and concerning medical entomology technicians, in the same country. Another case is that of certain major cities, like Paris, Lyon and London, where a great many departments, universities and research centres comprise a large number of technicians who wish for a better, more specialized training. A course of instruction, sometimes somewhat academic, can then be organized for the various types of technician, at the end of the day or in the evening once or twice a week. Such instruction is usually given at a technical university or research centre, in which case the field work, or practical application among the public concerned, generally takes place at the week-end. The Conservatoires des Arts et Metiers (university level engineering education) in Paris and elsewhere are very good examples of this. It must be recognised, however, that the technicians in question need a good deal of perserverance since the course does not take just one year. It involves an effort that has to be kept up for five or six years, which is tough going.

The writer personally knows a number of technicians who have succeeded in this way in soil chemistry, pedology, agronomy and phytobiology, and they are generally very remarkable people. Some have moved on from the technician stage and have become genuine researchers, even though they may be classified in France as research engineers.

Still another case is that of instruction provided at the end of the week, taking one working day and more or less the whole of the following day, normally a day off. This system has, for some reason, been generally unsuccessful, whether in Tunisia for rural engineering technicians or in Ivory Coast for prospecting pedologists.

The usual training method adopted is that of the medium-length or short training course.

The instruction is then very concentrated and must be provided by "teachers" highly specialized in the branch of study. Their recruitment presents numerous problems. They do not have to be professional teachers but they must be very experienced specialists.

If, as is recommended, the course in question takes place in a devastating country, the country concerned should be able to provide at least most of the instructors. This is unfortunately seldom the case. An effort should be made, it seems, to ensure that those who receive instruction provided with the assistance of the various United Nations agencies (Unesco post-graduate courses, the WMO instruction centre in Lausanne, and so on) are better trained to be able to serve, each in his speciality, as teachers on these courses for technicians. A complete file of persons available should be maintained by organizations like UNESCO.

As stated earlier, these courses should, despite certain local ~~difficulties, be put on at least a regional footing. They will nevertheless,~~ thus oblige most participants to be away from home. Yet they must not remain "foreign". The "work environment" of the course must therefore correspond to what each participant is familiar with in his own country. The equipment used must be exactly the same. Use may nevertheless be made of slightly more sophisticated equipment so that the most advanced training still seems to be the most attractive, permitting use of the latest devices yielding the most accurate results in the shortest time, i.e. electronic microscope, computer, devices for analysing remote-sensing images, etc.

Other general problems arise regarding all these training courses for scientific technicians:

Site

As already repeatedly stated in this paper, it is preferable to hold the courses in developimg countries themselves since these are the contexts in which the participants will subsequently be working. Unfortunately, this is as yet seldom possible but a big effort should be made in this direction. Whenever possible, particularly in the case of laboratory courses, instruction should be provided in - or in conjunction with - technical schools of the same kind dispensing school-type education in the discipline concerned, at either technician or researcher level. This kind of solution very often makes it easier to bring teachers together, and in all cases it facilitates use of laboratories and of the essential teaching and demonstration equipment.

One difficulty may arise, however, of which the writer has known several cases. A participant in such courses may, intentionally or unintentionally, subsequently give would-be employers or "team leaders" to believe that he has undergone one or more years of full training in the school whereas he has in fact, spent only a few weeks or, at the most, a few months there on a much simpler course. A clear distinction between the diplomas granted should avoid such confusion.

this problem does not occur when the technical course is attached to a research centre in a developing country, like the highly specialized entomological and medical course held for three months each year at Bouake (Ivory Coast), on river blindness control (instruction by ORSTOM)) or tsetse fly clearance (instruction by IEMVT).

It is also becoming increasingly frequent for a research or higher technical education centre to extend its action by organizing courses abroad, usually in developing countries, for the training of technicians. This system is an excellent one, since the course can take advantage, at least in part, of the centre's staff and equipment and its experience regarding the various forms of instruction.

In some cases, the parent body may be located in Europe or the United States of America, a case in point being the Delft Institute of Hydraulics and the Environment (Netherlands), which organizes courses in Malaysia, Indonesia and in various northern countries of South America; or the Enschede International Training Centre (Netherlands), which is to provide courses for photo-interpretation and prospection technicians in Colombia and Malaysia.

To an increasing extent, the instruction centre is also located in a developing country. Thus the rural engineering school at Ouagadougou in Upper Volta, with the support of various bilateral aid schemes, organizes training courses for technicians in that discipline in vaRious French speaking countries of tropical Africa, such as Chad and Niger. Each course lasts from three weeks to one month. Similarly, based on the Kenya training centre for hydrology technicians and with the assistance of teachers from industrialized countries, training courses of at least three months have in some years been held in Tanzania (1963-1964), Uganda (1967 and 1968) and in Nairobi (1969).

For courses where field work or contact with local populations is relatively more important, as for instance in courses on ecology, phytosociology, pedology or hydrology, or courses for agricultural instructors or supervisors or for herdsmen, and so forth, the problem of the site is a different one. The courses can then preferably be organized either in a place of special significance for demonstrations (such as the meeting point of several ecosystems) or where a real research or development operation is taking place. This practice has often been recommended at meetings of the Co-ordinating Council of the international "Man and the Biosphere" (MAB) programme or in discussions on certain themes studies in it, particularly those relating to ecosystems - Themes 1 to 7 (see, for instance, MAB Reports 1, 7, 10, 18, 23, 38 etc.)

This tie-up between the course and an operation of the MAB type is particularly essential where the course concerns certain aspects of the management of renewable natural resources and integrated physical planning. The very complex nature of such a subject calls for highlighting of the multi-disciplinary aspect of the entire operation relating to it. Technicians should know this and be able to "live" it in the same way as the researchers. Participation in a "MAB action" should enable them to be made aware of and become accustomed to this.

In many cases - and this is what we do for the soil prospecting courses organized by ORSTOM (France) - a compromise solution is preferable, since it very often happens that development or research operation sites, MAB or others, are not suitable for housing large numbers of participants (accommodation under canvas, as used in Turkmenistan for such courses, for instance, may in some cases be a solution) nor for providing more theoretical or even academic basic instruction.

Furthermore, in this precise case of the training soil prospectors, the back-up of a soil analysis laboratory is essential, and this is seldom possible on the site of a MAB, IHP, IGCP or similar operation.

In the case of courses organized for researchers, use is also made, of course, of areas where developmental, MAB or other operations are being carried out, and of centres for specialist training, academic in varying degrees - the "Centres of Excellence" provided for in Unesco, FAO, WMO, UNEP and other programmes.

It may then be reasonable to think in terms of at least partially merging the specialized training of the various groups concerned, as is done in some technical colleges such as the Centre National d'Etudes d'Agronomie Tropicale at Nogent-sur-Marne (France).

During the four-month course for the training of soil prospectors, organized by ORSTOM (France), technicians are given specialized theoretical instruction for two months, followed by joint work with third-cycle (post-graduate) students for the preparation and execution (one month) of a field study (soil prospection and mapping), and subsequently for analysis of the samples taken, preparation of the map and writing of the report. If possible, the work is done in two-man teams consisting of one student and one prospector. Experience bears out the merit of such a practice since the student is better able to discover the rules governing the relative distribution of soils and how they tie in with the various formation factors. The technician who is used to the work, having already done it in his country under very different conditions, will be more knowledgeable when it comes to conducting the operation and deciding where and how to make observations, take samples, and so on.

This joint work by two types of trainee has been taken even further in the short courses held for mosquito clearance in the South of France (Montpellier), with Unesco assistance.

<u>Duration</u>

These courses usually last from two to six months, three to four months being the general rule. This is fairly long and it is often difficult to release working technicians for such unbroken periods. On the other hand, it does not seem financially sound to gather instructors and, above all, participants together for a shorter period if the cost of travel is high.

In any case, even for theoretical work, a course has to last a certain minimum length of time to be any use and this is more especially so if it involves field work, which it very often does. This minimum is around three weeks to one month, as adopted for a hydrometrists' course in Mali. In other cases, six weeks may be regarded as an absolute minimum.

One solution put forward is that of courses of about one month to be held twice (or three times) a year or two years running. This seems a good idea in many respects, but in practice such a course needs to be organized for a specific meeting so as to cut the cost of travel for each participant. It is necessary too, for the rules regarding the award of fellowships (local, international organizations, or bilateral assistance) and the right of participants to travel to make the whole thing feasible, which is not always the case at present.

These courses should, of course, be held at a time when the technicians' absence will cause the least disruption in the department concerned. It should nevertheless, where applicable, permit field work at the course location.

<u>Content</u>

It is impossible to provide a general programme for these courses. The most that can be done is to indicate a few trends or even a few rules that, from past experience, seem helpful.

What is taught during these "operations" depends on a great many factors. It hinges on the standard of the participants' basic knowledge which is often very variable from one to another; on the target standard for the end of the course (in hydrology, for instance, technical personnel are often divided into four levels: observers, qualified observers, medium-level technicians and senior technicians; see reports of meetings of the IHP Commission on the Training of Technician); and, at least as much if not more so, on the branch of study.

Difficulties due to the very different academic backgrounds and proficiency levels of the various participants are just as great in post-graduate courses. One year for a couse of this kind on environmental management, there were, side by side, a student with advanced business training, a town planner, an architect, biologists, agronomists, two pedologists, and so on. There was thus the problem of what line to take in explaining pedology and discussing it with them. Fortunately the differences are usually snaller in the case of technicians. In the above instance, we can use the first of the eleven months of instruction to give each participant "a la carte", the basic knowledge he most lacks. Sometimes even, a whole preparatory year is needed. This method is far less applicable to technicians whose courses are very much shorter, especially if some participants require a preliminary language course lasting one or two months. In courses of a very marked multidisciplinary character given in the field, participants are seldom of the same proficiency or training standard. It must be added that this is not essential, but each of them must be able to understand what the others are doing in a joint operation.

The other major variation in content springs from the nature of the work to be done in each branch of study, e.g. laboratory work only, or accompanied by studies elsewhere at stations or trial fields, or prospecting or even contacts and discussions with local inhabitants.

Whatever the level of training and specialization, and whatever the method of instruction adopted, these specialization courses always comprise a theoretical basic knowledge section, a section concerned with general material slanted towards application, and a section devoted to the applications themselves and to practical work.

The proportion of time set aside for each varies a great deal in individual cases. However, from past experience and from the documents in our possession, such as those published by various organizations like Unesco or given to us, in particular by J. Cruette (ORSTOM), Chairman of the Working Group for the Training of Technicians under the International Hydrological Programme, we can give the following examples :

Course for technician laborfatory biologists (University) ; duration of course 4 months :

Academic instruction time : 3 hours a day on average
Time devoted to laboratory work : 4 hours a day on average.

Course for soil chemistry technicians; 5 to 6 months according to the year:

General theoretical instruction - about 50 hours

Applied theoretical instruction - about 100 hours

Field Work - 2 weeks

Laboratory work - rest of the time (at least $\frac{2}{3}$)

Course for soil prospectors - duration 4 months

Theoretical instruction - about 3 weeks

Application-oriented instruction and laboratory and office work (study of serial photographs) - 3 to 4 weeks

Preparation of field work - 2 weeks

Field work (soil mapping) - 1 month

Study of samples taken in the sector and writing of report - 1 month

Specialization course in hydrology - $2\frac{1}{2}$ to 4 months

Standard of course	Qualified observers	Technicians	Senior Technicians
Theoretical or applied instruction	3 weeks	1 month	$1\frac{1}{2}$ months
Laboratory work	3 weeks	$1\frac{1}{2}$ months	$1\frac{1}{2}$ months
Field work	1 month	1 month	3 weeks to 1 month

Theoretical training consists in the first place of basic instruction. For most scientific technicians this needs to cover applied mathematics, statistics and computer science in particular; and all participants also need a grounding in such subjects as physics, chemistry, biology, geology and petrography, but in varying degrees depending on the students involved.

For the extension technician concerned with physical planning and the utilization of natural resources, such training should also cover the principles of geography, ecology, sociology and economics, and the multi-disciplinary aspect of these studies should be very pronounced. For human science technicians, a grounding should still be given in the utilization of natural resources but much more emphasis should be placed on sociology, economics and human geography.

More specialized and more applied instruc tion completes this theoretical part. It is very variable according to the discipline, but it generally includes office work on specific examples, e.g. study of the accuracy of measurements, their interpretation limits, aerial photographs, analysis of surveys - whether agricultural, economic or sociological - and, in many cases, the performance of devices used and the most frequent causes of their failure.

Lastly, practical training, in the laboratory, in the field and in contact with local inhabitants, is of great importance. In the latter two cases it should whenever possible be provided in conjunction with, or as part of actual operations such as those of the major international scientific programmes like MAB, IHP, IGCP, oceanographic research (IOC), pre-development studies (UNDP, UNEP) or real development operations.

Thus the mosquito clearance course held in the Montpellier region, to which earlier reference has been made, is arranged within the operational teams themselves.

It should be made clear to technicians, however, that their participation in such operations, while being real and "life size" and able to provide a useful contribution to those in charge, is simply an exercise. One must avoid the kind of situation, once sitnessed by the writer, where the trainees believe themselves shouldered with actual responsibility that they as yet feel incapable of assuming properly.

All this instruction calls for materials. What is required may be textbooks, of which there are seldom any available. It would therefore be worth publishing some, especially if these courses become increasingly common, as is to be hoped, particularly in developing countries. What must be looked for is not school text-books but works substantially adapted and close to practical activity, making constant reference to actual cases. It often seems preferable, as recommended at meetings of certain committees of MBA, IHP, and WMO, to publish course outlines, each instructor filling them in in his own manner and in the most suitabble way possible having regard to the needs of each group of participants, which may differ widely from one year to another.

During the courses organized by ORSTOM for chemists or prospectors, we provide only sets of duplicated material on which the various types of instruction are based.

Some of those responsible for these courses recommend the most frequent use possible of audio-visual material. This seems highly recommendable, though it is still rare to find such material well adapted to the purpose.

In conclusion, it cannot be too emphatically recommended that the most effective liaison should be established between all those in charge of these courses, at least by a group of disciplines, as is already the practice with some post-graduate courses. This will make it possible to exchange material and hold discussions on actual experience; and this, as regards both technicians and academic specialists, may be the role of organizations like Unesco.