programmes. The emphasis here is not only on cultivating their technical competence, but also on teaching them finer aspects of the subject of training that they can use for teaching later. In this way, two objectives are being served: Participants can become self-sufficient and self-reliant, more precise and dependable in their work, and they are able to teach independently.

As each geographical region of developing countries has its own scientific standards, the train-the-trainers concept is especially suited in regional courses.

Training in physical sciences

In this field, the training courses organized by the Agency closely follow the requirements and needs as demonstrated by the technical co-operation (TC) programme. This is true both for the subjects and for the level of training. Thus, in the last 5 years several courses were prepared and implemented on an advanced level, in support of TC projects which have already reached some degree of maturity.

Parallel to the rapid development of physical sciences in the nuclear field, the topics of training courses have been adjusted to trends. While 15 years ago the Agency's courses emphasized the operation and physics of the research reactors or accelerators, the focus now is on the many facets of such facilities for applied, and sometimes fundamental, research.

The main areas of training courses in physical sciences are nuclear instrumentation (nowadays including the use of small computers); application of nuclear analytical techniques; and production and control of radioisotopes and radiopharmaceuticals.

Because many developing countries are mainly interested in introducing nuclear analytical techniques, a number of successful courses were organized on this topic. Some courses attempted to present participants with a broad view of application of different techniques; others, very specialized courses, dealt only with one technique, applied to a limited number of problems. Although both types of courses have found a good "echo" in developing countries, it seems that the specialized ones yield the best long-term effects.

Two of many: Reflections of a technical officer

What does it take to make a training course work?

by Joze Dolnicar

At the IAEA, two staff members are responsible for a training course: a member of the training course section makes the administrative arrangements, and a technical officer is appointed with responsibility for the course's scientific or technical contents.

Yet it takes more than two to make a training course effective.

Many more elements are needed: A closer look at two courses I have been involved with may help to illustrate the point.

Ghana, 1980

The IAEA's first training course in nuclear analytical techniques showed what can be accomplished with preparation and work. Observations on the proposals for technical co-operation projects submitted to IAEA from African countries every year indicated an increasing interest for applications of nuclear analytical techniques. They also indicated that guidance was needed as to what exact technique — nuclear or other — would be the best one to solve the specific analytical problem at hand. In developing countries, it is difficult to collect information and literature on modern techniques. So the idea was pursued to organize a training course, with the objective of familiarizing participants with several nuclear analytical techniques, their advantages and limitations, and with the preferable field of application. This is how the first IAEA training course on nuclear analytical techniques was born. Later, a number of similar courses were organized, with slight modification of the contents and emphasis.

Sixteen participants from African countries, and one from Jamaica, met in Ghana in July 1980, for this training course. I remember how difficult it was to select them; in the Agency we did not have experience with training courses in this field, and it is very difficult to be objective in the selection, which is based on sometimes scarce information contained in application forms. Selection of participants, by the way, is one of the most critical steps in arranging a training course and is made much easier when authorities in nominating countries are careful in their presentation of the candidates. In 1980, we were lucky: The team that assembled in the Kwabenya Nuclear Research Centre was composed of young and serious African scientists who were eager to get as much as possible from the course and its instructors. They did. Years after the course, I maintained contact with most of them, and several students today are the leaders of nuclear analytical laboratories in their countries. This might not be the only criterion by which to evaluate the course, but it is one of the good ways to judge the value of the training.

Why was this course held in Ghana? Would it have been more profitable if it had been convened in one of the largest research centres in an advanced country where all the

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modern equipment is available? Course graduates, when back in their home countries, would certainly not find the material conditions of an advanced laboratory. They would have to fight with many problems that do not exist (or do not exist any more) in a European laboratory, for example. They would not be able to count on the immediate support or service of manufacturers of nuclear instruments, and they would not easily find the chemicals needed for their work. Therefore, a course in conditions as close to those at home as possible gave the students more useful and specific guidelines than would have been the case if the training had been in a well-established modern and advanced laboratory.

Other aspects of the course stand out: It had a regional character, and it was probably also a psychological advantage to run the course in an environment close to the everyday experience of the participants. The participants were very open; if they did not understand my lecturing, they would interrupt with questions. Consequently, excellent contact was established, which is an important ingredient for a good course. Active and engaged participation of the students is a necessary condition.

Technically, the Ghana course was concerned with neutron activation analysis, X-ray fluorescence, atomic absorption, Moessbauer spectroscopy, solid-state nuclear track detectors, and another dozen techniques — too many for any participant to become proficient in. But the objective of the course was reached: To present a number of nuclear techniques and to evaluate their relative merits for solution of specific problems. Even among scientists in advanced countries, I meet very few who have a broad understanding of many techniques, in addition to the one that they are using.

Even so, in my opinion, the need for these types of courses, which are of a rather general and overview character, is limited. It is good that each country has one or two scientists with broad horizons about the nuclear analytical techniques. But it is more important that there are competent analysts who have mastered a special technique to the extent that their analyses are accurate and reliable. Each country needs many such specialists who are properly trained so that they can produce results. Which brings me to the next training course, an interregional one on the use of neutron generators that was held at the University of Chiang Mai, Thailand, in 1986.

Thailand, 1986

The Agency has helped many laboratories in developing countries to establish a neutron laboratory, and a systematic effort is being made to assist them in proper and efficient use of neutron generators, or small accelerators. With a neutron generator, one can make experimental studies in nuclear, solid-state, or reactor physics, in radiochemistry and in radiation chemistry. The most direct application of a neutron generator is fast neutron activation analysis. In the two previous training courses in this field, organized in Hungary in 1978 and 1982, the Agency's staff realized that it is difficult to train participants in all these different topics. A reactor physicist is seldom interested in activation analysis; whatever he might learn in a multidisciplinary course might be of interest, but will be of little value in his home laboratory. Therefore, it was decided to focus the 1986 course in Thailand entirely on fast neutron activation analysis, and to select in the first place candidates who were connected with an IAEA technical co-operation project.

The course was interregional, and the condition for a participant to be accepted was that he or she be actively working in a neutron generator laboratory. No beginners, but scientists who know something and need to know much more. For such a specialized course, with closely defined entry qualifications, the selection of the participants is easier. In the Chiang Mai course, all circumstances played together to result in an intensive, and highly useful training: the excellent organization of the host, the sincere interest of participants for the topic, the instructors who lived and worked with the participants during and after official hours. It is obvious: the discussions and the laboratory work can be most efficient if the participants and the teachers constitute a good team, both in the seminar room and at the neutron generator. In Chiang Mai the barriers between the instructors and the students disappeared, and I believe that the teachers learned almost as much as the participants. There were several interesting features of the course which should serve as an example for similar ones. Three come quickly to mind:

- Not more than 35% of the time was used for lectures, the rest was laboratory work. The students were asked to report on the results of the experiments, and thus a good part of the 35% in the seminar room was contributed by the students.
- The programme of the course did not include any basic exercises. No laboratory assignments took less than six hours; each was a full-scale experiment with real samples.
- During the last eight days of the five-week course, the students were organized into four groups, each with a special project. The topics for these projects were selected from the most recent fast neutron activation analysis applications. Perhaps the devotion of the participants can best be illustrated by the fact that one of the experiments required the continuous operation of the neutron generator during two nights. No problem: shifts were organized, and the work was successfully completed.

Mr Dolnicar (right) is now involved in a project in Jamaica, where the focus is on a research reactor and its uses. Here, he is shown (photo is based on a colour portrait by German artist Albrecht Dieter Masuhr) with Prof. G.C. Lalor (third from left) and members of his staff at the Centre for Nuclear Sciences of the University of the West Indies in Kingston.

Concluding thoughts

A good course also entails social activities. Participants can learn about the host country and meet its people, and they can start to understand and appreciate lands such as Ghana and Thailand. Among themselves, they can exchange information, about the topic of the course and about their lives and backgrounds. Everyone leaves the course much richer.

These notes and reflections might leave the impression that by now, the Agency's staff has found the complete answer to the question of how to make a good training course. This is far from the truth. There is plenty of room for improvement. But by now, we know at least in which direction to move. I am convinced that the Agency's training courses should become the central forum for development of efficient and excellent training in nuclear fields. The methods designed and tested in these courses can be of great value to nuclear training in universities and technical schools in individual countries.