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Unido Discussion meeting on new materials

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In what follows I will try to outline a few concepts and suggestions based on the experience in the educational and research policy which has been followed in Italy in the field of the Physics of Matter (which includes Biophysics, Condensed Matter, Atomic Molecular and Computational Physics).

I will also outline in some detail the experience of the International center on Theoretical Physics in Trieste, whose experience could be used in different fields.

The reason for the interest in the two above experiences is due to the fact that in most developing countries the major obstacles to use the international advanced scientific know-how is due to the small critical mass of the resident scientific comunity, the lack or dispersion of available facilities and the diffic ult connection with the international scientific environment both in terms of the flow of ideas and of the availability of technical support.

A case of coordination and growth in a research field: Physics of Matter in Italy:

The situation of non nuclear physics in Italy in the 50's was plagued by problems of the type

listed above: only six group-leaders with international training existed and a total of about thirty researchers were available around 1960. Moreover they were dispersed in the nation's universities, from Sicily to the North. Adding to this the availability of even simple instruments or technologies or of servicing was very difficoult outside of major cities.

In the beginning of the 60's, also in view of the growing importance of solid state physics and to balance the overgrowth of nuclear physics which was historically well established, a decision was taken which determined the evolution of the field of Physics of Matter.

The decision emerged out of a spontaneous choice of the researchers, who decided to coordinate themselves on a national basis, whatever the possible sources of support could be, and to choose international competitiveness as a reference frame.

Practically all scientific programs from then on have been discussed on a national basis and presented to financing agencies (both local, national or even international) with the mutual agreement of the community at large, and not accepting imposed choic es.

Further, a rule was established to invite

junior researchers to spend one or two years at foreign advanced laboratories and to bring back new ideas which they had incentives in setting up; this was complemented by holding each year a national school with both national and international teachers, of the duration of two weeks. National schools have later been started also for laboratory technicians and graduate students.

The above decisions, implemented over a period of more than twenty years, have helped to grow a community whose size is now over 1000 and whose interconnection and coordination is very high (as an example around 30% of the scientific papers are co-authored by people of different universities). This helps in overcoming the variety and the small sizes of the local groups operating now on very different subjects in the 30 Universities which presently have activities in the Physics of Matter.

The good interconnection and coordination has also made possible to set up a consortium between all Universities involved and to have one common represantation towards governmental policies.

If the elements of success are analyzed more deeply one can find two major elements; one

educational and one managerial.

The educational element is based on the personal acquaintance and fellowship of the various age groups on a national basis, which has been built through the national schools. Somehow . . the fact of living together for a couple of weeks has been proving more important than the actual teaching or learning activities performed.

The managerial element, which has helped to keep unity over the years in absence of funding authority but, actually, against the dispersive approach of most funding authorities, is the decision of having a very light center of coordination made by two secretarial people and a board of four to ten researchers who are in charge of the flow of information and of organizing the activities related to planning and education.

In the international context the competitivity of this field of research is insured, also in absence of large materials science laboratories, because the national network provides a distributed laboratory of sufficient size, well connected with internationally available large facilities.

How can we translate this experience into a proposal for the support of advanced use of materials in developing Countries?

The starting conditions have a number of points in common: low size (or lack) of existing local facilities and scientific know-how, difficulty to keep updated in the rapidly evolving international context and difficoulty in establishing a sufficiently large mass to cope also with local problems.

What seems to be important is to set up a well connected network of researchers who can readily and effectively exchange ideas and interlink to the existing advanced facilities and use the international level know-how for local problem-solving purposes. The evolution and updating of this network must be based on two elements: an educational one (international schools and seminars) and an organizational one (coordination center, availability of data and access to advanced laboratories).

Useful boundary conditions and additional contributions seem to be the evolution of the awareness, in the scientific world, of the specific advanced approaches required by many local needs and

the availability of either appropriate equipment to be used in small and difficoult to service institutions or of a number of strong centers located in developing countries in a geographical network which could be easily interlinked.

A further important aspect is the connection of the scientific with the techno-economic aspects which should always be taken into account in view of the transfer of scientific know how in new or advanced products.

A case of international educational effort: the ICTP

The educational approach could be managed at an international level using the experience gained in the operation of the Trieste International Center for Theoretical Physics (ICTP).

The ICTP provides an experience which may give a guideline to set up a centre of training and of interaction between scientists and technicians from developing countries among themselves and with qualified senior scientists and technicians from developed countries.

The activity of ICTP is based on a very small resident staff and on the availability of appropriate spaces to host lectures and guest scientists who spend periods ranging from one week to a few months. Junior scientists from developing countries spend at the Institute periods of time connected with specific seminars or schools. More extended stays are arranged through the Institute and spent at selected Institutions within Europe.

By allowing the use of facilities existing at other Institutions the theoretical courses are complemented by practical and experimental activities: more recently a microprocessors laboratory has been set-up and other laboratories are planned. This has evolved from a previous only theoretical activity.

The numbers of junior scientists involved are up to few hundred per year (depending on the availability of fellowships from the countries of origin and from the Trieste Center). The visiting scientists have, as a specific incentive, the possibility of meeting and working with other top scientists from around the world, with relatively limited teaching and no administrative commitments, in a sort of short sabbatical period.

The main result of the Trieste initiative is, apart from the direct educational result obtained through the seminars and workshops, the establishment of a network of personal contacts between junior researchers of different developing countries, which is gradually leading to the establishment of more cooperative contacts.

Adding to this, the contacts which can be established directly between the scientists and several institutions in developed countries bring out the possibility to be continuously connected with the international state of the art in a specific field.

It is estimated that, in the over twenty years of existence, over ten thousand junior researchers have been through ICTP.

In the next year some advanced "hands on" experimental courses will be experimented, for example one will inolve the processing and characterization of the new "High temperature" superconductors.

Conclusion and possible suggestions

The field of science related to the understanding and the use of materials is undergoing a very rapid and almost revolutionary growth, which is difficoult to follow on a wide spectrum for most but the largest and richest countries.

An additional difficoulty is that of applying the knowledge evolving from this fast growing area to apparently "less advanced" (and therefore not academically attractive) problems or materials more common in developing countries.

An integrated approach is needed which addresses the various elements of the problem and which can be followed over a sufficiently long period of time to become self sustaining.

On the basis of previous experiences, and of an analysis of the problems, we could summarize as follows a series of problems related steps to be followed under UNIDO sponsorship or in any other international cooperation:

- Education and individual networking: by international schools of the Trieste type where a interconnected turn-over of both developed

countries experts and developing countries researchers is insured over a sufficient number of cohorts.

- Refreshing and updating encounters between people acting as focal points in several developed and developing countries, to keep communication and mutual cooperation on the basis of coordinated programs.

- Development of an agreed coordination and information center, which acts as a catalizer of cross links between institutions and people improving the effective scientific mass of even small and isolated groups.

- Initiatives aimed at improving the availability and the mastering of advanced materials know-how and characterization equipment: this could be made through hands-on schools, stages at large laboratories or "scientific fairs" connected with the educational initiatives.

- Initiatives evolving international cooperation, e.g. in the field of exchange of standard materials or exercises on characterization

methods.

- Initiatives calling for support of the developing countries effort, e.g. orienting a percentage of already existing projects of developed countries to the development of locally available materials.

To implement the various aspects of the above suggestions it should be possible to find host Countries or Institutions which could take upon themselves the relatively small costs involved in setting up a coordination and an educational infrasctucture which could be achieved only by a better use of existing initiatives (Laboratories, Universities, etc.).