South-South & South-North Collaboration

Present Scenario and Future Prospects

PROCEEDINGS

Commission on Science and Technology for Sustainable Development in the South (COMSATS)

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COMSATS Headquarters
4th Floor, Shahrah-e-Jamhuriat, Sector G-5/2, Islamabad.
Ph: (+92-51) 9214515-7, Fax: (+92-51) 9216539
URL: http://www.comsats.org.pk, Email: comsats@comsats.org.pk

South-South and South-North Collaboration
Present Scenario and Future Prospects

Editors

Dr. Hameed A. Khan
Prof. Dr. M. M. Qurashi
Engr. Tajammul Hussain
Mr. Irfan Hayee

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Website: www.comsats.org.pk
Ph: (+92-51) 9214515-7, (+92-51) 9204892
Fax: (+92-51) 9216539

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FOREWORD

There is an emerging consensus on the significant role of science, technology, and innovation in economic growth and alleviation of poverty. Limited S&T related capacity in the developing countries hinders adoption, creation and dissemination of new knowledge and tools to advance developmental agendas. The gap between Science and Technology is, therefore, linked to the developmental gap in the third-world. Increasing investment in building S&T capacity and linkages at institutional, regional and international levels are the focal areas for decision-makers, wishing to narrow the ever-widening gap between industrialized and developing countries.

South-South Cooperation, a useful strategy to build S&T capacity, is not enough on its own. Today more than 90% of global investment in Research and Development (R&D) and innovation occur in industrialized countries. The linkages with the developed world are, therefore, considered critical to build and sustain a critical mass of knowledge, institutions, and policies for S&T capacity-building. At present, international assistance and collaboration has to be exploited fully and linkages established to make S&T capacity- building institutionally and financially sustainable, and more relevant to growth and developmental goals. Ample opportunities exist in this area that require commitment and collective efforts to materialize, for the benefit of all stakeholders, in the South and the North.

Analyzing the present scenario of South-South and South-North Collaboration, it has been observed that there is a realization to adopt new directions for technical cooperation among developing and developed countries. There have been attempts for technical cooperation among developing countries to work with the developed countries, in order for them to play a more active role, in both promoting and supporting collaborative activities. As a result, a large number of developing countries would be benefited.

The COMSTAS' Meeting on *South-South and South-North Collaboration in Science and Technology: Present Scenario and Future Prospects*, which was organized in collaboration with the Third World Academy of Sciences (TWAS), Trieste, and the Islamic Educational, Scientific, and Cultural Organization (ISESCO), Rabat, was a follow up on the initiative of encouraging collaboration in the field of S&T. Being a facilitator organization, our role is to build and encourage South-South partnership and strengthen linkages between the South and the North. This Meeting also served as a platform to exchange ideas about the identified priority areas, where we need to develop strong and enduring linkages between the developing and the developed countries.

There were a total of 23 speakers in the Meeting who made presentations in 6 Technical Sessions, of which 11 were foreign experts, representing countries like Italy, Morocco, Jordan, Switzerland, Senegal, Germany, Sudan, Nigeria and Turkey. Other participants included eminent scientists, heads of S&T institutions, scholars and students from various academic and research institutions. This book of proceedings comprise some selected papers and the recommendations that emerged during the conference.

In the end, I would like to express my gratitude to both Prof. Dr. M. H. A. Hassan, Executive Director Third World Academy of Sciences (Italy), and Dr. Faiq Billal, the Director Science, ISESCO (Morocco), for their ardent cooperation and support for organizing this conference. My earnest praise also for Dr. M.M. Qurashi, Ms. Uzma Ikram, Ms. Noshin Masud, Mr. Irfan Hayee and Mr. Imran Chaudhry from COMSATS, whose devotion made publication of the proceedings of this conference possible.

Dr. Hameed Ahmed Khan, H.I., S.I.
(Executive Director, COMSATS)

CERN, A WORKING EXAMPLE OF GLOBAL SCIENTIFIC COLLABORATION

Jurgen Schukraft
CERN, 1211 Geneva 23, Switzerland

ABSTRACT

The topic of this conference is 'South-South and South-North Collaboration in Science and Technology', which is being addressed in this contribution, in the context of basic research in high-energy physics (HEP). The question, whether developing countries can or should invest scarce resources in big science, is not covered. HEP may be less expensive than one might fear, but cheap it is not; so priorities have to be set and these may indeed differ from country to country. The scope of this article is not to argue, one way or the other, but rather to give an indication and practical examples of both the requirements and the opportunities for scientific collaboration with CERN.

I. CERN

The European Organization for Nuclear Research (CERN) is an inter-governmental organization (comprising 20 member states: Austria, Belgium, Bulgaria, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Italy, the Netherlands, Norway, Poland, Portugal, Slovak Republic, Spain, Sweden, Switzerland and the United Kingdom), located in Geneva, Switzerland, but straddling the French-Swiss border. It is the world's largest laboratory for fundamental research in particle-physics, with a support-staff of nearly 2500 and an yearly budget of ~ 1 billion CHF. Its mission is to provide facilities and infrastructure for carrying out experiments in basic research, primarily high-energy physics (HEP) and, to a smaller extent, also in the nuclear physics, astro-particle physics and theory, to answer fundamental questions, concerning structure and composition of matter ('What is the Universe made of') and forces ('What keeps it together').

CERN was founded in 1954 with the help of UNESCO with the prime aim to pool European resources for basic research, which would be beyond the means of individual countries. Less explicit, but at least of equal importance, were economical and political considerations in the aftermath of Word War II: to create a center of excellence, which would make and keep Europe competitive in leading-edge science and technology; stop the brain-drain of its most educated and creative citizens and rebuilt trust, collaboration and coherence between the nations of Europe.

Celebrating this year its 50th anniversary, CERN is considered a success almost beyond the most optimistic expectations. In research, it is today the foremost center for high-energy physics in the world, with several Nobel Prize winning results; it has not only stopped but reversed the brain-drain (more than half of the world's particle-

physicists participate in its programs). In terms of economical benefits, it is a vibrant incubator for R&D and technology-transfer, whose impact is not only limited to Europe (the Word Wide Web was invented at CERN in the 90's as a communication-tool for scientists collaborating across the world). On the political level, CERN is a most successful and effective example of international collaboration, which served as a blueprint for other research-organizations (ESA, EMBL, ESRF). During the cold war, scientific collaboration between West and East could be established via CERN, which kept open one of the very few communication channels between citizens across the iron curtain.

Given its excellent record in the past and the present, what does the future hold for CERN? On the research frontier, CERN is currently building the most powerful accelerator ever, the Large-Hadron Collider LHC. It will come into operation in 2007 and run for at least 10 – 15 years, keeping research at CERN at the cutting edge, well into the next decade. CERN has since long outgrown the N (for Nuclear) in its name by going to ever higher energies, and now it has effectively left behind the E (for European) with the LHC machine and its four large experiments (named ALICE, ATLAS, CMS and LHCb). Both the machine and, even more so, the detectors are designed, constructed and exploited by a global, world-wide Collaboration of scientists and engineers, which by now encompasses about 60 countries, including very significant participation from the 'South' and 'East'. Some 2000 physicists from non-member states today participate in the CERN program, corresponding to about 1/3 of all CERN users. While CERN is not likely to change its name or its administrative structure as a European organization, effectively it has reached out to the world, both to the developed and developing countries. This not only brings with it new opportunities, but also new challenges.

II. CERN USERS: EXPERIMENTS & COLLABORATIONS

CERN, as a facility, provides the large scientific tools and infrastructure needed to carry out experiments in high-energy physics to its users. These users are based in their respective home countries in university or research labs (CERN employs only a very small number of researchers, and most of them for a limited duration only). Research is both initiated and executed by these users, after review and ranking by scientific peer committees. The users organize themselves around individual experiments and collaborations, which are groups of scientists, ranging in size from below 10 to almost 2000 people. These collaborations propose, design, build and operate their experiment and all members of the collaboration have free and unfettered access to its data and results, which in the end are made public in the scientific literature. Funding for both construction and operation of the experiment is provided by national funding agencies, in general, directly to the individual participating groups. Otherwise the collaborations are rather administratively and scientifically independent and self-governing, i.e. they decide who can take part, who does what.

The four experiments at the LHC are amongst the most complex and challenging

technical endeavors ever undertaken, requiring many years of R&D to push technology well beyond existing limits, and many years of construction by literally thousand of experts (the smallest experiment includes more than 500 people, the largest almost 2000 !). Almost 20 years would have passed from first ideas to final realization, when the experiments will actually start taking data in 2007. Technologies employed are all state-of-the-art (and sometimes just beyond) in a number of areas: from mechanics and engineering (micrometer precision in objects of tens of meters, lightweight but stable structures), advanced materials in a hostile environment (radiation and chemical), sensor technology (from micrometer sized silicon sensors to hundreds of tons of heavy metals), micro-electronics (custom designed VLSI circuits and electronic boards) to information-technology (virtual communication & document sharing, large scale distributed computing with the GRID). All these technologies have obvious potential for technology-transfer and industrial spin-off.

A practical example of how such a collaboration works, and in particular, how the nations of the South can participate in this frontier research, is illustrated by the 'midsize' ALICE experiment. It consists of about 1,000 members (2/3 from CERN member-states, 1/3 from outside) from over 80 institutions in nearly 30 different countries. The construction cost is about 150M CHF. While Italy is the largest country in ALICE (with 160 scientists from 12 institutions), contributing well over 20% of the construction-funding, very significant participation and contributions are made by 'countries of the South', ranging from India (55 people, 7 institutes, 3M CHF) over China, Mexico, and South Africa to Cuba (1 Institute, 4 scientists, 0.045M CHF). India, which has been a member of ALICE since 1992 and contributes both scientifically and financially at the level of a number of CERN member-states in ALICE, has slowly but very steadily built up an international scientific reputation in the field explored by the experiment; it contributes with original research and state-of-the-art equipment (from sophisticated sensor technology to VLSI electronics) developed and manufactured, using indigenous talent and industry. On the other hand, South Africa and Cuba have been members since 2003 only; they have started on a more modest scale (with 1-2 staff and many students) and are involved, for the time being, in less capital intense activities, like computing and physics.

III. REQUIREMENTS AND OPPORTUNITIES

The example of ALICE shows that participation in research, even on the scale of an LHC experiment, can come over a large range of topics and scales. Experiments expect from their collaborators that they are motivated by scientific interest (exceptionally by technology for 'associated institutes'), that they are capable of supporting their activity largely by their own means and funding, and that they are actively participating by contribution talent and resources within their capabilities. Sheer size matters less, and a new activity usually starts on a small scale, sometimes as small as one single group with a few staff and a number of students. A minimum infrastructure at the home-institute has to be in place (or has to be created), most importantly for good communication (computers and networking). Indigenous

hardware contributions will, in general, need access to workshops and/or local industry. Funding is required both locally (salaries, infrastructure, international travel) and for investment in the experiment. The latter will differ from case to case but can start as low as 10,000 CHF per year in justified cases. A strong backing and support by the relevant national authorities and funding agencies is very important. International collaboration on this scale is governed by a Memorandum of Understanding, which is in general signed at the national level; while not legally binding it implies both benefits and commitments over a long-term scale.

The most important motivation (and benefit) for participating in an LHC experiment for the individual researchers is (or should be) scientific: To be a participant rather than a spectator in one of the most exciting and fundamental endeavors undertaken by the inquisitive human-mind. This may however not be sufficient reason to get the necessary resources. While it is not within the scope of this contribution to dwell in any depth on the various other benefits and opportunities for developing nations, participating in frontier HEP experiments, a few shall be listed briefly. High amongst them are the ones mentioned previously as one of the reasons for creating CERN in the first place. Even if the actual experiments are carried out outside national borders, participation will provide ample research-activity and infrastructure based at home, which is crucial to develop and keep a resident scientific elite; allow the 'good' to become 'excellent' (and internationally known), stop the brain-drain and maybe attract back some emigrants. Training and education of students is one of the main missions of CERN, with over 1,000 coming every year, for typical periods of several months up to 3 years. They receive 'hands-on' training in a variety of technologies in an international environment with clear objectives and deliverables, strict selection criteria and in general, return at the end, to the institute of origin. The large LHC collaborations are also an excellent place for 'international networking', as they allow (and in fact require) a multitude of personal and institutional contact and collaboration all over the world.

Technology-transfer, spin-off and industrial return are subjects, which have been extensively discussed and studied; they are recognized as a major benefit for most companies dealing with CERN and its experiments. Of relevance, in particular for developing countries, is the direct involvement of nationals and their incentive to involve local industry, for either convenience or price reasons. The often unique and 'custom tailored' specifications open a window of opportunity for small or midsized specialized industry, even if not internationally known. To quote again some specific examples, ALICE has, with the help of national physicists, found excellent and very competitive providers of tungsten in China, crystals in Russia, power cables in India, micro-cables in the Ukraine and soon.

IV. CONCLUSION

High-Energy Physics (HEP), as carried out at CERN, is science in the 'top league', at the cutting edge of science and technology. Participation requires talent, resources,

and a long- term commitment. HEP is BIG science, in terms of scale, but also in terms of importance and scope. Nevertheless, participation on a smaller scale is possible and even welcome. HEP is international and collaborative science and being part of one experiment means being connected to much of the world. CERN and its experiments are open to the scientists of the world, offering access to a unique research infrastructure and participation in multimillion dollar experiments at the absolute forefront of science and technology. HEP is a truly global venture, in both spirit and in execution if governments are willing to support it, scientists can make it work.

- An attractive option for the business community especially in the pharmaceutical (BT) and media industries (Cultural Technology) and (IT). Turkey's experience in facilitating private sector ownership and operation of satellite television channels is a case in point for Cultural Technology;
- CT and IT industries can create jobs and IT exports can be a source of foreign currencies;
- IT assimilation can lead to Brain Gain and contribute to Basic Science capacity;
- Catching the eye of the decision-maker in the context of TT will lead to more resources diverted to Basic Sciences;
- TTs, especially IT and BT, require limited start-up absorption capacity…

8.3 Biotechnology

Several firms and public institutions in the world are offering products and services that are the result of the new technology; Biotechnology. In the USA alone, there are 300 public (biotechnology-based) companies with a market capitalization of $353 billion and an annual turnover of $22 billion. Moreover, the growth of biotechnology-based industry is not restricted to developed countries. Developing countries such as Cuba, Brazil, India, and China have been pretty quick to identify the potential benefits of the technology; and own it too [24]. Singapore and Malaysia seem to sense Biotechnology's potential and are moving in at a fast rate.

Modern Biotechnology has already made significant contribution to the health and agriculture sector. Development of several drugs, various pharmaceuticals, and vaccines using recombinant DNA technology has given rise to multi billion-dollar industry (see Azad et al. [12]) In addition, PCR-based diagnostics has also emerged as an important component of health care.

BT can make an important contribution to our national priorities, particularly in the area of human health (including HIV/AIDS, malaria, Hepatitis, reproductive health, maternal and child health, typhoid and TB), besides food security and environment. In pursuit of these priorities, countries of the South are fortunate to be guided by the experiences of other countries.

Countries of the South should enable their organizations to anticipate and respond to current and future opportunities and challenges of Biotechnology. Some guidelines of a possible Biotechnology strategy that could be adopted by countries of the South have been discussed in detail by Shinwari et al. (2003) [25].

Biotechnology and genetic engineering carry great potential for economic and social development in the South. Of all emerging technologies, biotechnology has three main advantages:

- Low cost compared with IT, micro-technologies, and so forth;
- Availability of trainable manpower;

- Adaptability to division of labour even in a narrow field - not just between workers in different laboratories, but also between workers in different countries - resulting in a more economically viable system.

Of the distinct advantages of venturing into BT R&D is the likelihood of identifying a commercially viable field for which no more than a handful of researchers and technicians, would need to be trained in fewer than a dozen specialised techniques.

8.4 Information-Technology

Information and Communications Technologies (ICTs) have been expanding at a staggering rate over the last 10 years in our newly globalized world. It is an area where a divide has been developing - and already exists - between advanced and developing countries (an international digital divide) over an above, other existing "development" divides.

Reacting promptly to the IT tidal wave (bridging digital divides) can help in narrowing social and economic inequalities and offer new hope to local wealth creation. So it can be a major factor for speeding up socio-economic development as a whole as well as in a number of specific areas including commerce, governance, health, education (identified together with environment as development imperatives at the UN Millennium Summit) as well as science and technology [26].

Addressing national and international digital divides, is a multifaceted and multi-layered task, the foundation for which must be defining clear and achievable objectives, at the national and regional levels. Governments, private sector and science development organisations have parallel yet overlapping roles to fulfil in order to help developing countries to 'leap frog' into a position whereby they would reap maxim benefit from the current phase of the ICT revolution.

It is important to emphasise that by addressing the digital divide, we are not marginalizing other divides, but rather appraising how riding the ICT wave can lead to more efficient production, boost trade, revitalise governance and better deliver social services including health information. It can therefore, lead to a general improvement in the welfare of society and narrowing some of the other divides.

In countries where citizens still struggle for reliable sources of food, water, medical care and educational opportunity, bridging the digital divide may seem like a lofty goal. Information and communication technologies will never be the magic wand that eliminates the need for sound developmental investments, but they can serve as an *enabler*, enabling governments and individual citizens to improve the quality of life of their people and humanity.

8.5 Cultural Technology

One aspect of Cultural Technology is the use of satellite television to bridge cultural divides within and among countries. Indeed, satellite television in countries such as Turkey, China, India, Egypt, Pakistan and Indonesia has become a medium as well as being a powerful educational tool, with hundreds of channels featuring educational output that cater for school as well as for university students.

8.6 The Second Bottom Line: Give TTs a Chance

Transformational Technologies are a feature of the close of the twentieth century and dawn of the twenty-first. They are inextricably linked to globalisation via a complex set of relationships. Of the various Transformational Technologies, Biotechnology and Information Technology may provide countries of the South with the opportunity to jump-start their development efforts. Cultural Technology can be a powerful educational tool.

8.7 9/11: An Afterthought

There can be no doubt that North-South and South-South collaboration suffered a set-back after the events of 9/11.

"Some might argue that the war on poverty must take a backseat until the war on terrorism has been won. But they would be wrong. The need to eradicate poverty does not compete with the need to make the world more secure. On the contrary, eradicating poverty should contribute to a safer world…."

UNDP, Human Development Report 2003, p.1 [27].

9. CONCLUSION

This paper does not primarily address scientists or researchers. Rather, it is aimed at the decision-makers and politicians in countries of both the South and the North. It aims to reiterate the value of science as a tool for development and advancement. It presents political decision-makers in both the North and the South with an overview of what problems the world is likely to face in the 21st century. It promulgates the adoption of the Millennium Development Goals as yardsticks for development.

The adoption of Transformational Technologies, especially Biotechnology, Information Technology, and Cultural Technology, may help countries of the South speed up their development efforts and realise some of their developmental objectives as outlined in the Millennium Development Goals.

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