A Secure Internet to Promote World-class Science in Developing Countries

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My comments derive from the confluence of multiple perspectives:

1) Director of a national graduate school dedicated to international outreach,
2) Former manager of an organization developing technologies that underlie major instruments of scientific inquiry,
3) Editor-in-chief of a prestigious international journal devoted to scientific instruments and methods,
4) Active research faculty at a premier research university,
5) Firm believer that talent and inventiveness in science and technology know no boundaries.

Egypt

On June 2, 2011 Nobel laureate Ahmed Zewail told a cheering crowd in Cairo's Tahrir Square that Egypt's interim government had approved his dream for a "Cairo Caltech"[1] costing 2 B$. Would such a large sum be better spent improving the general infrastructure of science education in Egypt?

In the past three years in my introductory accelerator physics course I have provided scholarships to and taught a dozen Egyptian students motivated by an Egyptian initiative to create a new accelerator center. These students were bright, motivated, and hard-working but handicapped by deficiencies in their preparation at Egyptian universities. What kind of government investment would serve them best?

Jordan

A decade ago the Jordanian government gave funds for a building to house the first light source in the Middle East, SESAME. The original plan for SESAME was to install the

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old BESSY-1 storage ring. Germany pledged that equipment to the project. The original plan was scrapped in favor of building a ring with new equipment that would have a longer lifetime as well as some growth potential. Implementation of the storage ring has struggled, although it has brought together funding from countries with otherwise strong animosities toward each other, such as Israel and Iran. SESAME has enthusiastic support from international scientific bodies such as IUPAP and CERN. Will this project really come to fruition? When it will it be sufficient to produce world-class science? Will there be sufficient highly trained users from the Middle East to make the best use of the facility?

Turkey

The nascent Turkish Accelerator Center (TAC) aspires to build a medical accelerator a light source and even a spallation neutron source. Yet there is almost no native expertise in accelerators, although there are some first rate developers of nuclear instrumentation. Is the TAC merely wishful thinking? or is it squandering precious resources?

Questions

Do Jordan, Turkey, Armenia, Poland, Mexico, South Africa, Thailand – the list goes on – need a synchrotron?

Is the suggestion by the DG of a major northern European lab to power new mega-science in Europe with solar energy from North Africa an example of a new. sustainable colonialism? Do Libya, Tunisia, and Algeria get to control their own beamlines built at no added cost to those governments? When would a Libyan or Algerian get to be the DG in a northern European lab?

Opportunity

The rapid development of information technologies offers new opportunities to change the paradigm of the development science and technology in developing countries by leveraging high impact potential, "university-scale" technologies such as lasers, high quality ion beams, and neutron sources. From a strategic point of view the potential is to avoid the rapid divergence of scientific capabilities (especially physical sciences) between North and South. The most insidious aspect of this divergence is the loss of young scientific talent, who seek the opportunity to contribute at the highest level to the modern scientific enterprise. An incentive for the North (U. S. Europe and Japan) to promote such opportunities would be to make available analogous opportunities for major universities in the North.

What we see in the U.S., Europe and Japan is a continuing thrust to build ever-larger scientific facilities at the one-to-twenty billion-dollar scale. Be they for neutron science, studies of astrophysical matter, fusion energy R&D, or ultra-fast dynamical processes, these facilities are already unique on a regional scale. In the U. S. such facilities are the exemplars (and even the precipitators) of the decline of the infrastructure of the physical sciences at major universities and subsequent accumulation of facilities in the Dept. of Energy's national laboratories. At the extreme, for high energy physics, the scale of future facilities has become so large (30 – 100 km) that globally only one such scientific tool can be built. It is no embarrassment for developing countries to "buy a share" in a facility located elsewhere. Even the US can no longer afford a machine for first-class high energy physics. International science without borders is the only credible and viable approach.

But how is sharing done with the developing world at the human scale? How do developing countries ensure that they not irreversibly left decades behind? The approach I suggest is twofold: First, identify opportunities to create university-scale facilities with the potential to yield roughly 20% to 50% of the science at a hundredth to a thousandth the cost. This approach is essential to develop the native, human infrastructure of science. To this end small, powerful neutron tubes such as those that were developed at Berkeley or commercial table-top lasers to make GeV electron beams become more than scientific tools for "small science" condensed matter physics and chemistry. Small facilities for accelerator mass spectrometry would support many users from a wide range of disciplines. At the few million Euro scale they enable cutting edge science in research arenas that would otherwise be the exclusive domain of the North.

Still, just as the North can afford only one few-billion dollar facility, small developing countries may only be able to afford one or two few-million-dollar facilities, the most constraining factor being the scarce human capital required.

Here is the entry point for information technologies – to develop scientific human capital and to share in the international scientific enterprise in a coherent fashion. Major universities and scientific laboratories throughout the world are creating tools such as nano-positioning robotics, computational grids, and Internet co-laboratory software and hardware that will make virtual laboratories a vibrant reality. Doing so means much more than promoting active collaboration which is enabled and greatly facilitated by digital telecommunication. It means more than the sharing and analysis of scientific data on a real time basis. It means continuing telepresence in the monitoring, control and acquisition of these data. It means the secure multicast of data to assure that precious information assets are not lost either by accident or malicious design. It means the real-time sharing of the visualization of data as they are taken.

Virtual laboratories must succeed in these tasks while assuring the centralized security and safety of scarce resources at the same level that we demand in the US, Japan and Europe. What are the basic elements of a security culture[2] for nascent national co-laboratories?

Security Program

Security Organization – to build and maintains the IT security organization design. This includes composition, reporting structures, roles and responsibilities, skills, experience, and resource management.

Security Audits - activities to ensure that, periodically, all relevant objects are to be assessed against security requirements

Security Management

Ownership of information - establishes an overview of assets and the security properties of these assets.

Operations and monitoring- processes and procedures to manage & monitor security architecture, as well as incident response to ensure continuous compliance to security requirements.

Security Policy

Security Policies – formal, prescriptive directives, policies, standards, guidelines, and procedures for implementing security requirements throughout the organization.

Security Agreements - formal compliance agreements with parties to ensure secure

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[2] This listing of characteristics is adapted from a talk at the Remote Operations Workshop Shelter Island, 17 September 2002 By Hans Frese, DESY Hamburg

operations.

User Management

Access security - activities to implement user privileges and duties within the IT infrastructure.

Personnel related security - activities that establish and maintain awareness and education of staff.

Information Asset Security

System and network management - activities that embed security in the IT management processes.

System development & maintenance - activities that integrate secure design principles and implement functionality into information systems.

Protection and continuity

Physical security & security of environment –activities to ensure the mitigation of physical threats to the IT facilities**.**

Contingency Planning - necessary plans and procedures to enable recovery from major disruptions.

As virtual laboratories reach across national boundaries, all parties must come to agreement about legal norms that govern exchange and control of information and information technology. Once a country's network of scientific activity and scientist-to-scientist links are established, buying into major facilities at 2 to 4 million Euros per year makes sense.

World-class science is international and requires means for scientists from developing countries to come together with those from more privileged countries to study together, work together, and discuss together. Italy has been at the forefront in outreach here at Erice and at the ICTP in Trieste. Information technology can now help expand these efforts of scientific outreach and development a hundredfold:

EVO – The worldwide collaboration network hosted at Caltech

Internet simulcast of major scientific conferences

The Citizen Cyberscience Center at CERN

Co-laboratory tools across time zones for collaborations that never sleep

Web-based study tools

With such tools in hand, developing countries will be fully prepared to ask for substantial participation in the global enterprises that the U.S., Europe and Japan envision to create single large facilities which are actively controlled in an integrated manner from multiple laboratories around the world. In 10 to 20 years they can aspire to full partnership.

That is the promise. What is needed is the commitment and perseverance year after year:

1) From developing countries to identify and nurture the very best developing scientists and to make the investment in and the commitment to these scientists that will keep them in their countries;
2) From the North the willingness to share high leverage, cutting edge technologies;
3) For both to break down the sociological barriers to truly nationwide and global laboratories through telepresence.
4) For everyone to work toward a culture of global internet security reinforced by a harmonious legal framework.

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