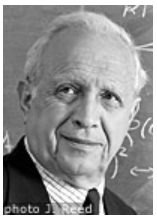
International Newsletter on Physics Education

International Commission on Physics Education • International Union of Pure and Applied Physics

Number 50 October 2005

The 2005 Nobel Prize in Physics

October 4, 2005. The Royal Swedish Academy of Sciences has decided to award the Nobel Prize in Physics for 2005 with one half to –



Roy J. Glauber

Harvard University, Cambridge, MA, USA

"*for his contribution to the quantum theory of optical coherence*"

and one half jointly to

John L. Hall

JILA, University of Colorado and National Institute of Standards and Technology, Boulder, CO, USA and

Theodor W. Hänsch

Max-Planck-Institut für Quantenoptik, Garching and Ludwig-Maximilians-Universität, Munich, Germany

"*for their contributions to the development of laser-based precision spectroscopy, including the optical frequency comb technique*".

New light on modern optics

As long as humans have populated the Earth, we have been fascinated by optical phenomena and gradually unravelled the nature of light. This year's Nobel Prize in Physics is awarded to three scientists in the field of optics. **Roy Glauber** is awarded half of the Prize for his

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GIREP 2006 Conference

GIREP holds conferences every two years. The forthcoming conference will be held in Amsterdam from **August 20 to August 25 2006**.

The main topic of the **GIREP 2006** conference will be **Modeling in Physics and Physics Education**. Plenary contributions will address the different aspects of this topic and highlight the important developments in Physics itself. The conference

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In this issue

India's President Delivers Inaugural Address in the ICPE Conference

The *World View on Physics Education 2005*, a conference sponsored by the International Commission on Physics Education, held in India was an important event to remember on 22 August 2005. About 300 participants from 30 countries felt the presence of India's President Dr. A.P.J. Abdul Kalam who delivered the inaugural address. Nobel Laureate, Professor Horst L. Stormer of Columbian University and Lucent

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ICPE Chair's Corner

After the very successful Conference in New Delhi, so admirably planned and organized by our member Pratibha Jolly, it is time for me to sum up the three years gone during our present mandate period. It seems that our Commission has managed to accomplish more or less what we hoped for three years ago, in terms of annual meetings, support of international conferences on physics education, publications and contacts with other organizations with the same aims.

To begin with the most recent event, the International Conference in New Delhi, it had the title World View on Physics Education in 2005. Focusing on Change. It was remarkable to have the President of India not only present in the inaugural ceremony but also deliver an enthusiastic talk on the importance of attracting the interest of young people for science in general and for physics in particular. The conference program was composed of plenary lectures, both on physics education and on physics in general, all of high standard. In addition there were Parallel sessions and Poster sessions, also of high quality. A group of Japanese high school teachers gave examples of how to teach physics by spectacular demonstrations, comprising rockets, model tornados and a range of linear motors.

One of the most important events during this period has been the appearance of the book Physics Now, edited by our ICPE member Jon Ogborn. It is an update of the book Physics 2000 which appeared some six years ago. It has already aroused considerable interest and is now available for downloading from the ICPE home page. During the 2005 ICPE annual meeting we also decided to produce a second, complimentary volume to the book Connecting Research in Physics Education with Physics Teacher Education. Matilde Vicentini agreed to lead the work of collecting material for the new volume.

My report for the years 2003-2005 will be available on our home page. I refer to that for further details of ICPE activities during this time. Let me just mention the fact that we are proud to have found two new ICPE medalists, both outstanding in their work to promote physics education, namely Laurence Viennot from France in 2004 and Svein Sjoberg from Norway in 2005.

It now remains for me to express my sincere thanks to members and associate members of ICPE for your contributions and for your willingness to work for our common cause. For those staying in the Commission I wish success for the next three years, together with the new members to be elected during the IUPAP General Assembly in Cape Town. It would indeed be nice to see all of you at some future conference on physics education, maybe at the one in Tokyo next year.

Gunnar Tibell

GIREP... *from page 1*

program will include parallel paper presentations on different topics, poster sessions, and workgroups.

The GIREP 2006 Committee aims at a broad audience for the conference. We want to bring together participants from many countries and backgrounds. Please send the address of this website to people that might be interested.

The local organisation will be taken care of by the AMSTEL Institute of the Faculty of Science, Universiteit van Amsterdam.

Source: http://www.girep2006.nl

INDIA'S... *from page 1*

Technologies, also delivered the keynote address for the conference.

In his speech, President Kalam stressed the importance of science and technology in the country's development. He even shared his experience with students who asked him about questions and queries on science and philosophy, gravity and space. He also talked about Albert Einstein - his life, characteristics as a great physicist and valuable discoveries. Lastly, he reminisced on his student's days and his admiration for his science professor who he considered a visionary teacher and fantastic development engineer of aeronautical systems.

(*for complete speech of President Kalam, go to page 8*)

NOBEL... *from page 1*

theoretical description of the behaviour of light particles. **John Hall** and **Theodor Hänsch** share the other half of the Prize for their development of laser-based precision spectroscopy, that is, the determination of the colour of the light of atoms and molecules with extreme precision.

Just like radio waves, light is a form of electromagnetic radiation. Maxwell described this in the 1850s. His theory has been utilised in modern communication technology based on transmitters and receivers: mobile telephones, television and radio. If a receiver or a detector is to register light, it must be able to absorb the radiation energy and forward the signal. This energy occurs in packets called quanta and a hundred years ago Einstein was able to show how the absorption of a quantum (a photon) leads to the release of a photoelectron. It is these indirect photoelectrons that are registered in the apparatuses when photons are absorbed.

Thus light exhibits a double nature – it can be considered both as waves and as a stream of particles. Roy Glauber has established the basis of Quantum Optics, in which quantum theory encompasses the field of optics. He could explain the fundamental differences between hot sources of light such as light bulbs, with a mixture of frequencies and phases, and lasers which give a specific frequency and phase.

The important contributions by John Hall and Theodor Hänsch have made it possible to measure frequencies with an accuracy of fifteen digits. Lasers with extremely sharp colours can now be constructed and with the frequency comb technique precise readings can be made of light of all colours. This technique makes it possible to carry out studies of, for example, the stability of the constants of nature over time and to develop extremely accurate clocks and improved GPS technology.

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Roy J. Glauber, born 1925 (80 years) in New York, NY, USA (US citizen). PhD in physics in 1949 from Harvard University, Cambridge, MA, USA. Mallinckrodt Professor of Physics at Harvard University.

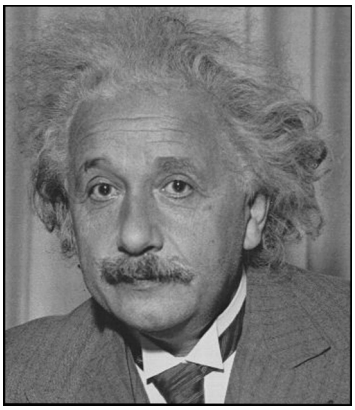
John L. Hall, born 1934 (71 years) in Denver, CO, USA (US citizen). PhD in physics in 1961 from Carnegie Institute of Technology, Pittsburgh, PA, USA. Senior Scientist at the National Institute of Standards and Technology and Fellow, JILA, University of Colorado, Boulder, CO, USA.

Theodor W. Hänsch, born 1941 (63 years) in Heidelberg, Germany (German citizen). PhD in physics in 1969 from University of Heidelberg. Director, Max-Planck-Institut für Quantenoptik, Garching and Professor of Physics at the Ludwig-Maximilians-Universität, Munich, Germany.

Source: http://nobelprize.org/physics/laureates/2005/press.html

Facts of Einstein's Life

The International Year of Physics celebrates 100 years of theoretical contributions of Albert Einstein to physics.



(Source: http://www.physics.uiowa.edu/adventure/spring_2005/einstein/einstein.jpg)

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Some people might get an impression that Einstein was purely a theoretician. He also tried experimenting. In fact, he acquired some patents in his name for various devices such as electromagnetic pump, hearing aid and gyrocompass. He even tried enhancing the operation of refrigerator by specially designing a hermetically sealed cooling system wherein the refrigerant circulated under the action of heat and gravity without the use of compressor.[1]

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During the last phase of his life, Einstein spent much of his time trying to promote peace in the world. He proposed the idea of a sort of world government, which could ensure lasting peace and harmony in the world, but was also considered by many to be very idealistic and not at all practical.[2]

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'Bear in mind that the wonderful things you learn in your schools are the works of many generations, produced by the enthusiastic efforts and infinite labor in every country of the world…' – Einstein [3]

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[1]Mande, C. and Sapre, V.B. (2005). Life and Work of Albert Einstein, Physics Education, 22:1:7.
[2]Mande, C. and Sapre, V.B. (2005). Life and Work of Albert Einstein, Physics Education, 22:1:15.
[3]Mande, C. and Sapre, V.B. (2005). Life and Work of Albert Einstein, Physics Education, 22:1:15-16.

SUSTAINABLE DEVELOPMENT IN PHYSICS TEACHER EDUCATION

By
Dr. Vivien M. Talisayon
University of the Philippines

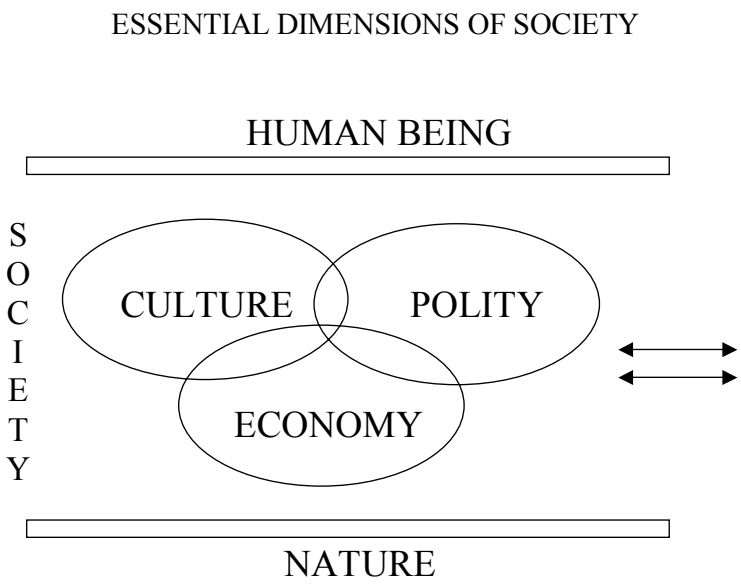
Introduction

The 1987 Report of the World Commission on Environment and Development (PCSD, 1997)) defined sustainable development as "meeting the needs of the present generation without compromising the ability of future generations to meet their own needs". The Report was the basis for Agenda 21, a global agenda for sustainable development that was adopted in the 1992 Earth Summit in Rio de Janeiro.

Using Agenda 21, the Philippines formulated Philippine Agenda 21 in 1997. This paper applies and adapts Philippine Agenda 21 to physics teaching for sustainable physics education development, focusing on physics teacher education and drawing from Philippine experiences, problems and concerns.

Philippine Agenda 21

Philippine Agenda 21 (PCSD, 1997) highlights the interaction of the human being, society and nature. It posits the interconnections of culture, economy and polity (form or method of government) in a country like the Philippines. It delineates sixteen sustainable development principles (Figure 1).



SUSTAINABLE DEVELOPMENT PRINCIPLES

- Development of Full Human Potential
- Holistic Science & Appropriate Technology
- Cultural, Moral & Spiritual Sensitivity
- Self-Determination
- National Sovereignty
- Gender Sensitivity
- Peace, Order & National Unity
- Social Justice, Inter & Intra-Generational, & Spatial Equity
- Participatory Democracy
- Institutional Viability
- Viable, Sound & Broad-based Economic Development
- Sustainable Population
- Ecological Soundness
- Biogeographical Equity & Community-based Resource Management
- Global Cooperation

Fig.1 Framework of Philippine Agenda 21

The principles are based on pillars of sustainable development (IEMSDO, 1996): economic development that aims for growth with equity, social development with the goal of people empowerment, and environmental management that leads to ecological integrity maintenance.

The principles can be viewed in terms of viability criteria of sustainability (IEMSDO, 1996): (1) economic – benefit to everybody without harm to anyone, or benefit to majority and no serious harm to minority; (2) ecological – ecological functions of environment and regeneration capacity of natural resources not significantly hampered or altered; (3) technological – environmental-friendly technology in production process; (4) political – people participation in project planning and implementation, people ownership of project, and benefits sharing; (5) socio-cultural – enhancement of community core values, beliefs and worldview that are consistent with human ecological principles, e.g, life-giving, peacekeeping; (6) institutional – capability of responsible institutions to sustain development activities.

Can Philippine Agenda 21 be implemented in physics teaching? How can physics education development, in general, be sustainable?

Sustainable Development in Physics Teaching

Sustainable development has several interpretations (IEMSDO, 1996). Among these are: (1) living on interest of natural capital rather than on natural capital itself, (2) future generations receiving social capital – human wealth in terms of financial capital, better infrastructure, knowledge & technology, better education and other social services; (3) living within carrying capacity of the environment and natural resources; (4) integration of environmental protection in socio-economic policy and decision-making; and (5) essentially a change process with long-lasting continuing benefits to society.

See next page

The interpretations adopted in this paper are (1) human wealth in terms of better knowledge and technology, and better education; (2) operating within the carrying capacity of the environment and natural resources; (3) integration of environmental concerns in education; and (4) long-lasting continuing beneficial effects to society.

Figure 2 illustrates a model of sustainable development in physics teaching. The interaction of the student with the physical environment and interconnections of physics, technology and society in a physics class are underscored. The model adapts twelve relevant sustainable development principles. What are some ways of applying these principles in a physics class?

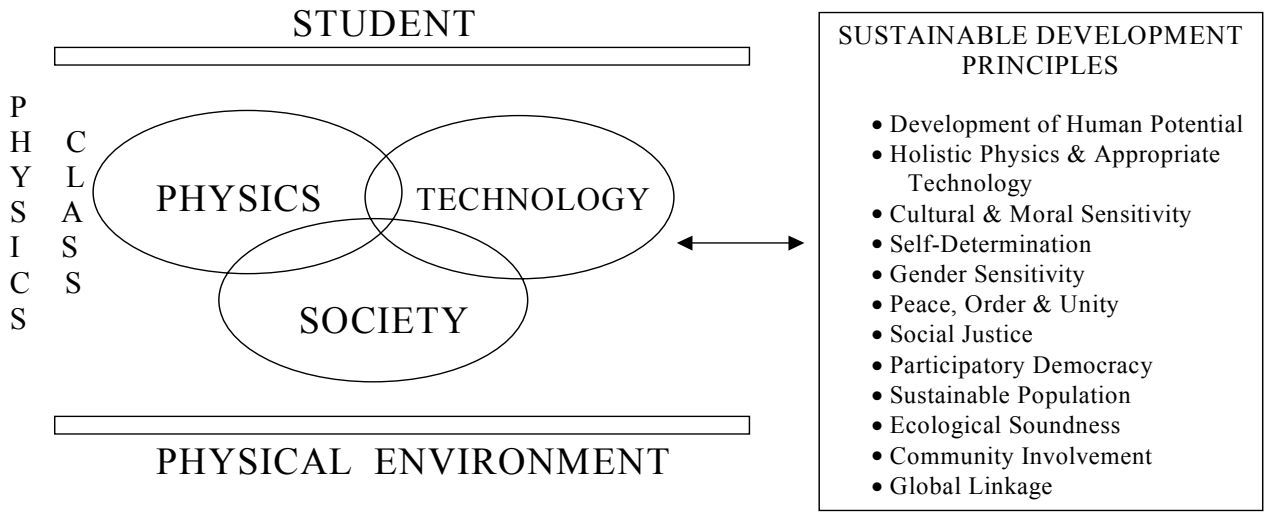


Fig.2 Sustainable Development in Physics Teaching

Development of human or student potential implies the attainment of objectives of physics education. These are development of critical thinking skills, including science process skills, understanding of physics concepts, and appreciation of scientific values.

The principle of holistic physics and appropriate technology signifies for a physics class the integration of applications of physics in daily life, as in school and at home (for example, bicycle and electronic devices). It is also important to discuss in class the importance of physics to technology and subsequent economic development, as shown by the critical role of the steam engine in the industrial revolution and the transistor for the electronic age.

For cultural sensitivity, physics-related artifacts, e.g., native toys (UP NISMED, 2000a) and musical instruments can be brought to class by students. Physics-related cultural practices (scientific and unscientific), e.g., fishing in a full moon, can be taken up when appropriate (UP NISMED, 2000b). Moral sensitivity can be demonstrated by discussing cultural values vis-à-vis scientific values, for example, influence of friendship on one's objectivity.

Community-based physics teaching (UP NISMED, 2001a), an approach for community involvement of the class, addresses physics-related community needs and uses physics-based resources. Self-determination and participatory democracy are developed in a physics class with group activities, experiments and discussion, inclusion of design of investigations or projects, and use of self-learning modules and Internet.

Gender sensitivity is promoted with (1) active equal participation of boys and girls in a physics class, as well as in textbooks, (2) encouraging girls to handle electrical and electronic devices, and (3) motivating girls to consider a career in physics.

Besides greater participation of girls in physics, the principle of social justice can be actualized with quality physics teaching for the poorest of the poor in public schools, especially remote schools. These schools need to be provided with master teachers and given the same instructional materials used in city schools. In any class, students at risk of dropping out can be identified and given instructional remediation program and counseling. Outreach physics programs like community-based physics projects can be designed for student dropouts for them to eventually come back to the formal stream.

To promote peace, order and unity, a physics class can have cooperative learning in group activities and experiments and a classroom climate conductive to learning. Values of responsibility, openness and respect for others can be developed among the students as they work in groups.

Student population or class size, by and large, in the Philippines is not sustainable. Many urban schools in the Philippines have large classes (40-80 students) in small classrooms (for 20-30 students). This situation also exceeds the carrying capacity of an average teacher, in terms of effectiveness, and the school in relation to its instructional resources. Short-term measures have been proposed, such as the use of a sound system and differentiated group activities or experiments.

Ecological soundness is relevant in the discussion of energy resources, nuclear power, and management of nuclear and electronic waste (e.g., lead, arsenic, sulfide and plastic in computer chips manufacture).

Finally, global linkage in physics teaching can take the form of collaboration with scientists through email, e-group discussion, and international competition, as experienced by students in the Philippine Science High School. Classes in

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SUSTAINABLE...*from page 5*

this school have been involved in joint or common laboratory experiments with classes in other countries.

Sustainable Physics Education Development

Pre-service (preparation of prospective teachers) and in-service (teacher training) physics education can similarly apply the twelve sustainable development principles in content and teaching methods (Figure 3). For the graduates and teacher trainees to implement sustainable development in their physics teaching, academic supervision, that is, administrative support and monitoring, is essential (UP NISMED, 2003).

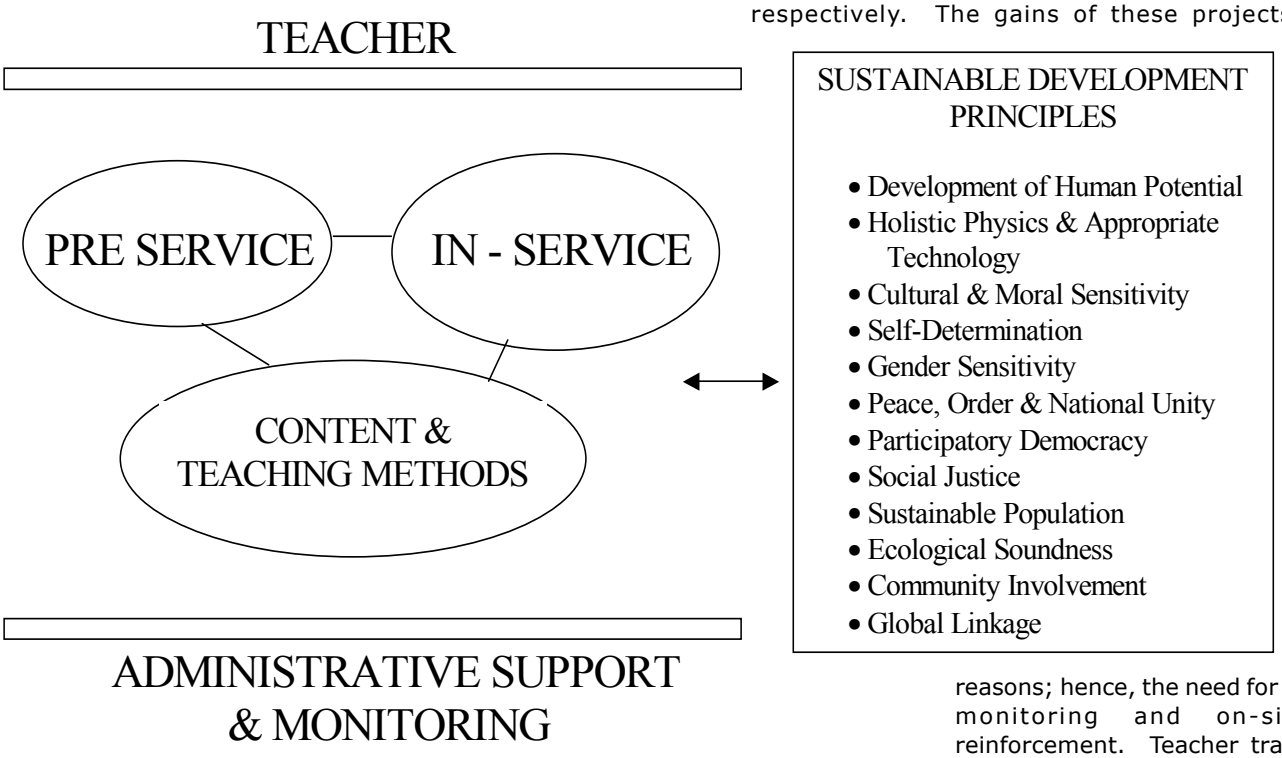

Fig.3 Sustainable Physics Education Development

The development of human or teacher potential, as in students, needs to include critical thinking skills, including science process skills, concept understanding that is greater than that of the students, and demonstration of scientific values. Moreover, effective and efficient teaching skills have to be developed, including the skill to improvise equipment and use low-cost or no-cost easily available materials for physics activities and
experiments.

For holistic physics and appropriate technology, the teaching skill is applying physics to daily life technologies and using them as motivation and context in lesson proper, as well as in student evaluation. The teacher also needs to be skillful in tapping physics-related community resources, human and material (e.g., experts, power stations, playground, basketball court) to illustrate physics concepts and facilitate the class helping the community.

In cultural and moral sensitivity, teacher's skills include (1) using cultural artifacts and places to illustrate or develop physics concepts and skills, and (2) relating cultural values to scientific values. Intended and implemented physics curricula are indigenized or culture-based.

Self-determination remains a goal in Philippine physics education development. Two major externally funded projects in science education in the country in the nineties were the Philippine-Australian Science and Mathematics Education Project and the Philippines-Japan Science and Mathematics Education Manpower Development Project (UP NISMED, 2001b). Among the outputs of the projects were resource materials on teaching strategies and sourcebooks of teaching plans with experiments using locally available materials, respectively. The gains of these projects need to be disseminated to the great majority of teachers and sustained by continuing administrative support and monitoring.

Teachers who have undergone training, for example, on the outputs of these projects do not necessarily implement the training received for various reasons; hence, the need for administrative monitoring and on-site training reinforcement. Teacher trainees need to be motivated to implement and pass on training received. Furthermore, pre-service and in-service teacher education need to include development of love for learning and lifelong learning skills.

Gender sensitivity in physics teacher education entails recruitment of male students to consider a teaching career, since male physics teachers are in shortage. In group experiments, active female student participation needs to be encouraged.

To promote peace, order and national unity, the teaching skill includes critical discussion of peaceful uses of lasers, nuclear energy, and electronic devices; and nuclear weapons with respect to world peace. In physics education management, national unity, from the teachers to the highest education officials, is critical in addressing the serious, persistent problem of low student achievement in physics in national and international tests.

Participatory democracy is enhanced by teachers' participation in curriculum development from conceptualization to

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implementation, and in policy formulation on equipment, textbooks, teaching aids, student evaluation, and academic supervision.

Social justice demands training for disadvantaged teachers - the non-physics majors, teachers in remote schools, and those in schools with severely limited resources. The poor economy of the country makes updating of all physics teachers on teaching innovations difficult.

The physics teacher population in the Philippines is not sustainable with the chronic shortage of physics majors. Less than 20% of the physics teachers are physics majors. In-service programs are for a limited number of teachers. In addition, in-service innovations are not necessarily taught at the pre-service level. In-service training cost per capita is much higher than that of pre-service education. These have been major problems for decades in the country. The Commission on Higher Education recently issued standards for undergraduate teacher education in physics and other fields to address low quality teacher education in several institutions.

The principle of ecological soundness requires the integration of environmental issues and concerns in intended and implemented physics curricula at the school and teacher education levels.

For global linkages, the teacher's skill is using information technology to access worldwide human and material physics resources for teaching. One website which teachers can use is that of the International Commission on Physics Education (ICPE): www.phys.ksu.edu/icpe. Participation in international conferences like the ICPE conference is a motivating, broadening and enriching experience for teachers.

Conclusion

Sustainable physics education development has been practiced in the Philippines on a limited scale. The challenge facing physics education in the country is the empowerment of the great majority of physics teachers and school administrators for sustainable physics education development.

Major ways of meeting the challenge are: (1) spreading nationwide and sustaining the gains of externally funded projects, (2) motivating teachers to implement and share training received, link physics, technology, society and environment in class, and form global physics education connections; and (3) train administrators on academic supervision for sustainable physics education development. Certainly, for the country, wide-scale sustainable physics education development is the future.

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Some Einstein Thoughts to Ponder

(Source: http://www.some-guy.com/quotes/einstein.html)

On Science and Math

"The whole of science is nothing more than a refinement of everyday thinking."

"The most beautiful thing we can experience is the mysterious. It is the source of all true art and science. He to whom this emotion is a stranger, who can no longer pause to wonder and stand rapt in awe, is as good as dead: his eyes are closed."
[Quoted on pg. 289 of *Adventures of a Mathematician*, by S. M. Ulam (Charles Scribner's Sons, New York, 1976)]

On Relativity

"Relativity teaches us the connection between the different descriptions of one and the same reality".

"Put your hand on a hot stove for a minute, and it seems like an hour. Sit with a pretty girl for an hour, and it seems like a minute. THAT'S relativity."

On Knowledge

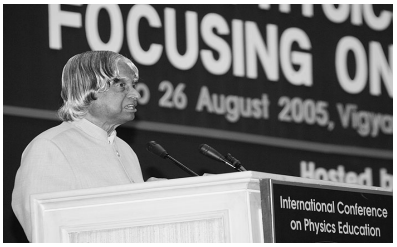
"The secret to creativity is knowing how to hide your sources."

Imagination is more important than knowledge. Knowledge is limited. Imagination encircles the world." (*What Life Means to Einstein: An Interview by George Sylvester Viereck*, for the October 26, 1929 issue of The Saturday Evening Post)

On Education

"Never regard study as a duty, but as the enviable opportunity to learn to know the liberating influence of beauty in the realm of the spirit for your own personal joy and to the profit of the community to which your later work belongs."

"Teaching should be such that what is offered is perceived as a valuable gift and not as a hard duty ."



ADDRESS DURING THE INAUGURATION OF THE INTERNATIONAL CONFERENCE ON PHYSICS EDUCATION ON 'PHYSICS EDUCATION IN 2005: FOCUSING ON CHANGE' AT NEW DELHI

New Delhi, 22 August 2005

Injecting Beauty of Science in Teaching

by Dr. A. P. J. Abdul Kalam
President of India

(*Source*: http://presidentofindia.nic.in/scripts/eventslatest1.jsp?id=967)

I am indeed delighted to inaugurate the International Conference on Physics Education titled "World view on Physics Education in 2005: Focusing on Change" organized by the University of Delhi in collaboration with International participants. I greet the organizers, eminent physicists, physics education researchers, educators, distinguished guests and the other participants in the Conference. I was very happy to read the book titled "One hundred reasons to be a scientist" brought out by the Abdus Salam International Centre for Theoretical Physics. I suggest that at least ten of the personalities who have childhood experience in science can be brought out as a booklet for introduction in school curriculum at 10 and 10+2 level. Keeping in mind the main theme of the Conference, I would like to discuss with you about: "Injecting Beauty of Science in teaching."

My experience with school students

During the last five years, I have met 600,000 students in all parts of the country in the age group of students between 10 to 17 years. I make it a point to answer at least 10 to 15 questions wherever I go, in addition I have answered thousands of questions through my website. I would like to illustrate the typical searching minds, particularly to the teachers, scientists, Education Planners so that you will know the ambient conditions of the Indian students while discussing about the "Physics Education: focusing on change".

Question on Gravity: On 20th August 2005, I went to Bangalore and participated in the inauguration of Silver Jubilee of Karnataka Rajya Vijnana Parishat. The function was attended by children of 12 different Bangalore schools. After my address, some of the children asked very interesting scientific questions which I would like to share with this audience. Master Prajwal P. Acharya of 9th Standard, Prarthana School, asked me "What is the relationship between Time & Universal Gravitation?" I appreciated this beautiful question. In my answer I told him that the concept of time, space and universal gravitation is a very exciting and interesting one. "Gravity is the force of attraction between massive particles due to their mass. Weight is determined by the mass of an object and its location in a gravitational field. While a great deal is known about the properties of gravity, the ultimate cause of the gravitational force remains an open question. General relativity is the most successful theory of gravitation to date. It postulates that mass and energy curve, space-time, resulting in the phenomenon known as gravity." There are books on the subject and websites that explain these concepts extremely well. I asked the students to study further.

Question on Ocean exploration: Master Bharath Choudhari M. - 10th Standard, Athena Public School, asked me "Why we are not exploring the World (Ocean) more than the Universe (Space)?" In my answer I told him that Ocean is restricted to the surface of the earth whereas the space is unlimited. The reaching the depth of the ocean is becoming tougher than reaching large heights in the space. In spite of the difficulty in reaching the depth of the ocean, we still explore the ocean and many benefits accrue to the mankind. And there are many treasures of knowledge waiting from the depth of the ocean.

Question on Science and Philosophy: Another student from the audience asked "What is the difference between a Scientist and a Philosopher". For this question, I answered – the thinking process is common both to the philosopher and the scientist. Scientist deals with theory which has to be validated. Philosopher postulates theological, philosophical and spiritual thoughts, the validation seams to be the societal dynamics. The science ultimately results in to technology and benefit the society. Philosophy, may give the way life is to be led in a dynamic society.

Question on Deep Impact on the Comet: I received an email from a 15 years old school boy from a north eastern state school on 5-July-2005, the day after the event "Mr. Kalam please tell me how important the Deep Impact spacecraft impacting on the comet Tempel-1? I was very happy to receive this question, even though I know the event I didn't give thoughts. Then immediately I have to give an answer, I have searched the information in many websites and then sent the following answer.

"A few days back one important event took place in space. That was the impact of the NASA spacecraft called deep impact smashing into the comet Tempel-I, with enough force to create football stadium sized crater with a depth of a 14 storey building. The spacecraft was navigated by an Indian Shyam Bhaskaran – the deep impact traveled 431 million kms in 172 days escaping from the earth orbit and intercepted the comet at a straight distance from earth at 134 million km. The comet was orbiting around the Sun every five and half years. This is a land mark in space exploration.

This event is important to divert in case of asteroids which may hit the earth in future. One such large asteroid 1950 AD is expected to hit the earth on March 16, 2880 AD. Like the "Deep Impact" many spacecrafts are required to be sent with high energy material to divert or break the asteroid to move it out of the earth orbit."

Still the boy was not satisfied, he again sent an email by asking what is the probability of hitting the earth? The email correspondence is continuing.

What are the messages emanating out these four

Continue to next page

questions? I am giving these queries from the young and my interaction, to all of you so that the experienced scientists and teachers should welcome such questions during the classes or during the interaction while they are giving the lectures elsewhere. Particularly few students between the age 14 and 17, it is very important to inject the beauty of science, challenge of science and bliss of science when one achieves. This is the period the students make up their mind, whether they should go far science, engineering, medical, bio, law or humanities.

Saturday, I was in the campus of Indian Institute of Science, Bangalore for felicitating Prof. CNR Rao, a solid state chemist and pioneer in India on Nano Science, by scientific community at Bangalore. Prof. CNR Rao in his acceptance remarks said "The working in science itself is the greatest award a scientist can dream of". This thought is reflected in his biography "Science as a way of life".

Propagate the probing of scientific minds

A. Towards Raman Effect:
Why is the sea blue? The view has been expressed that the dark blue of the deep sea has nothing to do with the color of water. It is simply the blue of the sky seen by reflection. Sir CV Raman then questions this view describing his own experiment on board the ship: Observations made in this way in the deeper waters of Mediterranean and Red sea showed that the color so far, from being impoverished by suppression of sky reflection was wonderfully improved here by. It was abundantly clear from the observation that the blue color of the deep sea is a distinct phenomenon itself and not merely an effect due to reflected sky light. Later Raman draws attention to the connection between the color of deep waters and the Einstein Smoluchowski formula. Naturally he starts with that the sky is blue because of scattering of light by the molecules in the upper atmosphere. The color of the sea is a different matter. Rayleigh believes it was all due to reflection, but Raman gives an entirely different view, that in this phenomenon, as in the parallel case of the color of sky, molecular diffraction determines the observed luminosity and in great measure also its color. Hence the birth of the Raman Effect.

Now let us study how great scientists in their school days got shape for science. First let us take up the example of Albert Einstein.

B. Teachers influence
In Albert Einstein life, we find that his interest in science started early, beginning with his encounter with magnetism, which he called "the first miracle". He was given a compass by his father and Einstein was endlessly fascinated by the fact that invisible forces could make object move. This experience made a lasting impression on him. His interest in compasses was reinforced when he found a caring mentor to hone his ideas. At the age of 12, he experienced second wonder in a little book given by his mentor Max Talmud with Euclidean plain Geometry which he called "Holy Geometry Book". Einstein called this his "second miracle". Here Einstein made contact with the realm of pure thought. Without expensive laboratories or equipment, he could explore universal truth, limited only by the power of human mind. Mathematics became an endless source of pleasure to Einstein especially if intriguing puzzle and mysteries were involved.

Visualizing pictures: Einstein's father was in an electro chemical business. Being in the midst of electro magnetic contraptions awakened an intuitive understanding of electricity and magnetism in Albert Einstein. It sharpens his ability to develop graphic, physical pictures that would describe the laws of nature with uncanny accuracy. This trait, the ability to see everything in terms of physical pictures, would mark one of Einstein's great characteristics as a physicist.

Freedom to Learn : Though born in Germany, Einstein moved to Zurich Polytechnic Institute in Switzerland. The entry into the polytechnic did not require a high school diploma, just a passing grade on its tough entrance examination was sufficient. Einstein failed in the entrance examination but he did exceptionally well in the Maths and Physics section. That impressed the Principal and he promised to take him during the following year without an entrance test. The message we get from this experience is about having a flexible system of admission. Also an ability to spot the aptitude of the student in a particular subject and nourishing the talents. In addition, Einstein enjoyed the liberal atmosphere of the Swiss school.

Simplicity in description: Unlike lesser scientists who often got lost in Mathematics, Einstein got in terms of simple physical picture – speeding trains, falling elevators, rockets and moving clocks. These pictures would unerringly guide him through the greatest ideas of the twentieth century. He wrote "All physical theories, their mathematical expression notwithstanding, ought to lend themselves to so simple a description that even a child could understand". This is a very important message for all physics researchers and physics teachers. Here the birth of famous simple, elegant and very powerful energy equation E=MC2, which decided war and peace system of the world.

In the profession of teaching, teachers are indeed playing the role of creating the creative minds. Sir CV Raman's questioning why the sky is blue?-leading to Physics Nobel Prize, is indeed inspiring teaching material to the teachers. Similarly a message of spotting an outstanding talent in physics in spite of failing the school entrance, is another message comes how Swiss school spotted one of the greatest scientific minds in 20th century, Albert Einstein.

My teacher: Prof. Satish Dhawan

Now I would like to share with you one experience I had with my teacher Prof. Satish Dhawan. I joined Defence Research and Development Organisation (DRDO) in 1958 at Aeronautical Development Establishment at Bangalore. There I took up the development of Hovercraft. Hovercraft design needed the development of a ducted contra- rotating propeller for creating a smooth flow balancing the torques. I did not know how to design a contra-rotating propeller though I knew how to design a conventional propeller. Some of my friends told me that I can approach Prof. Satish Dhawan of Indian Institute of Science, who was well known for his aeronautical research, for help in designing the ducted contra-rotating propeller.

I took permission from my Director Dr. Mediratta and went to Prof. Satish Dhawan who was sitting in a small room in Indian Institute of Science with lot of books in the background and a blackboard on the wall. Prof. Satish Dhawan asked me what the problem was that I would like to discuss. I explained the

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problem to Prof. Dhawan about my project work. He told me that it is really a challenging task and he would teach me the design if I attend his classes in IISc between 2.00 p.m. to 3.00 p.m. on all Saturdays for the next Six weeks. He was a visionary teacher. He prepared the schedule for the entire course and wrote it on the black board. He also gave me the reference material and books I should read before I start attending the course. I considered this as a great opportunity and I started attending the discussion and started meeting him regularly. Before commencing each meeting, he would ask critical questions and assess my understanding of the subject. That was for the first time that I realized how a good teacher prepares himself for teaching with meticulous planning and prepares the student for acquisition of knowledge. This process continued for the next six weeks. I got the capability for designing the contra-rotating propeller. Prof. Dhawan told me that I am ready for developing the contra-rotating propeller for a given hovercraft configuration. That was the time I realized that Prof. Satish Dhawan was not only a teacher but also a fantastic development engineer of aeronautical systems. Later during the critical phases of testing Professor Dhawan was with me to witness the test and find solutions to the problems. After reaching the smooth test phase, contra-rotating propeller went through 50 hours of continuous testing. Prof. Satish Dhawan witnessed the test himself and congratulated me. That was a great day for me when I saw the contra rotating propeller designed by my team performing to the mission requirement in the hovercraft. However, at that time, I did not realize that Prof. Satish Dhawan would become Chairman, ISRO and that I would get the opportunity to work with him as a Project Director in the development of satellite launch vehicle SLV-3 for injecting the Rohini Satellite into the orbit. Nature has its own way to link the student's dream and the real life later.

Conclusion

Physics is a fascinating subject. Mastery in physics needs understanding of mathematics. Mathematics in combination with science shines. What is needed is confronting theory with experimentation. For enabling the student to capture the thought, the student should be motivated to visualize and imagine the phenomenon as done by Einstein who reasoned that if you could run along side a light beam then the light beam should be perfectly at rest. This means that the light beam as seen by the runner would look like a frozen wave, a still photographer away. Learning physics needs freedom to think and freedom to imagine. Both have to be provided by our education system. Teachers have to become capacity builders and facilitators. They have to ask questions which are challenging and allow the student to think and come up with an answer. Teachers must also find answers to the questions asked by the students or at least the approach through which the student can find an answer. Eventually the teacher has to create a life long autonomous learner who will blossom into a physicist.

My best wishes to all the participants of this Conference and success in their mission of finding the new vistas in physics education.

May God bless you.

2005 ICPE Medal to Svein Sjoberg

Citation

Svein Sjoberg has had a long and distinguished career in Science and Technology Education, with particular attention to the role of Physics Education in a broad science education.

Svein Sjoberg began his scientific career with a PhD in experimental nuclear physics. He brought to science and technology education the rigorous thinking of a physicist allied to an understanding of psychological and social factors. It is crucial that distinguished physics educators like Svein participate in the development and definition of Science and Technology Education.

He turned from an early interest in students' conceptions, to the much broader field of social relations and science education, including important studies of gender differences, and of social and cultural differences. He has had a long-standing concern for girls in science education, particularly in relation to Physics Education. Svein Sjoberg was one of the first to see that international comparisons of standards such as TIMSS needed urgently to be complemented by international studies of attitudes to and responses to science, and one of the very first to act upon that understanding on a global scale through research.

Two remarkable studies, SAS *Science and Society – cross cultural study of factors of relevance for teaching and learning of science and technology*, and its follow-up, ROSE *Relevance of Science Education*, have been notable for the very wide international participation that they achieved.

Besides Svein Sjoberg's high standing in science education in the Nordic countries and in Europe, even more important is the world-wide international impact of his work, which has obtained valuable and convincing results from international comparisons, and at the same time has helped researchers in Africa, Asia and other countries to raise the standards of their research through active participation in these studies. He is chair of IOSTE, and a member of AFCLIST (*African Forum for Children's Literacy in Science and Technology*).

It is this international aspect of his work throughout the world, together with its high quality and important and meaningful results, which is the particular focus for the award of the ICPE medal.

International Commission on Physics Education C14, IUPAP, Activities 2003 – 2005

Membership 2003 - 2005

Chair : Gunnar Tibell, Sweden
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Dean Zollman, USA

AssociateMembers:
Minella Alarcon, UNESCO
Lakshman Dissanayake, Sri Lanka
Eduardo Molto, Cuba
Vivien Talisayon, Philippines

The activities of the Commission during the period 2003 – 2005 have contained annual meetings, working groups, international conferences and publications, both of books and a Newsletter with two issues annually. The Minutes of the annual ICPE meetings have been published in full on the home page and give the best description of our activities. The home page address is: http://web.phys.ksu.edu/icpe/

In the following the introduction to the mandate of the Commission will be given as well as a summary of some of the events mentioned above.

1. Mandate

Article 1 of the mandate gives the following prescription of the task of the Commission:

To promote the exchange of information and views among the members of the international community of physicists in the general field of Physics Education including:

a) the collection, evaluation, co-ordination and distribution of information concerning education in the physical sciences at all levels;
b) information relative to the assessment of standards of physics teaching and learning;
c) suggesting ways in which the facilities for the study of physics at all levels might be improved, stimulating experiments at all levels, and giving help to physics teachers in all countries in incorporating current knowledge of physics, physics pedagogy, and the results of research in physics education into their courses and curricula.

2. Conferences

The Commission has been active in promoting international conferences on physics education and most members have taken part as initiators and planners of such conferences. If the organizers ask for IUPAP support C14 has to endorse the meeting in question. During the three-year period discussed here the following conferences were supported by IUPAP, after endorsements by C14. Also mentioned are the C14 members most closely involved in the organization.

Eighth Inter-American Conference on Physics Education. Teaching physics for the future. Havana, Cuba, July 7 – 11, 2003. (Organizer: Eduardo Molto)

Enrico Fermi Summer School, Research on Physics Education. Varenna, Italy, July 15 – 25, 2003
(Course directors: Matilde Vicentini and former ICPE Secretary E.F. Redish)

What Physics Should We Teach?
Durban, South Africa, July 5 – 8, 2004
(Organizer: Diane Grayson)

World View on Physics Education in 2005: Focusing on Change.
New Delhi, India, August 22 – 26, 2005
(Organizer: Pratibha Jolly)

World Conference on Physics and Sustainable Development.
Durban, South Africa, October 31 – November 2, 2005
(UNESCO representative: Minella Alarcon)

The last conference listed above is organized by IUPAP together with UNESCO, ICTP in Trieste and the South African Institute of Physics. One of the four themes to be discussed is Physics Education.

Several other international conferences on physics education have been organized during this period, without asking for IUPAP support. Some examples are the ESERA meeting in Noordwijkerhout, Netherlands, the GIREP seminar in Udine, Italy, and the Seventh EUPEN General Forum, Uppsala, Sweden, all in 2003, as well as EPEC1, the first education meeting organized by the European Physical Society (EPS) in Bad Honnef, Germany, July 4 – 7, 2005.

Often the annual meeting of ICPE is held before or after one of these conferences. Examples are 2003 in Noordwijkerhout, 2004 in Durban and 2005 in New Delhi. Several of the members of ICPE were also active in the adjacent conferences as invited speakers, giving contributed talks, presenting posters or as session chairpersons. In addition, it has been common for the ICPE members to serve on the international organizing committees and thus help in the planning.

3. Publications

The *ICPE Newsletter* has continued to appear twice annually, normally in issues of 12 pages, with our associate member Vivien Talisayon as editor. News items have been published as well as feature articles on educational topics. Recently a so called ICPE Chair's Corner has been opened where I have been given some space to express my thoughts concerning important Commission issues.

In the annual meeting of 2003 it was decided to update the ICPE book *"Physics 2000"*, by asking all IUPAP Commission chairpersons to revise their earlier contributions. Jon Ogborn volunteered to serve as editor of the new book which was called *"Physics Now"*. It was printed in India by Thomson Press Ltd and appeared in time for the Council and Commission Chairs Meeting in Mumbai, in October 2004.

Physics Now has been printed in 2500 copies – of these 1000 were bought by UNESCO and 500 by the Indian Physical Society. The original 1000 copies, financially supported by IUPAP, have been distributed free of charge to all IUPAP Commission members and to participants in several physics education conferences and one physics competition, IYPT, held in Winterthur, Switzerland in July 2005.

Physics Now and the previous ICPE book *"Connecting Research in Physics Education with Teacher Education"* are both available on the ICPE website for free downloading.

The *ICPE website*, run by Dean Zollman, is hosted at Kansas University under the address *http://web.phys.ksu.edu/icpe*

As mentioned above it contains the Minutes of our annual meetings, the two ICPE books as well as other relevant information on ICPE and related issues.

4. ICPE Medal

According to the stipulations for the ICPE Medal the recipient should have fulfilled the following two criteria:

1) The contributions to physics education should have extended over a considerable number of years, and,

Continue to next page

Contributions to ICPE Newsletter

Physicists, physics professors, lecturers and teachers, and physics education researchers are invited to contribute to the ICPE Newsletter.

Contributions may be: news of physics education activities, seminars, conferences; research articles; write-up of unique student experiments/ investigatory projects; description of teacher demonstrations, improvised equipment and accompanying student experiment; book reviews; and novel physics problems and test items.

Text (including pictures) of contributions is limited to 1-3 pages, single-spaced. Your contributions should reach the editor by mail or e-mail, at the latest by **end of February for the April issue or end of August for the October issue.**

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2) The contributions should be international in their scope and influence.

Since the first medallist in 1980, up to and including the year 2000 ten men had received the medal. This trend was broken in 2002 when Tae Ryu, Tokyo, Japan and Lillian Mc Dermott, Seattle, USA, were chosen. During the period 2003 – 2005 another two highly esteemed physics education researchers were awarded the medal, namely Laurence Viennot, Paris, France in 2003 and Svein Sjoberg, Oslo, Norway in 2005. The 2003 medal was handed over during the Durban Conference and the 2005 medal during the New Delhi Conference, by the inaugural speaker, India's President, Dr Abdul Kalam.

5. ICPE Working Groups

Between the annual meetings C14 works in groups with specific aims. Some examples are given from the decisions made in the 2005 annual meeting in New Delhi. The following topics were chosen for further studies:

1) Publications on Physics Education Research,
2) Information About Physics Teacher Education Programs at Universities, and,
3) Strategies for Increased Participation of School Teachers in Physics Education Conferences.

The first two are meant to result in inventories which could serve as a source of reference, whereas the third aims at investigating methods of financing or otherwise facilitating the presence of school teachers in conferences. In the latter case it was recognized that it is also important to make the conference program more attractive to teachers, for instance by devoting some time to specially designed events.

6. Links to Scientific Bodies

C14 is happy to foster links to many different organisations, both global and sometimes regional in character, with aims wholly or partly identical to those of our Commission,. Some examples will be given below, high-lighting the particular contacts taken during the period 2003 – 2005.

1) UNESCO: Very good relations have been built up with this world-wide cultural and educational organization. With a UNESCO official as a C14 associate member this has been very rewarding, in particular for the publishing activities.
2) GIREP: In several conferences and seminars of this group ICPE members have been given main roles in the planning. We keep each other well informed about the activities of respective bodies. Next year's GIREP conference in Amsterdam was endorsed by C14 for IUPAP support.
3) EPS: As mentioned above EPS has held its first conference on Physics Education in July 2005. Our Commission was represented by several members, and the Chair is also a member of the board of the EPS Division on Education.
4) EUPEN and STEPS: Although the former thematic network has now ceased its activities, the follower STEPS (Stakeholders Tune European Physics Studies) and our Commission will be in close contact in the future.
5) AAPT/APS: Several personal links between C14 members and these organizations make it easy to keep information channels open. It can be mentioned that the New Delhi Conference was supported by the International Committee of AAPT.
6) ASPEN/LAPEN: Both the Asian (ASPEN) and the Latin American (LAPEN) Physics Education Networks, of which the latter is in the planning stage, are linked to our Commission members serving also in these.
7) ESERA: The European Science Education Research Association, although not specially established for physics, is very active and organizes conferences on a regular basis. As mentioned above the C14 annual meeting in 2003 was organized in direct contact with an ESERA conference.

7. Concluding remarks

In 2006 ICPE will meet in Tokyo, Japan, directly after the conference planned there, in August 2006. Our Commission has endorsed the request from the organizers for IUPAP support. The theme is "Physics for all". Both teaching methods and the physics content will be on the agenda. Special efforts will be made to attract school teachers to the conference, not only from Japan but also from other countries.

Finally, on behalf of our Commission I should like to express our gratitude to the IUPAP Council for generous support for our activities during the period 2003 – 2005.

Uppsala, Sweden, September 19, 2005
Gunnar Tibell
ICPE Chair 2003 - 2005

IUPAP – ICPE
International Commission on Physics Education
International Union of Pure & Applied Physics

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