International Newsletter on Physics Education
International Commission on Physics Education • International Union of Pure and Applied Physics
Number 55 April 2008

ICPE Chair's Corner

Last month I had the privilege of participating in a two-day training workshop led by prominent environmental activists, the 2008 Nobel Peace Prize laureates Rajendra Pachauri, chair of the UN Intergovernmental Panel on Climate Change (IPCC) and the Director General of The Energy and Resources Institute (TERI) at Delhi; and Al Gore, an inspiring speaker, who spent an entire day presenting a slide show based on his path breaking film, *An Inconvenient Truth*, interweaving fact and story to create an immensely convincing case that the effects of climate change will be cataclysmic unless we act now. The event aimed at creating a global action network of proponents, drawing on a diverse group from government, industry, voluntary organizations, academia and civil society. Indeed, it is important for each individual to be cognizant of the challenge and be part of the solution; and this includes the students.

There is a discernable paradigm shift in the global understanding on climate change. The United Nations declared 2005–2014 to be the Decade of Education for Sustainable Development (DESD) with UNESCO as the lead agency. The objective is to integrate the principles, values and practices of sustainable development into all aspects of education and learning. The triennium, 2007–2009, with 2008 as the International Year of Planet Earth (IYPE), aims to capture people's imagination with the exciting knowledge we possess about our planet, and to see that knowledge used to make the earth a safer, healthier and wealthier place for the future generations. An initiative of major geo-scientific communities, the main thrust is to establish the idea of *Earth science for society* through outreach programs spanning the ten broad, multidisciplinary themes of health, climate, groundwater, ocean, soils, deep earth, megacities, hazards, resources, and life.

With Planet Earth and Climate to the fore, conflicting demands of climate, energy and food security are the new concerns. Despite resistance, sustainability is slowly gaining ground as the organizing principle by which all nations should develop and grow. Beyond the socio-political ambit, the emerging technological problems and solutions are exciting *per se*. As we map our carbon footprints, develop carbon capture and storage methods, harness renewable sources of energy, redefine standards of energy efficiency, develop more efficient low carbon fuels, integrate micro-generation technologies, and envision an increasingly greener future by 2020, 2050 and 2100, the obvious question is: should we not be engaging young students with these ideas in the formal science classroom? There is need to constructively engage students to evaluate evidence and data on which predictions of future are based; to develop investigations to test concepts of energy efficiency; and to create hands-on activities incorporating green technologies. Perhaps we should develop, not just a "green component", but a "green layer" in the curriculum. We hope that the soon to be launched PHYSWARE workshops will provide us an opportunity to work in this direction.

Pratibha Jolly

Pratibha Jolly, ICPE Chair, Delhi

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Physics Education on the Move in Canada

T. Antimirova, M. Milner-Bolotin and P. Goldman
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Introduction

The technology needs of modern society, recognized by the governments of the industrialized countries, have led to unprecedented changes in science and engineering education all over the world. Today more students than ever take undergraduate physics courses, and Physics Education Research (PER) is represented by well over one hundred groups world wide with a few dozen active PER groups existing in the United States alone[1]. In Canada, there is only one official PER group situated in a Department of Physics – the Physics Education Research Group at Ryerson University[2]. Also, a new Science education centre based at the Faculty of Science has been initiated at the University of British Columbia, headed by Nobel Prize Winner Carl Wieman. In this newsletter, we would like to describe the initial success of the PER developments in Canada, as well as the challenging situation with PER funding in our country.

PER in Canada

The active PER community in North America is represented by the American Association of Physics Teachers (AAPT), which currently includes more than 11,400 members (with over 1300 international members), the Forum on Education of the American Physics Society, and the Canadian Association of Physicists (Division of Physics Education). AAPT has affiliated sections in three Canadian provinces: Ontario, Alberta and British Columbia; and a new section of AAPT will soon be formed in Mexico.

The fields of subject-based science and engineering education are essential for the success of a nation which prides itself in its technological achievements. Our main goal is to improve science education in Canada using our science backgrounds and our knowledge of how people learn science. While there is a growing awareness of PER and a significant interest in the field among Canadian physicists, one may ask why PER is so severely underrepresented in Canada.

Excellent early work has been done in Canada for many years by pioneers like E. McFarland at the University of Guelph, R. Hawkes at Mt. Allison University and A. Slavin at Trent University, to name just a few. They researched and promoted innovative teaching methodologies and employed scientific methods to analyze the impact of their work on student learning. Even though this work had been done with little institutional or financial support, it planted the seeds of Science Education Research (SER) in Canada. As a result, nowadays faculty devoted to the field of SER can be found in several University Science Departments and in High Schools all across Canada. A description of a few case studies of PER in Canada can be found in our recent paper[3]. However, these PER efforts are severely undermined by the lack of government funding for PER in Canada. Today, SER in general, and PER in particular do not officially exist as a scientific discipline in the eyes of Canadian granting agencies.

Funding for PER/SER

We will draw comparisons between the funding models in Canada and in the US, which the authors are most familiar with. In Canada, the research in natural sciences and engineering is funded by the National Science and Engineering Research Council (NSERC), and research in the Social Sciences and Humanities is funded by the Social Sciences and Humanities Research Council (SSHRC). Surprisingly, NSERC does not see the area of subject-based science education research as a legitimate area of research in the sciences and therefore does not fund subject-based science education research. In Canada, the Science Education portfolio currently belongs to the SSHRC, which refuses to fund subject-based science education, claiming that it does not fall within its mandate. As a result, PER literally falls through the cracks between the two granting agencies. We strongly believe that the present practice of limiting SER funding to SSHRC puts fundamental limitations on the fields of research. If a researcher is interested in investigating the effectiveness of a particular science teaching method or the student understanding of a particular topic, then SSHRC will not be an appropriate funding agency for this kind of research.

Recent controversial decisions by the SSHRC, like for example their position on "intelligent design theory", have highlighted the need for scientists to become involved into the decision making process regarding research in science education. The Canadian Association of Physicists (CAP) has recently sent a letter to the presidents of the three major Canadian granting agencies (NSERC, SSHRC and CIHR) suggesting a way to improve the evaluation of research grant applications in the field of science education through the participation of the representatives of all three agencies[4]. An acceptance of this proposal would, in our opinion, be a big step forward from the current impasse, but it still may not be enough. The total absence of a subject-based SER in NSERC's mandate is in striking discrepancy with the situation in the US, where the National Science Foundation (NSF) has as one of its mandates to fund SER. Moreover the NSF fully supports ALL aspects of work aimed at improving science education in the US, including K-12, teacher preparation, and curriculum development efforts. Projects are funded by the NSF's Division of Research, Evaluation, and Communication, and also by the NSF's Directorate for Education and

Human Resources whose Division of Undergraduate Education runs the Course, Curriculum, and Laboratory Improvement program. Similar funding model exists for other science disciplines. In addition, NSF's Directorate for Physical and Mathematical Sciences which provides funding in traditional research fields of physics, chemistry, etc., has taken steps to fund discipline-based education research. In addition to the nation-wide funding opportunities mentioned above, there are also opportunities at a state level.

Another obstacle to funding SER in Canada arises from the fact that in Canada Education is considered a provincial responsibility. It is time to admit that the field of SER is of a national and international scope, and as such, should be funded nationally. Unfortunately, science education is hardly mentioned in such important national documents as the government's new policy statement with regard to Science and Technology called *Mobilizing Science and Technology to Canada's Advantage*[5] and *The State of Science and Technology in Canada*[6] produced by the Council of Canadian Academies. The absence of government support at all levels has a detrimental effect on Canadian science faculty, teachers and students. Since SER faculty cannot compete for NSERC funds, the funds for the overwhelming majority of SER-related projects must come from scarce university budgets, mostly at the faculty or departmental level. By its nature, SER is the field in which research results can and should directly translate into better pedagogies and new research-based curricula that lead to major improvements in quality of science instruction.

Consequences

Unfortunately, the lack of funding has far-reaching consequences: it impedes not only the research itself, but also undermines curriculum development efforts across the country thus reducing the impact of this research on the overall science teaching practices across Canada. Currently, science faculty in Canada receive virtually no external support for designing, implementing and evaluating innovative curricula. Most of the time the faculty do not have a release time to re-design existing courses or to develop new ones or new programs – almost always this work is done on a voluntary basis. For example, addressing the need for revitalization of undergraduate physics, the Canadian Association of Physicists (CAP)/Division of Physics Education (DPE) committee developed a recommended under-graduate physics curriculum for Canadian universities that can be found in the CAP website: CAP/DPE[7]. This work was pursued by a group of faculty members without any grant support.

While currently more and more students express their interest in pursuing graduate studies in PER, no such graduate programs officially exist in Canada today, to a large extent, because of the current "un-fundability" of the field. Unable to pursue their interest and passion, these prospective students have no choice but to leave Canada in order to pursue their interests elsewhere. Perhaps the story of Paula Heron can properly emphasize this problem. Paula finished her undergraduate degree in Physics at the University of Western Ontario. Her dream was to pursue a career in PER. However, as much as she wanted to stay in Canada, there wasn't (and there still is not) available a single graduate program in PER or subject-based SER. She enrolled in the PER graduate program in Washington State and pursued her PhD under the supervision of world-renown PER expert, Professor Lillian McDermott and then became a faculty member in the same Department, one of the most recognized PER centres in the world.

Some hopeful recent developments

Despite the funding-related challenges that are faced by subject-based SER faculty in Canada, we work relentlessly to advance and promote the fields of Science Education in general and Physics Education in particular for the benefit of our country. More and more Canadians now recognize the importance of what we are doing, even though our work is still pursued without the support of national granting agencies, or too often without any support at all. Currently, we have a growing number of scientists in Canada who are interested in science education and are ready to contribute to the field. They want to stay in Canada, rather than pursue their research elsewhere, but in order to do so, they need to be recognized and supported.

The movement to introduce subject-specific SER in Canada is gaining momentum, for the time being propelled by individual faculties at some universities. We would like to mention a few major recent developments in the Canadian PER scene. Recently, the University of British Columbia was able to attract a Physics Nobel Laureate, Professor Carl Wieman, by offering him 12 million dollars to start a Carl Wieman Physics Education Initiative[8]. This initiative opened a new era in Canadian SER, showing the interest and commitment of a major Canadian research university with the ultimate goal of improving the quality of science teaching. Another major research university, University of Toronto is investing 4.7 million dollars into building a new state of the art introductory physics laboratory to create a workshop/studio style, activity-based environment with the research-based curriculum.

Ryerson University in Toronto is a rapidly growing institution, known as a leader in socially-relevant professionally-oriented education. Ryerson took major step towards formally recognizing and promoting the field of PER: during the past four years two full-time tenure-track physics faculty members were hired by the Department of Physics specifically to conduct PER, and two more faculty members devote part of their research to the field. To our knowledge, this is the first time that tenure-track faculty in the field of PER were hired in Canada. One of the major themes of our research is how enquiry-based learning in large introductory physics classes is enhanced by the use of modern technology (clickers, real-time data acquisition and analysis

technologies, interactive computer simulations, Video-Based Motion Analysis and online tutoring/ homework/testing systems, etc.). Another focus of our research is the impact of the high school physics experience on the students' attitudes towards science, student motivation and learning outcomes in the introductory physics courses.

Ryerson students actively participate in undergraduate physics courses with the help of Personal Response Systems (clickers).

All these initiatives have been undertaken mainly at the University level, and have not yet had a significant effect on the funding of SER initiatives at other Canadian universities. However, we believe that they are indicative of significant changes to come. It would be a big mistake to miss an historic opportunity to bring Canadian science education to the world level.

The authors would like to thank Dr. P. Walden for stimulating discussions on the role of major Canadian funding agencies in funding Science Education.

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[6]http://www.scienceadvice.ca/documents/The_State_of_Science_and_Technology_in_Canada.pdf.
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IUPAP – ICPE
International Commission on Physics Education
International Union of Pure & Applied Physics

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Visit our web site at:

http://www.phys.ksu.edu/icpe/

GIREP 2008, International Conference and MPTL Workshop
Nicosia, Cyprus, 18 – 22 August 2008

Colleagues are invited to attend the GIREP 2008 International Conference and to attend the MPTL Workshop to be held in Nicosia on 18–22 August 2008.

Conference objectives

The theme of the conference *Physics Curriculum Design, Development and Validation*, highlights an aspect of great relevance to recent innovation efforts in Physics Education: research-based curriculum design as a mechanism for unifying different approaches to enhance our knowledge of learning processes and explore the role of context, designed or circumstantial, in physics learning and instruction. GIREP 2008 will be a great opportunity not only to present the results of your work, but also to communicate and discuss research topics of common interest with other colleagues.

Domains of the Conference

- Modelling, Simulation and Video Measurement in Physics Education
- Use of Multimedia
- Physics Understanding
- Curriculum Innovations in School and University Physics
- Motivational Strategies
- Physics Teacher Education
- Physics and Society
- Physics Education Research

GIREP Special Interest Groups

During the 2008 conference we will initiate a process of creating Special Interest Groups.

More information about the MPTL Special Interest Groups is available on the Call for Papers girep_call4papers.pdf .

IMPORTANT DATES

Abstract Submission Deadline	31 Jan 2008
Review Decisions Announced	31 Mar 2008
Deadline for receipt of certification of enrolment for early registration as a student	1 Apr 2008
Early registration deadline	15 Apr 2008
Registration deadline for inclusion in the conference program	1 Jun 2008
Final Program Announced	15 July 2008

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3rd IUPAP International Conference on Women in Physics
8 – 10 October 2008, Seoul, Korea

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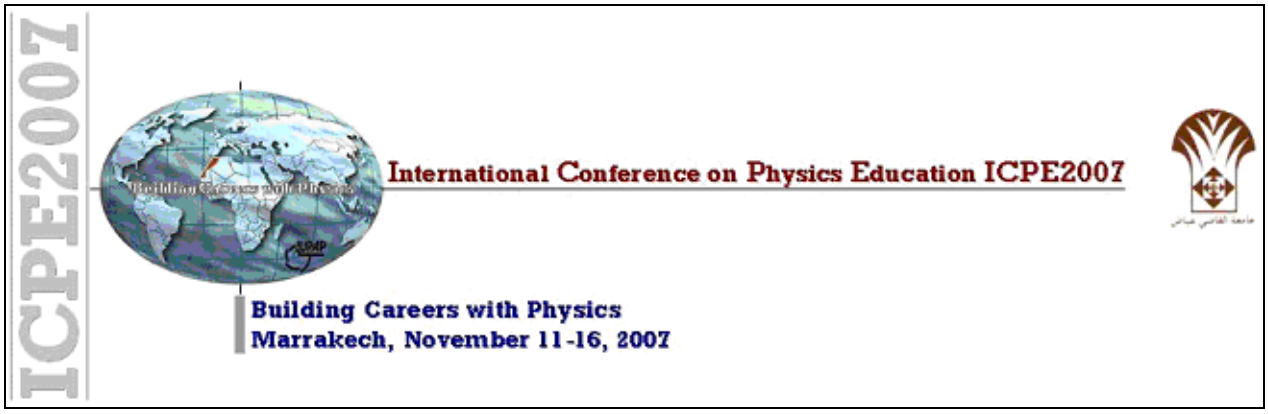
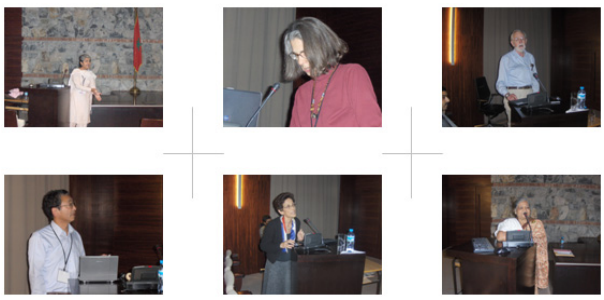


Under the High Patronage of His Majesty the King Mohammed VI

المؤتمر الدولي حول علوم التربية في الفيزياء

Scientific Report of the ICPE2007 Conference Building Careers with Physics

Under the High Patronage of His Majesty the King Mohammed VI, the Cadi Ayyad University of Marrakech hosted *The International Conference on Physics Education ICPE2007: Building Careers with Physics*, in collaboration with the International Commission on Physics Education (ICPE), the Tunisian Society of Optics (STO) and the Moroccan Society of Applied Physics (SMPA). This conference was supported by the International Union of Pure and Applied Physics (IUPAP) and the UNESCO.



The ICPE2007 was the first IUPAP-supported international conference on physics education in North Africa. A major objective of the ICPE2007 was to provide the opportunity to exchange ideas and experiences about Building Career with Physics, and to discuss the potentialities the physical sciences offer in curriculum development, and their impact on enriching the professional skills of graduate students. The Marrakech conference gathered around 350 physicists including physics educators, physics education researchers and curriculum developers from 39 countries. They were able to share, discuss and communicate their findings and experiences in the physics teaching-learning process in general, and in career-oriented curricula and Educational Reforms in particular.

Physics education in developing countries is a main focus of interest for IUPAP commission C14 and was also an important theme for the ICPE (International Commission on Physics Education) 2007 conference. Creative experiments with “low cost” or “no cost” materials were mixed with advances in learning associated with high-tech equipment.
This conference was aimed at comprehensively presenting issues and examples of praxis that highlight the following themes:

- *A – New Job Opportunities*
- *B – Effective Teaching Strategies*
- *C – Learning with Technology*
- *D – Physics for Sustainable Development*
- *E – Bridging the Gaps*
- *F – Women and Girls in Physics*

Given the importance of the conference and the role of the thematic development of our country, particularly the engagement in educational reforms, of Morocco with the Maghreb countries, as well as other countries, the meeting was open to scientists regardless of their nationalities and citizenship. This conference presented the six themes in the form of 27 scheduled sessions as follow:

9 Invited Plenary Lectures
24 Invited Talks
19 Workshops
105 Oral contributions
85 Poster contributions

Physics for All?

The conference presented several science caravans and other outreach activities to bring physics experiments to rural areas. In addition to this multitude of national projects, the conference also presented coordinated large scale projects in collaboration between the UNESCO and ICPE aiming to make physics and science education available to everyone. A few of these projects and events are listed below.

International Forum on Physics and Education

In addition to all these sessions, the French Association of Optics and Photonics (AFOP) organised an international exhibition for two days during this meeting (12–13 November) which was dedicated exclusively to physics and education. Many exhibitors came from France: *Didalab*, *Horiba Jobin-Yvon*, *IDIL Fibres Optiques, Institut d'Optique, PYLA*, *Quantel*; from Belgium: *PHYWE Instruments*; and from USA: *PASCO Scientific*. They brought their innovative equipment in the field of physics, which helped to create a very large interaction between participants coming from different countries.

In this exhibition a special stand was dedicated to SPIE (International Society for Optical Engineering), which provided support to this meeting by covering charges of USA based participants. Many recent programs and activities were presented with offers on training programs in optics and photonics.

ALOP Active Learning in Optics and Photonics

Optics and photonics have been identified as areas suitable to help students learn experimental physics and engineering. These areas can be seen as 'enabling science' forming the basis of many modern advances in high technology. The ALOP (Active Learning in Optics and Photonics) project began in 2003 and involves collaboration with ICTP, SPIE, OSA and ASPEN (Asian Physics Educational Network). Students are introduced to basic optics concepts and systems, including the eye, communications, the atmosphere and the role of interference and diffraction in spectroscopy and photonics. Several workshops have been held — e.g. in Ghana, Tunisia, Morocco, India, and Brazil — with the aim to train and prepare teachers to teach introductory optics by using active learning with hands-on activities and by drawing examples from local research activities. For more information, contact Minella Alarcon at UNESCO (m.alarcon@unesco.org).

ICPE Medal for 2007

Professor Priscilla Laws, research Professor of Physics at Dickson College, Carlisle Pennsylvania, USA, was awarded the ICPE Medal in recognition of her significant contributions to teaching and learning of physics. See the citation on page 9 of this newsletter.

Women in Physics

The IUPAP working group on Women in Physics was formed in 1999 and since then two International conferences have been held in Paris (2002) and in Rio de Janeiro (2005), with the next conference scheduled for Korea in 2008. One of the tasks for the working group is to survey the situation for women in physics, and these conferences have emphasized the need for more data. During dedicated sessions at ICPE2007, data from several countries were presented. In some cases, data from earlier years were impossible to trace, since student gender had not been included before. Dr Azita Seiedfadaei showed how female students dominate Iranian undergraduate physics, but the fraction gets drastically reduced at higher stages. Dr Aquila Islam from Pakistan described the difficulties faced by many young female physicists. The discussions were not only around difficulties for women in physics but also during coffee and lunch breaks, we shared the challenges and joys of juggling career and children.

To reach the frontiers of research we must start with young students. This was one of the messages from Khalija Mohd Salleh from Malaysia in the closing session. The meeting brought together many highly

competent women from different countries. To have them as role models and leaders may help new trees to grow under their protection.

Seven Wonders of Physics and Technology

Many physics discoveries have truly changed the way we live and the way we view our world and the universe. Yet the Seven New Wonders of the World, announced in July last year, did not include any modern technological developments. It was proposed to establish a new list of seven physics-related technological wonders of the world. Attendees at the conference were asked to choose from a list of 21 possible items, seven which had changed, or were changing, the way we live today.

The result of the voting can be found on page 11 and 12 of this newsletter.

In the heart of ICPE2007

Physics education as a discipline is given relatively little emphasis in the developed world institutions, and even less in developing countries. Since there is no official institute on physics education in Morocco, the organization of the ICPE2007 was both a big challenge and also an opportunity to foster physics education in our country.

A conference with many participants and many parallel sessions sends everyone back home with different ideas. I will mention here a few of the presentations; it is by necessity a personal choice, to some extent filtered also by the possibility to find helpful links or publications.

- Professor Laurence Viennot from Paris talked about the need for attention to coherence in physics education. She discussed 'teaching rituals' we go through, often without reflection (Viennot 2006), and how students appreciated the additional effort of challenging some of these rituals.
- Joachim Schlichting challenged the participants with confusing photographs of lights, shadows and reflections. His website (Schlichting 2007) has a monthly photo challenge, as well as copy of his presentation.
- Ron Thornton told us about studies of behaviours learners who had turned out to be teaching resistant, as evaluated using the Force and Motion Concept Evaluation (Thornton and Sokoloff 1988). During the discussions he also mentioned that the concept diagnoses that have been developed probably are the part or PER that have done the best to undergraduate physics teaching.
- Khalija Mohd Salleh from Malaysia talked about Physics for Sustainability, during the closing session, but also shifted the question around to a need for a curriculum reform to ensure sustainability of physics, in view of declining interest among new students. She also challenged us not to forget to share the *values* of physics, that physicists have a special way of thinking

The proceedings, to be published by the American Physics Society, will bring many more examples and details.

Special thanks

First of all, on behalf of the Organizing & Programme Committees of the ICPE2007 we are very grateful to His Majesty the King Mohammed VI who gave us his insurance by bringing us the High Patronage which is the best encouragement to host this international meeting in Marrakech, Morocco.

Citation for the Presentation of the ICPE Medal to Professor Priscilla Laws Dickinson College, USA

Marrakech, Morocco
November 2007

The Medal of the International Commission on Physics Education of the International Union of Pure and Applied Physics recognizes contributions to international physics education which are "major in scope and impact and which have extended over a considerable period of time". At the ICPE2007 conference in Marrakech, this year's medal was awarded to Professor Priscilla Laws for her significant contributions to the teaching and learning of physics". It was presented by Professor Mohamed Marzak, President of the Cadi Ayyad University in Marrakech, and the chair of ICPE, Professor Pratibha Jolly, who delivered the following citation.

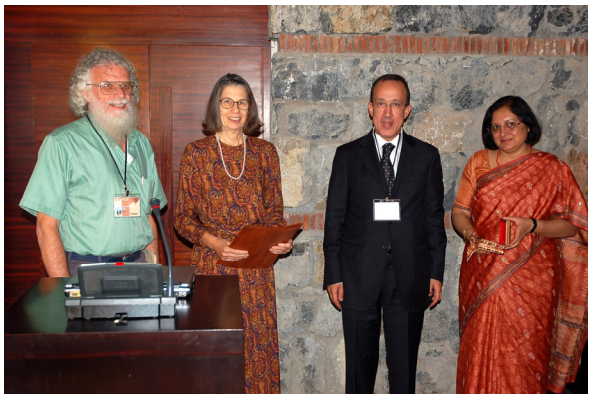
Priscilla Laws, Research Professor of Physics from Dickson College, Carlisle, Pennsylvania, USA, is awarded the ICPE Medal in recognition of her significant contributions to the teaching and learning of physics. Her distinguished career has included many research and development activities which have had international impact and have served as a role model for many women physicists and physics educators.

Dr Laws completed her baccalaureate at Reed College and her doctorate at Bryn Mawr College. In 1965 she joined the faculty of Dickinson College where she has spent her entire academic career. During the early part of her career she focused on the health effects of radiation. However, she is most known for work which began in the mid 1980s when she began the development of activity-based curricular materials and computer software to enhance student learning.

While one naturally thinks of technology enhanced physics education in connection with Dr Laws work, technology has been a means rather than an end in itself. Foremost in her developments is an effort to engage the learners actively in the learning process and minimizing the role of the instructor as the transmitter of knowledge. Her 1991 article in *Physics Today*, "Calculus-Based Physics without Lectures", exemplifies this approach of putting the students' learning first.

Dr Laws has been recognized for her efforts by receiving several prestigious awards, including the 1996 Robert A. Millikan Award from the American Association of Physics Teachers and the 1993 Charles A. Dana Award for Pioneering Achievement in Education. She was also voted as one of the 75 most influential physics researchers or educators in the past 75 years and is a Fellow of the American Physical Society.

Dr Laws' research and development has long influenced the teaching and learning of physics throughout the world. Today, she focuses on enhancing research-based, active learning of physics using local contexts and available equipment in all localities in the world. As one of the organizers of the education component of the World Conference on Physics and Sustainable Development, she helped bring together physics educators with quite different backgrounds and resources to begin an on going effort to assure that all students can have a high quality physics education and can do so in a familiar setting.
For her pioneering work in developing and disseminating student-centered physics education and for her continuing efforts to promote quality physics learning through the world, the International Commission on Physics Education is pleased to present Professor Priscilla Laws with its 2007 Medal.



Professors Dean Zollman, Priscilla Laws, Mohamed Marzak and Pratibha Jolly

The seven wonders of science and technology: some personal reflections

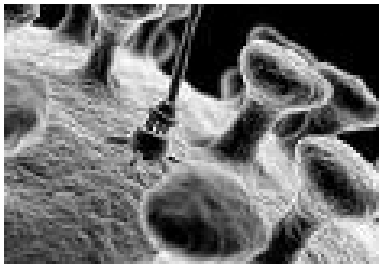
Robert Lambourne, piCETL, The Open University, United Kingdom

At the ICPE2007 in Marrakech last November, attendees were asked to identify seven wonders of science and technology which have truly changed the way we live (see ICPE Newsletter #54, page 9). From a list of 21 items given, the following 7 received the greatest number of votes in that order. Clearly this exercise was sure to generate a good deal of discussion, and to raise strong opinions. I was therefore very pleased when the editor of the ICPE Newsletter invited me to give some personal views on the seven wonders that topped the poll.

1 The World Wide Web

I am not surprised the Web topped the poll; it has had an immense impact on all our lives and promises to have an even grater impact in the future. It is especially pleasing that the 'top' wonder should be so firmly rooted in physics. The idea of using the internet (which predates the Web) to access a system of interlinked hypertext documents was formally proposed by Tim Burners-Lee (now Sir Tim) at CERN in 1989. We all know that there has been life on Earth for more than 2.5 billion years, but only since the advent of the Web has it been possible to feel that the world itself has a nervous system.

2 Nanotechnology

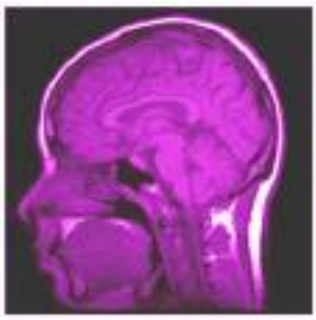


The second wonder was more surprising since it still seems to me to be mainly a promise of future wonder rather than a present day achievement. Of course, we ourselves are the result of natural nanotechnology since our bodies depend on a variety of biochemical processes that evolution has engineered at the atomic and molecular level. I share many of the views that Richard Feynman expressed in his celebrated 1959 lecture, "There's Plenty of Room at the Bottom" but I think it will still be some time before we see tomorrow's nanotechnology enriching our lives in the way that today's microtechnology already has.

3 Satellite communications

I write this just a day after the sad news from Sri Lanka of the death of Sir Arthur C. Clarke, the visionary science fiction author who first proposed that a family of satellites in geostationary orbit, 35,786 km above the equator, would provide an appropriate basis for worldwide wireless communication. Seeing satellite dishes on homes and offices around the world, all aimed at some point on the geostationary orbit (sometimes called the Clarke orbit), is a constant reminder of both the wonder of satellite communications and the wonder of the laws of physics that make the associated orbit such a precious global resource.

4 Medical and industrial imaging



Modern imaging provides a great way of interesting students in physics without first having to take them through the details of mechanics and electromagnetism. The inclusion of imaging, particularly medical imaging, in the list of wonders seems appropriate and perhaps even inspiring. Ultrasound, MRI, functional-MRI, X-ray tomography, positron emission tomography and all the other modern imaging techniques are having a direct impact on peoples' lives and clearly indicate the marvels that physics can supply.

5 Transistors

The transistor – the term comes from '*trans*ferring current across a res*istor*' – was invented more than 60 years ago and won its inventors, Bardeen, Brattain and Shockley, the 1956 Nobel Prize for Physics. (Bardeen, once described as 'the man who could see electrons', won a second Nobel for his contribution to the BCS theory of superconductivity.) The transistor is so fundamental to modern life and has turned up in so many different guises and applications that its appearance in the list of seven wonders is not a surprise. Indeed it's rather like seeing an old friend who, though greatly valued, is in danger of being overlooked because of their familiarity.

6 Lasers

Once known as 'a solution in search of a problem', the laser, particularly the solid state laser, has become an essential part of many devices from surgical and manufacturing systems to domestic CD and DVD players. Even so I must admit to being somewhat surprised that lasers managed to seize a place amongst the seven wonders. Do lasers really deserve to outrank telescopes, microscopes, aeroplanes and electric generators? Perhaps only a group of physicist would think so, but that may indicate the work still to be done in reminding the public of just how much devices firmly rooted in quantum physics actually affect our lives.

7 Wireless communication

There is some overlap between this last wonder and the satellite communications that won third place. Nonetheless it would be hard to begrudge a place to such a powerful method of communication and information sharing, especially now that it is also bringing us the joys of wireless internet access and mobile phones. Wireless communication, with its clear links to modern microelectronics and its rich history in the work of Maxwell, Hertz, Marconi and others, provides a fitting last entry in the list of seven wonders of science and technology.

Overall results of the Voting

World Wide Web	**76**	Microscopes	28
Nanotechnology	**60**	Heat engines	27
Satellite communications	**55**	Particle accelerators	25
Medical and industrial imaging	**54**	Space travel	21
Transistors	**49**	Astronomical Observatories	20
Lasers	**47**	Data Visualization	20
Wireless communication	**43**	Superconductors	20
Aeroplanes	42	Spectroscopes	14
Electrical generators	42	Remote scanning devices	7
Optical fibre technology	39	Telescopes	7
Hubble space telescope	32		

PHYSWARE: A Collaborative Workshop to Promote Physics Teaching and Learning in the Developing World

16 – 27 February 2009

The first in a series of workshops to create a collaborative workshop on low-cost equipment and appropriate technologies that promote undergraduate level, hands-on physics education throughout the developing world is tentatively scheduled for 16 – 27 February 2009. The workshop will occur at the Abdus Salam International Centre for Theoretical Physics (ICTP) in Miramare, Trieste, Italy.

The goal of this workshop is to enhance the quality of physics understanding for students in the developing countries. This workshop will focus on mechanics teaching as the first in a series of international and regional workshops on important physics topics. Participants will be expected to become leaders of similar efforts in their local regions. During the workshop these teacher-leaders will share and work with prototypes of affordable "hands-on" equipment that can be locally adapted for construction by teachers and their students throughout the developing world. The workshop participants will also develop instructional materials, create construction plans, and ideas for activities to help educators make effective use of the equipment.

Topics and Activities

1. Low-cost Equipment Development for Teaching Mechanics: Participants will work in teams to exchange ideas about equipment that can serve local educational needs and be constructed by teachers and their students;
2. Active Learning Materials Development for Teaching Mechanics: Participants will also work in teams to develop activities that will help them and fellow teachers make effective use of low cost equipment; and
3. Using Emerging Technologies for Physics Teaching: With the assistance of the ICTP M-Lab staff and leaders in the development and use of new educational technologies, participants will discuss ways to help teachers in developing countries make effective use of new relatively low-cost electronic and computer technologies for computer based data collection and analysis as well as networking.

Participation

Scientists and students from all countries which are members of the United Nations, UNESCO or IAEA may attend the Workshop. As it will be conducted in English, participants should have an adequate working knowledge of this language. Although the main purpose of the Centre is to help research workers from developing countries, through a programme of training activities within a framework of international cooperation, a limited number of students and post-doctoral scientists from developed countries are also welcome.

As a rule, travel and subsistence expenses of the participants should be borne by the home institution. Every effort should be made by candidates to secure support for their fare. However, limited funds are available for some participants who are nationals of, and working in, a developing country, and who are not more than 45 years old. Such support is available only for those who attend the entire activity. There is no registration fee for this event.

The Application Form is available on the ICTP Web server: http://agenda.ictp.it/smr.php?1928 (which will be constantly updated) or from the activity Secretariat. It should be completed and returned before 10 October 2008 to:

PHYSWARE (smr 1928) (c/o Ms Suzie Radosic)
The Abdus Salam International Centre for Theoretical Physics, Strada Costiera 11, 34014 Trieste, Italy, *or*
Email to smr1928@ictp.it (please save and send file attachments in PDF or RTF format)
Tel: +39-040-2240226
Fax: +39-040-22407226
Email: smr1928@ictp.it

Financial support for the workshop is being provided by IUPAP, ICTP and UNESCO. The directors of the workshop are:

- Pratibha Jolly, (Professor, University of Delhi, India),
- Priscilla Laws (Professor, Dickinson College, USA),
- Elena Sassi (Professor, University of Naples, Italy), and
- Dean Zollman (Professor, Kansas State University, USA).

The local organizer at ICTP is Joe Niemela. Presenters will include workshop directors, ICTP personnel, and individuals who will be selected from the participants.

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