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The International Commission on Physics Education

A. P. FRENCH

Physics Department, Massachusetts Institute of Technology, Cambridge, MA 02139. U.S. A.

ABSTRACT. This article describes the work of the International Commission during the twenty years since its inauguration at Unesco in Paris. and gives an account of the major conferences and seminars for which it has been responsible.

1. Origins

It is almost always instructive to look back into the circumstances and motivations that accompany the birth of any particular activity or organization. This is certainly true in research, where the ideas of the pioneers, however incomplete and imperfect, provide the stimulus for all that follows. It is equally true, I believe, for the much more delicate and elusive field of education. Therefore, I make no apology for beginning this article with a reminder of the origins of the most nearly global organization that exists to serve the cause of education in physics..

Just about twenty years ago, at the end of July, 1960, there was held an International Conference on Physics Education. Nothing comparable to it had happened before. It took place at Unesco House, in Paris, under the auspices of the International Union of Pure and Applied Physics, the Organization for European Economic Cooperation, the National Science Foundation of the U.S.A., the Asia Foundation, and Unesco. The conference was attended by 86 participants, representing 28 different countries.

The conference, which discussed many different aspects of physics education, ended by formulating a number of resolutions, amongst which was the following:

"We recommend to the International Union of Pure and Applied Physics that it should take appropriate action, possibly in collaboration with other international organizations, to establish an international committee of professional physicists to accept responsibility for:

1. The collection, evaluation, and co ordination of information and the stimulation of experiments at all levels of physics education.
2. The suggesting of ways in which the facilities for the study of physics at all levels might be improved in various countries.
3. The collection and evaluation of information on methods used for the assessment of standards of performance of students of physics and for the evaluation of the qualifications and effectiveness of teachers of physics.
4. The giving of help to teachers in incorporating modern knowledge in their courses.
5. The promotion of the exchange of information and ideas among all countries by methods that would include the holding of international conferences.”

Before the end of the same year (1960) the International Commission on Physics Education came into official existence as the 15th commission of the International Union of Pure and Applied Physics (IUPAP). The Paris conference is in fact generally regarded as having been the first project of the new Commission: certainly the membership of the new Commission came from the chief organizers of that conference.

2. Organization and programmes

As a creature of IUPAP, the Commission on Physics Education fell into a pattern already fairly well defined by the commissions already in existence. Its members, initially seven in number, came each from a different country of the IUPAP family, which now (1980) includes 37 nations. The membership of the Commission comes up for review once every three years at a IUPAP General Assembly; at the present time there are twelve full members and three associate members. The Commission tries to meet at least once a year, but budgetary limitations prohibit anything more ambitious; the meetings are often linked to the holding of a conference on some aspect of physics education.

In view of the Commission's general field of interest, it is not surprising that it has had from the beginning, and throughout its existence to date, a strong tie with Unesco. In addition, the Commission has served as a collaborator with Unesco in the production of major publications on physics education — notably the volumes entitled *New Trends in Physics Teaching* about once every four years.

The chief function of the Commission, in conformity with the stated aim of IUPAP generally, has been the organizing and facilitating of international conferences. The main emphasis has been on the teaching of physics at secondary (high school) and tertiary (college or university) levels. (These conferences are listed and described later in the article.) However, the Commission has been broadly concerned with all the matters identified in the founding statement reproduced above. Thus, for example, it worked closely with Unesco in the production of a detailed survey (1966) of the teaching of physics at universities in different countries. And in promoting exchange of information about physics education, one of its most successful projects has been the publication, about twice a year since 1977, of an international newsletter containing announcements of meetings, descriptions of physics education projects, etc., based on information supplied by correspondents from around the world. This newsletter, financially supported by Unesco, is sent free of charge to a mailing list of about 1000 individuals and organizations.

3. How international?

It is a cosy truism that science is international, but this statement needs to be examined. What it means, of course, is that a scientific experiment, properly conducted, yields the same result (within the margins of error) wherever it is done, that the criteria of scientific belief are universal, and that the language of science knows no national boundaries. But the practice of science, and especially of physics, has never been truly international — least of all today for the simple reason that research at the frontiers calls upon technical resources that may be lacking in all but a few countries.

Looking at education in science, and in physics in particular, one can argue that it is both more and less international than pioneering research. It is more international in the sense that every civilized country has science as an essential component of its educational programmes, and a country without particle accelerators can still teach physics, even to a high level. On the other hand, an educational system is part of the social fabric of a country, and the way in which science is taught may be shaped or constrained by local conditions and resources.

This difference between physics research and physics education has, I believe, an important influence on the role of the International Commission, and on what it can hope to achieve.

On the positive side, there is no doubt that teachers in different countries have much to learn from one another. It is emphatically not a one way street in which poorer countries pick up what they can from the richer. An ingenious pedagogic idea may, indeed, have a greater likelihood of being born in a place where material resources are limited. More importantly, however, teachers of physics in all countries share the same concerns and purposes, and stand to benefit by getting together to discuss how they operate. The Commission, therefore, has consistently sought to make participation in its activities as broadly international as possible. Its greatest success to date has been the Edinburgh conference in 1975, at which about 75 different countries were represented.

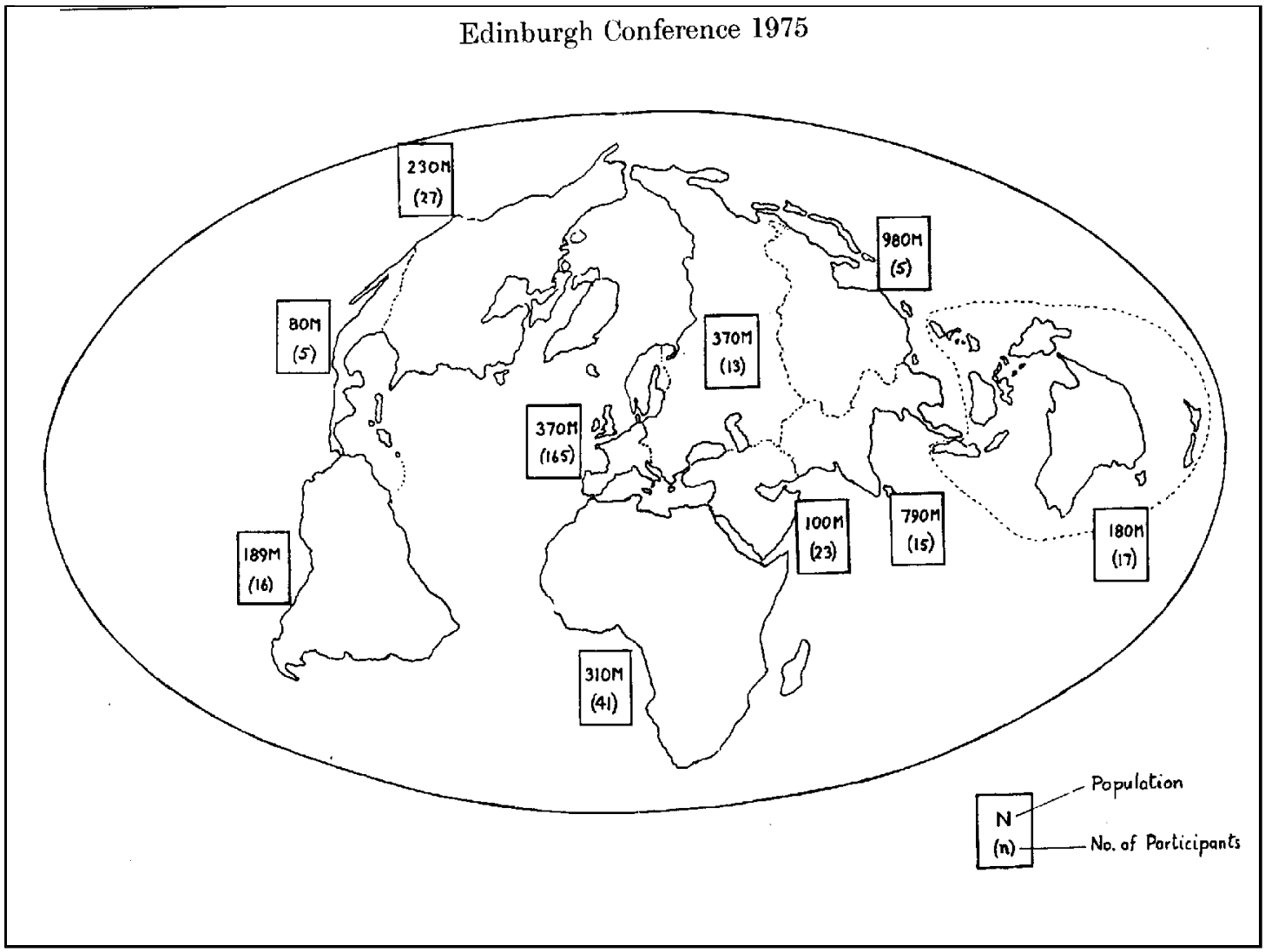
On the negative side, it must be admitted that physics education is a poor relation, a Cinderella, compared to most of the research fields represented in IUPAP. The Edinburgh conference just mentioned was by far the largest conference held under the Commission's auspices, yet it had fewer than 350 participants, whereas some of the research speciality conferences are up in the thousands. Of course size in itself is not a virtue, and may even be a drawback—in any case it affects the whole style and character of a conference—but it is ironic that physics education, which involves vastly more practitioners (by one or two orders of magnitude) than individual research fields, operates on a quite small scale when it comes to international meetings. (It may be worth pointing out, in this connection, that the membership of the American Association of Physics Teachers alone is about 10,000.) The limiting factor – a very grave one – appears to be the lack of funds available to enable teachers of physics to attend international meetings. The problem is severe for university or college teachers, and almost prohibitive for secondary-school teachers, yet most of those who do manage to attend such meetings would, I believe, attest to their great value as a forum for the exchange of ideas and experiences.

Although the Commission can claim some success in making its activities genuinely international, the picture is by no means fully satisfactory. To take a specific instance, the total attendance at the Edinburgh conference in 1975 was about 330 registered participants spread over 73 countries. However, when examined in close detail, the distribution was astonishingly non uniform. This is shown in the table and in the map. For convenience, the world has been divided here into ten main regions, as listed in the table. The number of participants averaged about one per 10 million of world population, but at one extreme was the Orient (primarily China and Japan) with only 5 participants from about 1000 million population (i.e., about

one per 200 million) and at the other was Western Europe, with 165 participants from 370 million (i.e., about one in 2 million). Also very noteworthy, and regrettable, was the contrast between Western and Eastern Europe (including the U.S.S.R.) a factor of more than ten difference in the numbers of participants for essentially equal total populations. Of course, it is to be expected that the host country for a conference will be disproportionately represented, but this goes only a small way towards accounting for the big East-West difference just referred to. At an earlier conference, held in Hungary in 1970 the representation from Western Europe was 70% of that from Eastern Europe. Thus, much remains to be done if the scope of the Commission's activities is to be truly representative of the world's many different educational systems. The outstanding omission — which recent political developments may help to repair — has been any involvement at all from the People's Republic of China.

Region	Countries	Total Participants	Total countries	population (millions)
N. America	2	27	2	230
Central America	4	5	13	80
S. America	5	16	11	190
W. Europe	16	165	21	370
Africa	18	41	42	310
USSR/E. Europe	6	13	11	370
Middle East	10	23	10	100
Orient	3	5	7	980
India/E. Asia	5	15	12	790
Australasia	4	17	6	180
73	327	135	3600	

Edinburgh Conference 1975



4. The Commission - sponsored conferences

4.1. The first conference (Paris, 1960) (Brown and Clarke 1960, Sears 1961).

This conference, from which all the Commission activities developed, was conceived by Professor Sanborn C. Brown, who subsequently became the first chairman of the Commission, and by Dr. W. C. Kelly, who was elected chairman in 1972. The opening address was by Professor Yves Rocard, who expressed the hope "that we shall arrive at a definition of an international teacher of physics, who should be a generator of fruitful exchanges, and who should contribute to breaking down the potential barriers of out of date nationalism between our countries, in a century in which the great enterprises of science call for universal collaboration."

The main themes of that conference have proved to be recurring ones: Physics as part of a general education; Examinations and the selection of students; Curricula; Laboratory; Physics for other sciences and engineering; Training for teaching and for research; Films and television as teaching aids. In the nature of things, much time was devoted to comparing and contrasting the educational systems in different countries. One participant (Dr. M. Santur of Turkey) expressed himself eloquently on the Two Cultures theme:

"Physics as a method and philosophy does not have a very great impact on the way of thinking of the majority of cultured men at the present time. A man of culture takes pride in his knowledge of letters, philosophy, and fine arts; he can quote from Cicero and Aristophanes, he can discourse on the subconscious and knows the difference between abstract and impressionist painting, but he easily confesses that he never understood physics . . . He considers it a dry subject, a mere craft, which, to be sure, yields some profitable results but which should be left to the appropriate craftsman. If physics as a way of thinking is to take its rightful place along with other humanities, and if it is to influence the attitude of mind of large masses, a great effort has to be made..."

I am tempted to suggest, pessimistically, that the only significant change in that picture, twenty years later, is that the level of general culture on the purely humanistic side has fallen, without any compensating gains for science. Certainly, physics as part of every man's (and woman's) education remains a distant dream— but at least some vigorous attention is now being devoted to it. Both qualitatively and quantitatively, however, it presents vastly more difficult problems than the training of our own kind, and the time scale for any significant impact is undoubtedly long.

Besides its proposal for the creation of the International Commission on Physics Education, the conference in its final resolutions recommended a major improvement in the degree of professionalism and the working conditions of physics teachers, and a closer relationship between universities and secondary schools in the area of physics education.

4.2. Conference on Physics in General Education (Rio de Janeiro, 1963) (Brown et al. 1964)

This conference took its theme from the first of the resolutions passed at the Paris conference, which began: "In our view, physics is an essential part of the intellectual life of man at the present day." Its stated area of concern was the broad training given to all children up to about the age of sixteen. The conference had 149 participants from 29 different countries.

The conference recognized that, at the general educational level, physics could not be fully separated from other facets of that education, even though it needed to be taught as a subject in its own right. The holding of the conference in Brazil, a technically underdeveloped country, helped to concentrate attention on science as a component of a *general* education, but, within this framework, as the chief key to progress for developing nations.

In keeping with this broad theme, although there was some discussion of particular courses, especially the American PSSC programme and the British Nuffield project, the main emphasis was on exploring the status of physics as part of our culture, and on how teachers and students alike could be given an adequately broad view of its role.

Gerald Holton contrasted the narrow and sequential pattern of a traditional physics course with the possibilities of a course having numerous connections to other sciences and to other areas of intellectual and cultural endeavour. Eric Rogers advocated a programme that stayed within the bounds of physics but broke through the artificial partitions between different areas of the subject, and that had as its conscious aim the basic understanding of physics, rather than the acquisition of numerous formal results and unrelated facts. These influential educators have, of course, embodied their ideas in works which, like PSSC and Nuffield Physics, have become deservedly famous *(Harvard Project Physics* and *Physics for the Inquiring Mind).*

There was agreement amongst the participants that physics should be introduced at an early stage in all educational systems, but that existing courses usually fell far short of presenting the subject in such a way as to do justice to its importance and its

achievements. Ways of improving the situation, through better curricula and more enlightened methods of teacher training, were discussed.

4.3. Conference on Education of Professional Physicists (London, 1965) (Brown and Clarke 1966)

This conference had a much sharper focus than either of the first two, and was felt to be correspondingly more successful. It had 93 participants from 26 different countries.

In his opening address Lord Beeching (of Imperial Chemical Industries, and formerly Chairman of the British Transport Commission) argued strongly that university training, at least in Britain, took insufficient account of the fact that most of its physics graduates were destined to work outside academia, and often in jobs not making direct use of physics. In consequence physicists are not as prominent as they should be in top management, administration and politics, where their scientific training would often make them more effective than the arts graduates who traditionally occupy such positions. He quoted an earlier remark of his on this theme: "To my mind it is highly desirable that physics should be regarded much less than it is at present as a form of vocational training and much more as a part of general education for life in a technological world." He suggested that perhaps the research and the teaching roles of physics departments ought to be made somewhat separate, with perhaps some shift of emphasis from the former to the latter.

Not surprisingly, Lord Beeching's remarks elicited a fair amount of discussion. The interface between the universities and industry was the subject of full length papers by Mr. G. Bosworth (English Electric Co.) and Dr. H. G. B. Casimir (Philips Eindhoven).). Casimir emphasized the value to industry of getting graduates who were strong in fundamental knowledge and capable of frontier research. With characteristic wit he remarked,

"From the point of the company manager it is clear that the research laboratory and the physicists must serve his purposes, which is often expressed symbolically by saying that the physicist must help him to earn money. I say this is a symbolic expression because, to my mind, whereas physicists deal with concrete things like electrons and atoms and electromagnetic fields and wave functions, business men deal with abstractions like money. That it is an abstraction is quite clear because, whereas most physicists will agree on the definition, of an electron or atom, no two economists will agree on the definition of money!"

He asserted the possibility of "an honourable compromise" in which a physicist pursues work of value and importance to himself while at the same time contributing to the well being of the company that employs him. The involvement of university professors as consultants in industry was also, in his view, an important two–way connection with educational implications.

Most of the other sessions of the conference were based on descriptive accounts of university physics teaching programmes in different countries Belgium, Britain, The Netherlands, South Africa, U.S.A., and U.S.S.R. The existence of widely different traditions was apparent, with massive formal training in the U.S.S.R. at one extreme, and some approximation to physics as part of a general cultural education in a number of four year colleges in the U.S.A. Special Sessions were held on laboratory work and on the use of films and television, including the use of television to reach students outside the universities.

4.4. Seminar on the Education of Physicists for Work in Industry (Eindhoven, 1968) (Diemer and Emck 1969)

This international seminar brought together 60 participants from 19 countries. There was an essentially equal mix of industrial and academic representatives.

The seminar had been preceded by several months of selection and study of relevant literature and reports. Building on this, the seminar itself was structured into five working groups, concerned with the following topics: (1) Circumstances and requirements of industry; (2) Possibilities for improvement in university preparation for industrial careers; (3) Specialist versus generalist education; (4) Cooperation between university and industry; (5) Extramural education.

The editors of the Proceedings commented that "a common denominator of the whole seminar was undoubtedly the main emphasis on mental attitudes, general abilities and methodology both in the physicist's education and in his professional career, and not on specific knowledge and specialist curriculum content." It was felt that a central problem was that students in general are very poorly informed on the diverse careers open to physicists in industry, and let themselves be put off by such pejorative catch phrases as 'rat race' and 'cog in the machine.' Universities can and should undertake a major role in remedying this situation. It was felt that the possibilities of mutually beneficial cooperation between industries and universities, combining their different kinds of strengths, were very great but in general were being inadequately exploited. The importance of making refresher courses and supplementary education available to physicists in industry was strongly

urged. Another point, seldom given much attention in the academic training of physicists, was the enormous importance of effective expression and communication, especially technical writing, for physicists in industry, whether they stay in research or go into management

4.5. Seminar on the Role of the History of Physics in Physics & Education (Cambridge, Massachusetts, 1970) (Brush and King 1972, Brush 1972)

This seminar was the smallest and most specialized of all the meetings that have been held under the sponsorship of the Commission. It had 32 participants, representing 12 countries (but with more than half from the U.S.A.). The impetus for it derived from the Rio de Janeiro conference in 1963, where Professors G. A. Boutry (France) and G. Holton (U.S.A.) had both discussed this theme.

The meeting was not lacking in controversy as to how, or even whether, physics and history (or physicists and historians) could be brought together. Martin Klein contrasted "the rich complexity of fact, which the historian strives for, with the sharply defined simple insight that the physicist seeks," and arrived at the pessimistic conclusion that "in this respect, at least, the modes of thought of the physicist and the historian of physics are antithetical." Others were more hopeful — for example, Samuel Devons, who felt that teachers of physics would experience enlightenment (and surprise) in learning the true story of how various physical concepts developed, in contrast to the packaged and distorted versions that find their way into many textbooks. Professor Dirk ter Haar expressed the view that the history should be presented in areas (e.g., certain aspects of quantum theory) where problems that troubled the creators of the theory (e.g., Dirac and Pauli) had been set aside rather than solved, and so might pave the way for future research. Some felt that an historical approach might help in spreading some knowledge and appreciation of physics to the wider public. The meeting took due note of the growing awareness and appreciation of the value of preserving the historical record of relatively recent physics through oral and visual, as well as written, materials.

The meeting adopted a format that has been paralleled in subsequent conferences, mixing plenary sessions with working sub groups addressing particular questions. Out of all this came a number of recommendations, the first of which was for the production of a book on the history of physics under the joint auspices of IUPAP and the International Union of the History and Philosophy of Science. (This did not come to pass, but the proposed chairman of the editorial committee, Dr. Max Jammer, has since made major contributions along this line by his own independent efforts, as readers of his books will know.) Other recommendations, of a more general nature, urged that physics teachers be helped to obtain and use historical materials, that the acquisition and care of archival materials in all countries be encouraged, and that international cooperation be sought for information exchange, preparation of translations of important books and articles, etc.

4.6. Congress on the Education of Teachers of Physics in Secondary Schools (Hungary, 1970) (Brown *et al.* 1971)

This conference attracted over 150 participants from 28 different countries. Particularly noteworthy was that the opening address was by Professor P. L. Kapitza of the Soviet Union. Conceding that he was not a teacher, he nevertheless spoke forcefully and with great insight on the basic questions of scientific education in modern society. He saw as prime problems the need to educate young people in the creative use of their ever increasing amounts of leisure time, and also the need to foster individual creativity within the school context, Many participants in the subsequent discussion expressed their concern that young students were turning away from physics, and from science generally; there was speculation that perhaps major changes in approach and subject matter were called for. The conference did, however, spend most of its time discussing specific questions of teacher training and the constraints within which it is carried out. There were working groups on preservice training, in service training, curriculum innovation, educational technology and the special problems of developing countries.

4.7. General Conference on Physics Education (Edinburgh, 1975) (Archenhold et *al.* 1975, 1976, Paldy 1975, Lewis *et al.* 1976)

This conference, prepared and conducted in close association with Unesco, took for its purview the whole range of physics education at secondary and tertiary levels. As noted earlier it was the Commission's largest and most ambitious conference, and also the most truly international, with about 30% of its participants coming from 46 developing countries (out of the total of 73 countries represented). Most of the participants were teachers at college or university level.

The conference was organized around about 20 working groups, corresponding rather closely to a similar number of background papers on various topics, commissioned and printed in advance of the conference. In rough terms, the topics of the conference fell into three categories Course Content, Methodology, and 'Sociology' (this last including such topics as Science and Society, Women in Physics, etc.). Each participant was asked to choose two working groups in which he or she

would join. The most popular topics were curriculum development, the relation of mathematics to physics teaching, and new approaches to methodology. During the course of the conference, each working group developed a report based upon the original background paper, modified by the group discussions and other inputs. After the conference, these reports were further edited, and published collectively as one of the Unesco *New Trends* volumes (Lewis *et al.* 1976).

The conference also had a number of plenary sessions addressed by distinguished scientists and educators, including Pierre Aigrain (now France's Secretary of State for Research), Hermann Bondi, A. R. Kaddoura (Assistant Director General for Science at UNESCO), and Victor Weisskopf.. The full texts of all these plenary talks have been published, and make very good reading (Archenhold *et al.* 1975, 1976).

Looking back, one can see that the Edinburgh conference was held at a significant time for physics education, and indeed for physics in general. It came after two decades of great activity, exciting discoveries, and massive expansion of physics as a professional field after the end of World War II. The student radicalism that had swept the universities a few years earlier had largely subsided, and in any case had affected science less than other fields. But by 1975 the chill winds of economic recession had begun to blow, and enrollments in physics (and other scientific and technical fields) had begun to dwindle, at least in the highly developed industrial societies of the West. Under the circumstances it was not surprising that attention became refocused on the recognition that an ever increasing part of our teaching must be concerned with those who are not going to be professional physicists, or even scientists of any description. Hermann Bondi pointed to the unreasonableness of ever designing our university curricula as if their main business was to produce future academic physicists when, in a steady state, only about 1% of our students can be absorbed into the academic positions that fall vacant through retirement of older faculty members. Professor Kaddoura, taking a still broader view, argued that the concept of education as something concentrated in time and space during a person's younger years must go, because the present system perpetuates social stratification — a problem that is particularly acute in the developing countries.

4.8. Conference on Teaching Physics for Related Sciences and Professions (Cambridge, Massachusetts, 1976) (French 1976 a, b))

This conference had a total of 95 participants from 27 different countries. Its title very directly reflects the kinds of concerns mentioned above, and the conference tried to address in some detail the problems of teaching physics for other clienteles. It did this through separate working groups on physics for engineers, technicians, other physical sciences, life sciences, biomedical students, and prospective teachers. The results of their deliberations are briefly reported in one of the two published articles describing the conference (French 1976b).

Despite a good deal of effort, the conference did not attract many representatives of those other professions whose interests as consumers it was trying to address. Thus, although there was much fruitful discussion, this conference left one with a sense of unfinished business. A natural sequel to it, at some future date, would perhaps be a series of separate meetings, each concerned with just one consumer group, and with steps taken to ensure that the consumers were present in goodly numbers.

4.9. Conference on the Role of the Laboratory in Physics Education (Oxford, 1978) (Jones and Lewis 1980)

This conference had the special feature that it was a joint project of the Commission and the organization known as GIREP (Groupe International de Recherche sur l'Enseignement de la Physique), which was founded in 1966 and has a special concern for pre university physics and for teacher education.

The conference had 150 participants from 44 countries. Its theme was perfectly expressed by a Latin inscription that one sharp eyed participant observed on the wall of the Botany Laboratory in Oxford's Botanical Gardens: *Sine Experientia Nihil Sufficienter Scire Potest.* The participants came together with the conviction that good laboratory work is essential to the teaching and learning of physics; the concern of the conference was to discuss ways and means of achieving this goal.

Part of the background material for the conference was a set of six background papers, commissioned by Unesco,, on physics laboratories in various countries or regions: Africa, Chile, the Arab World, Eastern Europe, India, the Philippines.

The membership of the conference reflected a rich variety of backgrounds. There were people teaching physics at widely different levels, and under even more widely different local or national backgrounds. This was exemplified, quite deliberately, at the opening session, which had one speaker discussing the teaching of elementary physics in largely rural schools in the Philippines, and another describing a highly specialized laboratory at university level in a technical university in Sweden. But, as the conference proceeded, there was a convergence as the role of the laboratory was reappraised at all levels, and common ground between school and university, between developed and developing country, came to be appreciated.

The conference was organized into nine working groups concerned with different aspects of the general theme, and including (following the GIREP tradition) two groups concerned with very specific areas of subject matter (electronics and optics). Other groups dealt with such matters as low cost apparatus, assessment of laboratory work, open ended project work, etc.

4.10. Other conferences

As this article goes to press, preparations are almost complete for two international conferences to be held in 1980 one, at Trieste, on Education for Physics Teaching (in secondary schools) and the other, at Prague, on Post graduate Education of Physicists (primarily for research or for university teaching). In these topics we see a recurrence of themes discussed at earlier conferences, but this does not necessarily imply repetition, any more than does a series of annual conferences on a particular field of research. To be sure, progress in pedagogy is probably less rapid and less clear cut than in, say, plasma physics, but things do change, and — perhaps even more important — each conference brings together a significantly different group of people, through whom the first hand exposure to colleagues and developments across the world is gradually spread from an increasing number of local centres..

It should be admitted, however, that the pattern of the future may well shift, and perhaps ought to shift, in the direction of regional rather than fully international meetings. It is highly stimulating to exchange experiences with teachers from totally different backgrounds, but it cannot be denied that substantial changes in curricula and teaching methods are more likely to grow out of a concentrated and detailed effort by teachers from a particular region, who can get together in substantial numbers to discuss problems that they face in common. The Commission has no mandate to organize regional meetings of this sort, but it has been glad to associate itself with one such conference the Southeast Asian Regional Conference on University Physics (1977) (Singh 1977, Singh and Seward 1978), out of which came a proposal for the creation of an Asian Physical Society. Of course, many other national or regional associations exist and function independently of the Commission — such as the Latin American Center of Physics (CLAF) in Rio de Janeiro.

Mention should also be made of a conference on Co operation between Science Teachers and Mathematics Teachers of which the Commission was a co sponsor along with the International Commission on Mathematics Instruction, Unesco,, the Committee on Teaching of Science of ICSU, and the Institute for the Didactics of Mathematics at Bielefeld,, West Germany (where the conference was held, in 1978). The mathematical background of their students is a familiar concern (perhaps better described as a headache!) for all physics teachers, and this conference was a serious attempt to grapple with the problem at the secondary level. There would certainly be scope for similar joint conferences between mathematics and physics teachers with regard to teaching at university level, both undergraduate and post graduate. The interested reader is referred to the conference proceedings for full details (Steiner 1979).

5. Relations with Unesco

As mentioned early in this article, the Commission has had a close relationship with Unesco, and this has led to some of the Commission's most significant activities and publications. The *Survey of the Teaching of Physics at Universities* (Kelly 1966) was a detailed and impressive study of all aspects of university physics education in six countries covering a spectrum of academic traditions and structures (Czechoslovakia, France, United Kingdom, U.S.A., U.S.S.R. and West Germany). A more global survey (but restricted to post graduate education will be part of the output of the 1980 conference in Prague. A rich sourcebook (Lewis 1972) on secondary school physics teaching was published as the result of collaboration between Unesco and John L. Lewis, working in his capacity as Secretary to the Commission. The *New Trends in Physics Teaching* volumes are a direct result of Unesco initiatives, and Unesco support has been important in the production of the *l.C.P.E. Newsletter* and of what has been perhaps the Commission's most widely noticed publication to date - its book prepared in commemoration of the first centenary of Einstein's birth (French 1979).

This fruitful partnership is only one small component of the relationship that Unesco has had, ever since its foundation in 1946, with the International Council of Scientific Unions (ICSU) of which the Physics Union (IUPAP) is one of about twenty members. Through a long standing arrangement, Unesco gives to ICSU an annual subvention, which is then apportioned among the various Unions and their individual Commissions. Over and above this, Unesco enters into individual contracts for the support of individual projects.

In the main, this association of Uneseo with ICSU has been productive and enormously beneficial. In the background of the relationship, however, there remains the fact that Unesco is a creation of the governments of the world’s nations, whereas ICSU is international but strictly non governmental. The ultimate control of Unesco lies with its General Conference, a political body made up of the official representatives of individual countries, which meets once every two years. Unfortunately, we have seen instances in which the political forces have sought to influence or limit the ability of scientists

to participate, regardless of national affiliation, in international professional meetings. In such cases it has been essential for the scientific bodies, such as our Commission, to make clear that the apolitical nature of science, and the assurance of free circulation of scientists, are paramount principles, and that the acceptance of Unesco support is possible only on this basis. Such problems are fortunately rare, and have no bearing, in any case, on the friendly relations and the superb cooperation that our Commission has always had with the professional staff of the science education sections of Unesco.

6. Assessment, and looking ahead

'International Commission on Physics Education' is a fine sounding title. Have the Commission's achievements measured up to the expectations that its name may engender?

It is important to recognize certain sober realities. The Commission is, in itself, no more than a committee of individuals scattered over the globe. As mentioned earlier, they are not able to come together more than about once a year, and in the long intervals between meetings they have, for the most part, very little collective communication. As a matter of policy, they are chosen to represent different countries, different academic traditions, different cultures The one thing that draws them together is their common concern for the improvement of physics education. But this group of ten or a dozen individuals, with a guaranteed annual budget of only $500 a year from IUPAP, cannot by itself make any appreciable impact on the shape of physics education. Its only possible role is to act as a catalyst for activities involving large numbers of other people.

Working within these considerable constraints, the Commission has - as I think many physics educators would agree - built up a rather remarkable record of achievement, as described in the earlier sections of this article. Each conference sponsored by the Commission has involved the setting up of a special planning committee, a quest for supporting funds, and an assiduous effort to bring together an appropriate group of participants and speakers. To maintain the momentum for such activities requires a great deal of work and enthusiasm, and there is no doubt that a large fraction of this has been provided by the Commission's very dedicated Secretaries, of whom there have been only four in the lifetime of the Commission so far - Norman Clarke, W. C. Kelly, John L. Lewis and P. J. Kennedy. These same people have played a major role in initiating and maintaining the activities of the Commission in general.

One may, of course, still question the ultimate effect, on individuals and on educational systems, of the numerous meetings that the Commission has organized and the substantial body of published material that has resulted from its activities. My own belief is that these influences tend to be slow, subtle, and often indirect, so that it is rare that one can point to an obvious cause-and-effect relationship. The situation here is, I think, very similar to the process of teaching itself. It is a fortunate teacher who can feel sure that he or she has been directly responsible for some dramatic improvement in a pupil's performance. More often, it seems to me, the effort that one puts into teaching is a sheer act of faith, based on the hope that perhaps, in a few minds, one may now and then plant a seed that will flower elsewhere, many years later. If we tried to assess our effectiveness in terms of directly attributable consequences, we would probably give up in despair!

Perhaps one of the most valuable things the Commission can do, and has done, is to help give to physics teachers across the world a stronger sense of community. This can be particularly important for teachers in countries far removed from the densely populated and technologically advanced regions of Europe and North America. The Commission's *Newsletter* has been remarkably effective, out of all proportion to its modest cost of production, in responding to this need. It may well be worth many a conference, especially when the conferences inevitably involve only a tiny fraction of the population of physics teachers. The conferences do, however, play an irreplaceable role in their potential for direct impact on those individuals who are able to attend them. Ideally, the published Proceedings of the conferences would communicate this experience, albeit in less vivid form, to a much wider audience. It must be admitted, however, that this does not happen to any great extent. The printed records are not exactly best sellers; they tend to languish, unnoticed and soon forgotten, on library shelves, and renewals of actual personal contacts at the international meetings are vital — an acknowledged fact in all areas of scholarship.

And now, what of the future? To quote Shakespeare's familiar words, "What's past is prologue" (1623). The recommendations made at its first conference in 1960 laid out a programme that has amply occupied the Commission until now. Should it simply continue to thrash over the same agenda, or has past experience begun to suggest new areas of concern and different sorts of emphasis? Such a sharp dichotomy of the possibilities would be unreasonable, but I believe that a real 'new trend' has begun to be apparent. The 1960 recommendations placed great emphasis on the impersonal aspects of physics education: curricula, examinations, information about national educational systems, etc. But after two decades of active concern with such matters involving such rich and valuable curriculum projects as PSSC, Nuffield Physics, and the Harvard Project — I think that physics teachers are becoming more and more conscious of two things. First, that the attributes of the individual teacher are far more important than any particular curriculum. (I remember reading

about the wise though uninstructed adolescent, preparing for confirmation, who was asked "What is the outward and visible sign of baptism?" Instead of giving the canonical reply, "The cross inscribed on the forehead with holy water" he answered, cogently and devastatingly, "The baby.") Yes, I feel sure that the absolutely central role of the teacher, and the fact that physics education is still ultimately a human activity, will become a more conscious focus of future endeavours. Second (as emphasized earlier in this article) I believe that we are coming to realize that much more thought and effort need to be directed towards the place of physics and physicists in society as a whole. This does not, of course, imply any dilution of physics as a rigorous academic subject, the preservation of which is the natural concern of most professional physicists. In addressing most of our past efforts to that area we have been doing things that were important but relatively easy. Now we are being confronted with our relative failure to educate the general public in scientific matters, and with our own inattention to the social ramifications of physics research. At this point we could use some of the drive that such men as J. D. Bernal, Lancelot Hogben and C. H. Waddington brought (from a particular point of view, to be sure) to the questions of the social responsibilities of science. The emergence of technology in the developing nations heightens the urgency of such questions, and I would hope that the Commission on Physics Education would find ways of contributing usefully to their solution. But the teaching of physics as a subject in its own right will never cease to be one of our major concerns. In conclusion, I should like to thank the editor of *Contemporary Physics* for inviting me to prepare this account. It is so easy to equate physics with research that I am glad to have this chance to draw attention to some of the challenges that physics education presents to us, and the role that the International Commission has tried to play in answer to these challenges.

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Page prepared by:

- *E. Leonard Jossem*