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75 Years of Linking the World of Electricity

By C.J. Stanford

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Three-quarters of a century have now passed since 33 leading scientists and engineers from 14 countries met in London on 26th and 27th June 1906 to constitute the International Electrotechnical Commission (I.E.C.). Undoubtedly, that meeting has proved to be of inestimable value for all concerned with electrical engineering, since the I.E.C. has played a vital role in promoting the applications of electricity, in ensuring the safe operation and the interchange of electrotechnical products as well as the exchange of knowledge between practitioners of all countries.

In retrospect, there was never any doubt that a permanent international body would have to be set up to prepare international agreements to link the world of electricity. A glance at history underlines this point: almost from the start, the progress of electrical science has been the result of an international pooling of knowledge enabling successive generations of scientists and engineers to further progress.

The electrical era began in the first half of the 19th century, following Faraday's discovery of electromagnetic induction in 1831 which made possible the direct conversion of mechanical energy into electricity. By mid-19th century, electricity and its applications had moved from the novelty into a semi-commercial stage following the inventions and discoveries of the many giants of electricity of that period. For example, Leclanché invented his famous cell in 1867, Graham Bell the telephone in 1876, and Edison and Swan the incandescent lamp in 1878.

It was these discoveries, and many others, that provided the basis for an electricity supply industry and the creation of a manufacturing industry for the provision of dynamos, motors, cables, switches and other equipment needed to exploit the new form of energy. As is well known, the main preoccupation of the nascent industry was the electric light.

By 1881, the industry was sufficiently well developed to warrant the calling of the first International Electrical Congress in Paris, where the foundations for the dynamic development of the electrical industry were laid. There, for the first time, scientists and engineers from 28 countries discussed the standardization of electrical units. The problems facing those eminent pioneers were enormous, for units differed from country to country, thus hindering the exchange of knowledge and information on the performance of products.

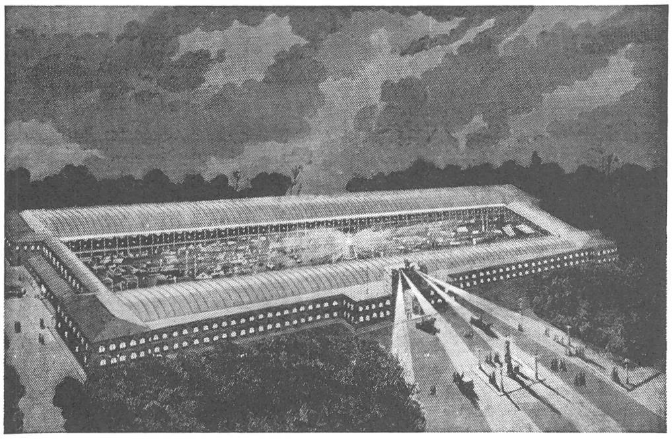


Fig. 1 The World's first International Electrical Congress held in Paris in 1881
It was at this Congress that international agreement was reached on electrical units

Despite these variances, international agreement was reached on seven electrical units. But another significant aspect of that Congress should not be overlooked, for it enabled the results of the work of electrical engineers and physicists throughout the 19th century to be brought together, and provided guidelines for their future work. Whilst it cannot be said that the outline of the future IEC had yet become discernible, it is true to state that it was in Paris, 100 years ago, that the spirit of international standardization was born; electrical engineers of all countries had learned to work together, had become aware that electricity would transform the world, and that regular international cooperation was essential.

The Commission's roots

Although the first paper to be presented at an International Congress on standardization appears to be that of *Col. R.E.B. Crompton,* a delegate of the Institution of Electrical Engineers, which he presented at the St. Louis Congress of 1904 under the title "Standardization of Dynamo-Electric Machinery and Apparatus", the author paid tribute to the standardization activities that had taken place in America and Germany.

Crompton's paper drew attention to the difference in standardization between the electrical and non-electrical sectors. He wrote:

"I think we must all agree that electrical standardization must bear a different meaning to standardization of the far older and more crystallized types of machinery used by mechanical engineers. It is highly undesirable that any types, patterns or sizes should be standardized if these are likely in any way to hinder the future development of design, but *all who have looked into the matter know how much useful electrical standardizing can be carried out in such matters as the settling on correct nomenclature, and definitions of certain terms hitherto used in a somewhat loose way in text-books or in trade lists, in settling standard test conditions,* in determining a satisfactory method of measuring the rise of temperature in the parts of electrical machinery that are affected by temperature rise."

The italicized part of the quotation shows how far-seeing were the founders of the IEC. In his paper, Crompton also described the method of working of his Committee on standards; the successive circulation of drafts, approaching more closely the consensus philosophy: "when all that was possible had been done by correspondence, it became necessary to hold a conference to decide on matters that remained unsettled", this procedure enabling "considerable progress to be made without the necessity and loss of time which would have followed if we had held conferences to decide on all these minor points". This is still the basis of IEC practices.

It was the reading of this paper that led the Chamber of Government Delegates to pass, on the afternoon of the 16th

September 1904, the well-known resolution calling for the setting up of "a representative Commission to consider the question of the standardization of the Nomenclature and Ratings of Electrical Apparatus and Machinery". Less than two years later, as a result of this resolution, the constitutive meeting of the IEC took place in London in June 1906.

In point of fact, the St. Louis Congress is so important that it requires nice judgement to decide whether the IEC was born in 1904 or 1906! The role of *Crompton,* both in St. Louis and in organizing the founding meeting in London, entitles him to be called "the Father of the IEC".

One historical coincidence that has passed almost unnoticed is the signing in 1906 of the first International Convention of Radiotelegraphy in Berlin. Today, when over 50% of the IEC's total activity is devoted to electronics, the child of the radio and the telephone, it is opportune to pay tribute to the pioneering work in electrical standardization that came from these circles.

There is a long tradition of cooperation between the IEC and the International Consultative Committees (C.C.I.R. and C.C.I.T.T.) of the International Telecommunications Union not only in the field of nomenclature, letter symbols for units and quantities and graphical symbols but also for general specifications for tests. The close cooperation between these Committees and the IEC is probably unparalleled in other fields of engineering and science.

Fig. 2 The 'Founding Fathers' of the IEC

They passed the resolution at the 1904 St. Louis (U.S.A) International Electrical Congress that led to the IEC being established in 1906

1. Herr W. Litzrodt, Germany
2. Prof. Dr. S. Arrhenius, Denmark and Sweden
3. Dr. R.T. Glazebrook, Great Britain
4. Prof. Elihu Thomson, United States
5. Prof. Moise Ascoli, Italy
6. M. Guillebot de Nerville, France
7. Señor Antonio Gonzalez, Spain
8. Prof. H.J. Ryan, United States
9. Ing. A. Maffezzini, Italy
10. Dr. F.A. Wolff, Jr., U.S. Bureau of Standards
11. Herr Bela Gati, Hungary
12. M. Dennery, France
13. Ormond Higman, Esq. Canada
14. Dr. A.E. Kennelly, United States
15. Señor M. Otamendi, Spain
16. John Hesketh, Esq. Australia
17. Cap. Ferrié, France
18. Col. R.E.B. Crompton, Great Britain
19. Prof. Norge Newbery, Argentine Republic
20. Prof. L. Lombardi, Italy
21. Marquis Luigi Solari, Italy
22. Dr. S.W. Stratton, United States
23. Prof. H.S. Carhart, United States
24. Prof. John Perry, Great Britain
25. J.C. Shields, Esq. India

Initial work

As could be expected, the IEC's initial work was aimed at international agreement on that subject fundamental to international trade terminology. Other areas of early work included symbols, ratings of machinery and standard mains voltages. But to describe all the early work of the IEC would be outside the scope of this article. It is sufficient to mention that work was directed at standards for the heavy current side of the electrical industry.

Successes were numerous, all of which helped promote the applications of electricity, and the standardization of electrical units serves as an excellent example. Agreement was reached on electrical units—the ampere, joule and watt—units which are basic to the work of electrical engineers all over the world. From this agreement came the M.K.S. (or Giorgi) system leading in turn to the expanded International System (SI) which is now applied in almost all countries. Another is the IEC's International Standard of Resistance for Copper, first issued in 1914, which is still the basis for many purposes.

A simple but important example of how the IEC laid the foundations for an expanding electrotechnical industry is that of the rationalization of the dry battery. Prior to the IEC examining this subject, there were scores of batteries of different sizes and shapes on the market. Indeed it seemed that almost every battery-powered electrical appliance had its own pile. To overcome this problem, the IEC issued recommendations which effectively reduced the number of batteries on the market by a factor of 5. As a result, the consumer is now able to obtain replacement batteries for any appliance in all corners of the world.

Expanding activities

Technological progress and innovation, two continuing features of the electrical industry, have long placed increasing demands upon the work of the IEC. Take, for example, the sector of electronics and telecommunications. In 1947, the IEC had only one Technical Committee active in this sector, dealing with Radiocommunications, but four Sub-Committees were set up in 1948. As this sector expanded, however, the IEC had to follow suit to meet the international need for agreements on electronic tubes and valves, electronic components, semiconductor devices, micro-electronics and other developments. By comparison, today, over half of the IEC's activity (represented by more than 100 Committees) is within the electronics and telecommunications sector.

The IEC has also played an important and expanding role in the consumer field by its attention to the safety and performance of household appliances. As recently as 1960, most electrical goods in the home were well known and technically simple. Today, technology has given rise to new social habits and sophisticated appliances with the result that the general public cannot hope to assess their quality and value. The cost of household appliances is often an appreciable part of the household income. Moreover, appliances are often imported from a foreign country where ways of life differ from those known locally. For this reason, the IEC set up a Committee to unravel the tangle of test methods used in different countries to measure the performance of appliances.

In parallel with this activity, the IEC also greatly increased its activity on safety rules for consumer goods. After all, the safety of an appliance is of primary consideration in any application, although what is understood by safety varies according to whether the equipment is to be used by skilled personnel or by the layman.

Whilst the IEC has played a major role in many key sectors of international electrotechnical trade, the capital goods area has long represented the greater part of its work. This is only to be expected, for this sector covers the widest range of equipment used in the generation, transmission and utilization of electrical energy—generators, transformers, insulators, overhead line conductors, switchgear and controlgear, cables and installations in ships and buildings, medical equipment, radio transmitters, electric traction and so on.

Returning to the electronics and telecommunications sector, the IEC initially concentrated on standards for components and sub-assemblies because of the wide variety of end products that could be assembled from standardized parts. To meet new demands, however, the IEC has progressively extended this activity to cover a wide variety of systems in which electronics play a substantial and integral role. The complexity of such systems has made the requirements for electronic components to be far more stringent than when these latter devices were primarily intended for home entertainment. The concepts of reliability and quality assessment have consequently found a place for study within the IEC framework.

Highlights of present-day work

The IEC's programme of work is now so wide that it seems invidious to pick out some as being particularly important. After all, the activity of each Technical Committee is of great importance for the particular sector with which it is concerned. I shall limit myself, therefore, to some general considerations that cross the boundaries of many Technical Committees.

Terminology

The first concerns nomenclature (or terminology). It should be remembered that one of the points on which the founders of the IEC laid special emphasis was 'nomenclature' or as *Crompton* put it "the correct definition of certain terms hitherto used in a somewhat loose way in text books or in trade lists". The founders were not concerned with this problem in abstract terms, as the reference to 'trade lists' proves. They realized the essential nature of clear and precise definitions of terms in commercial transactions—all the more important when commerce is between partners separated not only by geographical distance but also by linguistic and cultural backgrounds.

The electrotechnical sectors have been well served by the IEC in this respect. Its multilingual vocabulary—the International Electrotechnical Vocabulary (I.E.V)—is probably unique both in volume—15600 terms are defined in 3 languages—and the general level of accuracy of their definitions. Equivalent terms are listed in 6 other languages. The I.E.V. was a forerunner in respect of multilingual vocabularies, as they are now known, as it was the IEC that conceived the idea of preparing

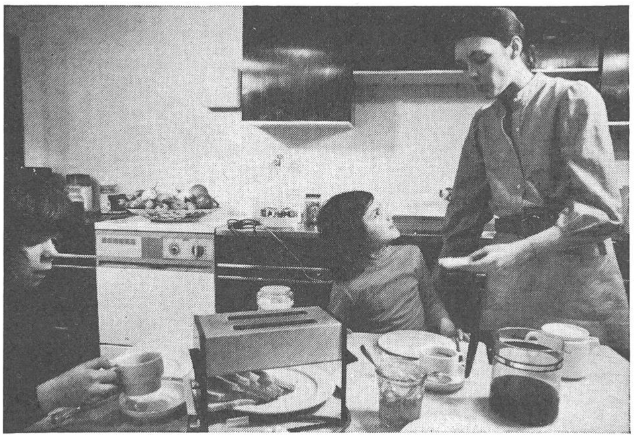


Fig. 3 IEC standards for the home
Many IEC standards have been published to ensure the safety of household appliances

vocabularies by Groups or Chapters of related subject matter. It is not well known that the first IEC Publication on terminology, published in 1911, was a *dictionary* with some 50 terms arranged in alphabetical order. It was the difficulty of revising this first dictionary that gave rise to the concept of preparing and issuing related groups (or chapters). It is only the use of modern techniques—the sorting of words into alphabetical order by computer and the immediate translation of the list so prepared into a photographic image suitable for immediate printing—that enables the IEC to plan the issue in 1982 of a dictionary based on the I.E.V.

The commercial significance of the I.E.V. was well underlined to the author by a remark made to him some years ago by a senior executive of the U.S. automobile industry: "If only we had had something similar to the I.E.V. in our field, we could have saved hundreds of thousands of dollars in mistakes made in ordering parts and in translating instruction manuals."

My reason for stressing this point is that today there appears to be a viewpoint in some circles that industry is not ready to pay for delegates to take part in terminology work. I believe this to be a short-sighted, albeit understandable point of view, for today the sectors covered by the IEC are benefitting from the immense effort put into the I.E.V. over the past 50 years. But not to keep the I.E.V. up to date is comparable to industry not maintaining its machinery—to begin with, the ill effects are limited but sooner or later there can be total breakdown.

One cannot emphasize too strongly, therefore, that the aim of 'standardization' is 'communication' between all parties interested in a given product and one cannot sell a product where performance or advantages are not described accurately. I believe that it is the duty of everyone responsible for obtaining support for IEC work in their respective countries to make known this point of the value of terminology work.

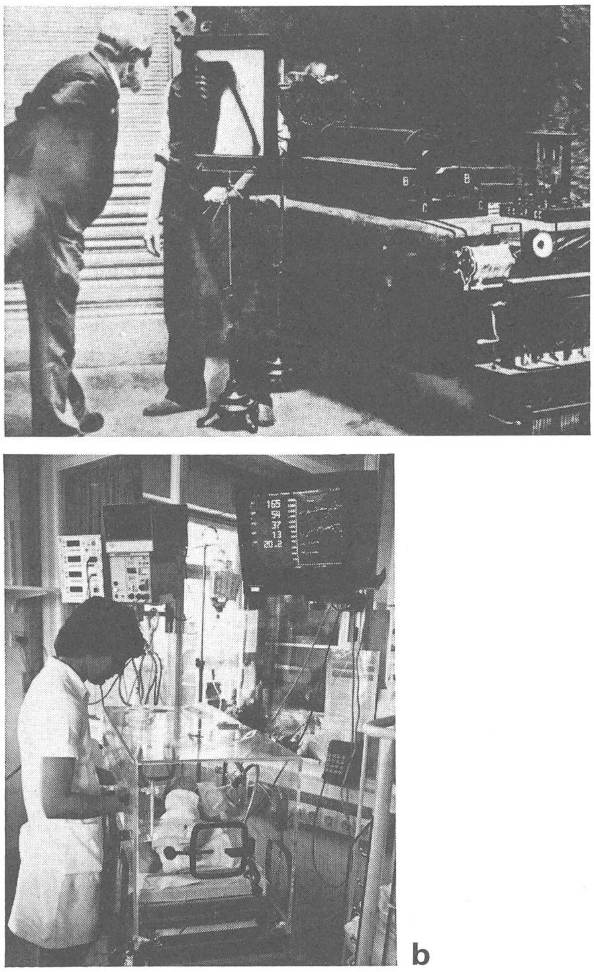
Digital techniques

Until recently, it was felt in many circles that the various aspects of digital techniques (e.g. interfaces, bus systems, programming languages) were of exclusive concern only to the mainframe computer manufacturer or user. Suddenly (or so it appears), the electrical world woke up to the implications of the widespread applications of digital techniques that had either occurred or were about to occur. The IEC was publicly criticized for not having taken steps to provide standards. This probably arose because of the phenomenal drop in the price of microprocessor chips and memories, enabling them to be used in areas that were unimaginable a few years earlier, so giving rise to needs that were not previously apparent.

To overcome this problem, the IEC decided in mid-1980 to set up a Sub-Committee (47B) to deal with microprocessor applications. This Committee will hold its first meeting in Montreux. The electrical and electronics industries have been so conditioned by the ease with which equipment with analogue signal inputs and outputs can be made to 'work together' that it is perhaps understandable that in some circles it appears to be felt that, even today, digital techniques can be made to work together by the IEC simply limiting itself to 'hardware' considerations.

Today, it might well be forecast that by the end of the decade, the 'local bus' concept—i.e. a bus that is not likely to be interconnected to another—will most probably have disappeared and we shall be faced with interconnection of any bus system with others over inter-continental distances.

Fortunately, late though it may be, the IEC has taken a lead in this matter and took the initiative earlier this year in bringing together the main bodies concerned with standards to emphasize the need for a coherent approach. However, inside the IEC, a concerted and continuing effort has to be made to solve the problems as they transcend the individual Technical Committees and their terms of reference (scopes). One way of tackling the problems may be by allocating a 'pilot' function to a number of Technical Committees for different facets of the overall problem.



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b

Fig. 4 IEC standards for the medical world

a A thorax fluoroscopy with an induction apparatus of 1898 ...

b bears no resemblance to modern day medical electrical equipment

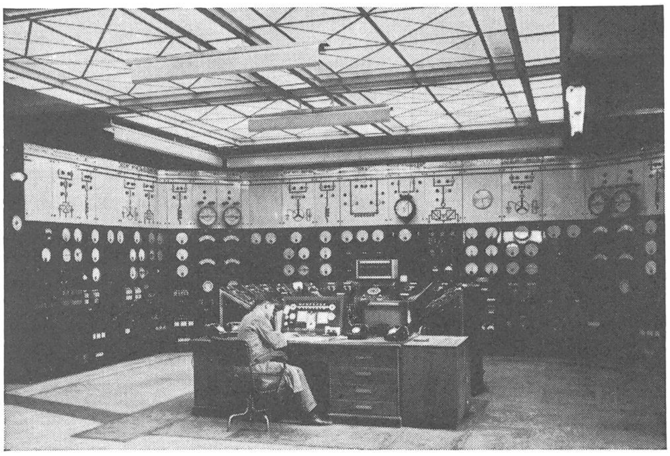


Fig. 5 IEC standards for the distribution of power

This control room represented the peak of technology around 1930

Speed of working

It almost goes without saying that if the IEC is to succeed in these new fields, there are two concomitants. One is a judicious choice of subject matter, concentrating on the really essential points and avoiding the temptation to write a textbook that will be obsolete before it can be drafted, let alone approved and published.

The second is to take advantage of the speed of communications offered by modern telecommunications. Unfortunately, the lack of standards inhibits the widespread use of digital text transmission on the many-to-one correspondence (relationship) needed in communications with the Central Office. But in the one-to-one relationship inside a country, much could be done.

The IEC Central Office is equipped for digital text transmissions and reception over the public telephone network (and uses this method for the printing of certain publications). The Central Office is also equipped with facsimile facilities for both transmission and reception.

Conclusion

Whilst the IEC has been closely linked with the many developments of the electrotechnical industry, the philosophy of international standardization has remained unchanged over the years. It is one thing which should be remembered and respected by all involved: Standardization cannot wait until experience has shown the ideal choice of parameters to be defined. To do so would result in differing solutions being adopted and consolidated by practice in different countries and regions.

Neither should standardization be begun so early as to hamper technical progress. This, in contrast to that of facilitating interchangeability of goods and international trade, of reducing costs by encouraging longer production runs, could fossilize technical progress and hamper the timely introduction of new techniques and products.

With technical progress continuing at its rapid rate, the Commission is striving to reduce the overall time it requires to publish an international agreement. To do otherwise could well result in IEC standards becoming obsolete soon after being issued—or even before!

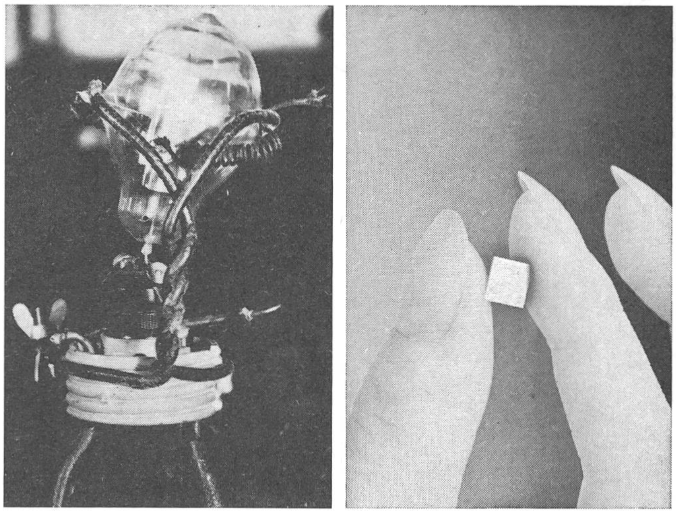
The IEC has undoubtedly enjoyed many successes over the years thanks to the continuing support of the member National Committees, of those who at management level direct and influence the electrical industry (in its widest sense of user as well as maker), and of the delegates who devote so much of their time and effort to preparing the draft standards. Through this support, the IEC has been able to provide a framework for international agreements spanning every sector of electrotechnology.

Certainly, the future is full of new challenges. Some are already present and in Montreux—the first meetings of two new Committees are being held on microprocessor assemblies and lightning protection. Studies into requirements for telematics and the direct conversion of solar into electrical energy are subjects already earmarked for early future IEC action. Other new challenges, such as standards for bio-engineering, are likely to become evident in the very near future. Not least among the challenges will be finding the resources, human as well as financial, to carry out the required programme. By meeting these challenges, the IEC will continue to play its established role of linking the world of electricity, let us hope, as successfully as in its first 75 years.

The major reason for the success of the IEC lies in the fact that the IEC is dealing with a well defined discipline, which is linked by a common thread running through all the activities, no matter from which sector come the participants—power generation and distribution—heavy industrial users, household appliances—electronics—telecommunications.

This commonality stems from two facts. The first is that all applications of electricity are governed by the same fundamental physical laws—namely the electron in motion obeying Maxwell's equations. This means that everyone concerned with the IEC, from the Council members to the newest delegate in a Working Group, have at least a minimum of common ground and can thus appreciate and understand the immediate problem of the other man, no matter what his final specialization.

The second is that the effect of the electrical current on the human body is the same throughout the world, meaning that the safety aspect is a common feature for all applications.



a b

Fig. 6 IEC standards for semiconductor devices

a The vacuum tube was at the centre of the development of radio and electronics in the early 1900s ...

b but minute semiconductor devices, tiny, powerful and tremendously efficient, have long taken their place

These two fundamental principles explain the great cohesiveness of the IEC's work, as they remain true no matter what may be the applications of electricity—applications that are now more and more penetrating into other sectors of human endeavour than those traditionally considered to be electrical.

This internal cohesion has meant that the IEC can offer not simply "x pages" of standards, but a co-ordinated system of standards that provide a firm basis for design and trading, the electrical sector having been right from its infancy one of intensive international trade. Let us hope that future generations will continue to appreciate the benefits that this internal cohesion and specialization have brought, through the IEC, to the whole of mankind, in giving to men and women around the world, no matter what their race, creed or form of economic organization, the benefits of the magic wand of electricity.

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