The Education of an Electrical Engineer.

By L. F. COOPER, A.M.I.E. Aust. (Member).

In presenting this paper to the Conference I do so with the desire that members will fully discuss this question. It has been debated in many different Societies for some considerable time with the result that the Profession of Electrical Engineer is more and more becoming to be looked upon with respect and the efforts of the Electrical Engineer to be more and more recognised each day.

Yet the Electrical Engineer is still far behind his fellows, Shire, Municipal and Civil Engineers, as far as salary is concerned, although his work is of a more dangerous nature and his responsibilities are greater. I feel that it is time that he was brought into line with engineers in the other branches.

Now we must consider what constitutes an Electrical Engineer. This has often been debated. The title of Electrical Engineer has been laid claim to by all and sundry, but it has only been more definitely decided within the last few years. I can well remember when almost anyone working at an engineering trade called themselves "engineers," and I believe that a large number still do so. They may be first class tradesmen, but are far from being engineers.

To get down to exactly what constitutes an Electrical Engineer, I would say that we should start with a good sound education at a Primary School. The Electrical Engineer must be well versed in general knowledge and be able to express his views both orally and by pen. He should be reliable and painstaking in all his undertakings. He should be able to read and make plans with the greatest of ease. He should be a good mathematician, with a good knowledge of the use of the Slide Rule, Logarithms and Trigonometrical Tables. He should be able to understand and use all the tools of trade in the Engineering line.

Again, the Electrical Engineer must have a good knowledge of surveying and be able to use the main instruments of the surveyor. He may be called upon to design re-inforced concrete work and steel structures; in fact, if he is not actually called upon to do this work himself he must be able to superintend the civil engineers who may come under him.

He must also have a thorough knowledge of Steam, Suction Gas, Crude Oil and Hydraulic Plant, and must know thoroughly Business Principles and the Laws relating to his Profession.

I have briefly outlined the qualifications necessary for the Electrical Engineer, although there may be many more, I will leave these for you to discuss, and will now proceed to review the methods adopted in the training of the Electrical Engineer.

At the present time, after a boy has finished his Primary school, he can enter a High school, a Junior Technical school, or a University, where he will be trained in all the subjects that he is likely to encounter in his profession. He is also given a little practical experience as well as most of the theory necessary, but I will say that it is impossible for any Technical school or University to turn out a **fully qualified engineer;** they simply train his mind in the right direction so that when he enters upon his career he will have no difficulty in grasping the problems which confront him. I know of one Technical school which will not issue a Diploma to its students until they have served twelve months or two years of approved practise, and this I believe should be adopted by all our Technical schools and Universities.

We must now pass to the case of the young man who may be living in the country and unable to attend Technical school. For him there is only one method and that is for him to take up a correspondence course in Electrical Engineering. If he is apprenticed to a Council or to a Private Electrical Supply Company he has a very good chance of becoming a competent engineer, provided, also, that he does not neglect his studies and succeeds in passing his examinations.

Another matter that I would like to mention is that of the examinations. These are not always a fair test of the student's ability, but tend to favour the student with the best memory in as much as they require the applicant to memorise a large quantity of formulae, whereas his being acquainted with them and able to quickly grasp and turn them up in his reference book would meet the case.

I believe that reference books should be allowed in the examination room and, to illustrate the point, will take the case of a question concerning the design of a transformer or of a high tension transmission line. No engineer should be required to carry all the formulae required for the two examples mentioned in his head, but he should be able to obtain quickly all the necessary formulae from the reference books and so be able to design the required structure in the quickest possible time.

An engineer must read the latest books and technical journals and be constantly keeping up his studies or he will find himself dropping behind in his profession.

These are my views on the subject, and I would be pleased to hear what other members have to say.

DISCUSSION.

Mr. Dunstan: I agree with a lot that Mr. Cooper has said, but I would just like to ask: "Is it not a fact that under the method now in vogue and under which certificates are granted, the system which this Association has been responsible for, there will be no electrical

engineers in the future, holding Local Government certificates, who will not be fully qualified. I take it that the certificates to be issued in the future will only be to absolutely qualified men."

Mr. Lemaire: Do not Mr. Cooper's views apply more to the electrical engineering profession generally? The remarks of the previous speaker referred to Local Government engineers only. There is the case of a man setting himself up in a repair shop, a work shop, an establishment of electrical appliances, or machinery. Mr. Cooper, I think, means that man also, before setting himself up in such a business, should have proper training.

Mr. Stewart: Is not Mr. Cooper rather confusing "knowledge" and "education." Education is looked at as **training** more than as the **acquisition of knowledge.** We used to be told that the word Education came from the Latin **E,** out of, and **Duco,** I lead. But according to the present day interpretation it was **E—Duco—** "To paint over." The popular idea of education is to put a coating on a man and call him educated. Memory training is not true education or the acquisition of knowledge.

Mr. Mead: I question whether a correspondence course is advisable for apprentices in the country. I have seen something of these courses but have not yet come across anything that I would care to recommend to any apprentice under me.

Mr. Vormister: Mr. Cooper's paper on the above subject covers such a wide field that I am afraid a discussion of it very fully might have the tendency to offend some Electrical Engineers, while being complimentary to others.

I thoroughly agree with Mr. Cooper that Shire and Municipal Civil Engineers are treated better than most Municipal Electrical Engineers financially, and members should feel very grateful that this Association has succeeded in raising their status to the position they are in to-day.

From the salary standpoint this may be problematical, as we are still paid on a revenue basis. This practice I quite agreed with a few years ago, but do not do so to-day. For example—a Municipal Electrical Engineer may exert all his energies to reach a goal of, say, £20,000 annual revenue, and his Council decide to reduce charges so that this figure is reduced to, say, £15,000. The Engineer is thus debarred the benefits of his increase in salary on reaching £20,000 per annum.

To my mind, therefore, there is only one fair way of assessing the rate of salary, and that is "on unit sales." This would stop many Councils reducing the salary of their Electrical Engineer, not because they are interested in the consumers, but more often purposely to keep the Engineer's salary down.

In the paper from paragraph 4 onwards, Mr. Cooper says, and I quite agree with him, "That the education of an Electrical Engineer should be primary-secondary and technical." I am afraid, though, that he has overlooked the fact that Electrical Engineering has very many branches, yet they are all classed as "Electrical Engineering."

I would enumerate a few of these branches:—Electrical Generators—AC. & DC.; Measuring Instruments; Power-house—design &/or working; Transmission line work; Switchgear; Illumination; Power application in factories, etc., etc.

In addition to these there is the Operating Electrical Engineer on HT, LT, E.H.T., Power-house and sub-station work, all of which, especially Transmission and switchgear, require first class qualifications for their proper attention.

The student electrical engineer, after completing his college course and apprenticeship, will drift into one of the above-mentioned branches of the business (more often accidentally and unintentionally), yet he is far from being qualified as an Electricity Supply Engineer. In this branch of the profession the **extra** qualifications, of common sense, tact and patience, are necessary, and without these it is impossible to stand up to the dictatorship of persons who are above him and who are absolutely ignorant of the first rudiments of electricity.

The Electrical Engineer with all his experience must, to be successful, be a sound business man for, with all his cleverness, degrees, etc., unless he can make his undertaking pay his council will only consider him a failure. The Council only judge by financial results.

Lastly, Mr. Cooper quotes the reading of Technical journals, etc. I think that members will agree that as an Electricity Supply Engineer finds his undertaking growing, he finds the time available for study becomes less and less, leaving only one course open, and that is to impart his knowledge to the student coming on, expecting him to be a better Electrical Engineer than his Chief.

Mr. Cooper (in reply): When I wrote this paper I did not know what the syllabus for Electrical Engineering Courses comprised in N.S.W. I have a good idea of the training of an electrical engineer in Victoria. For two years after the war I was teaching at one of the Victorian technical schools, and was surprised to find that in New South Wales there is only one technical school, and that is in Sydney. Regarding examinations, I do not believe that anyone sitting for an examination should be compelled to go in without a text book, for the simple reason that a man could not be expected to carry a lot of formulae in his head. The country boy, studying for the profession, was at a disadvantage compared to the city boy. I have seen something of one particular correspondence course, and as far as I can see it is a good course, and would assist the student to be able to pass examinations later on. But with a lot of these correspondence courses the trouble is that they are not practical. They are purely theoretical, and unless the student is engaged in practical work they are useless. Where an apprentice was engaged with a shire or municipal council or other concern, it is up to the engineer-in-charge to help him in any matter relating to the profession.

Mr. Dunstan: It might be a good idea to see if we cannot get some recognition of correspondence courses, in justice to the boys of the country.

Mr. Creswell: This association should request the Technical College Authorities or ask the Minister for Education to make provision in the Technical College Syllabus to institute a correspondence class for boys or apprentices in the country. The Technical College could handle it easily.

Mr. Crisp: The Education Department was proud of the number of children who went up for the intermediate and leaving certificate examinations without ever seeing their teacher. That work done by correspondence was a success, and I believe it would be a very wise move to approach the Technical College with a request that they should extend similar facilities to students of technical courses.

Mr. Thorncroft: I think that it would be better if we could have representation on the Sydney Technical College Board. That would be a step in the right direction.

(It was decided to write to the Technical College including Mr. Thorncroft's suggestion.)

A Comparison of Averages from the Annual Table of Costs and Records with those of the Mullumbimby Hydro-Electric Scheme.

By S. D. BERRY, Jr.I.E. Aust. (Member).

Two years ago, after sending the annual statistics to the Secretary for compilation in the Tables, a communication was received from him questioning several figures, as they were so out of comparison with those of other undertakings, that they seemed to be inaccurate. The writer, however, confirmed them and this paper is the result of a suggestion that a paper discussing the figures might be of interest.

The paper is written, therefore, on that account, and not as a eulogy of the Scheme or the writer.

Brief Description of the Scheme.— In the Mullumbimby H.E. development water is diverted from Wilson's Creek, a tributary of Richmond River, into Yankee Creek, a tributary of Brunswick River, by means of a short tunnel through Koonyum Range giving a fall of 320 feet.

The Generating plant consists of 2-140 kW Impulse Turbine driven Alternators and 1-135 kW Oil-driven alternator set.

The Water turbine sets are changeover sets, the pipe line being designed to carry the water for one set only. The two sets can be run together (with reduced head) but this is rarely necessary. The Oil-driven set is a dry season standby and averages about 10 per cent. of operating hours, being usually run for two shifts per day while dry season lasts.

The plant is owned by the Municipality of Mullumbimby and supplies retail in Mullumbimby and bulk to the Byron Shire towns of Byron Bay and Bangalow, also to farms in the district. Throughout all Records, and in this paper also, bulk supply to Byron Shire is neglected in the averages per consumer, as otherwise the figures would be useless (with one qualification as shown later), and as there are no unusual consumers in Mullumbimby, the averages are well based.

Unless otherwise mentioned, comparisons are based upon the 1931 figures from the Association's Annual Costs and Records.

Capital Cost.—The first unusual average is Capital Cost. This stands at £95 per Consumer. The nearest approaching this is the Town of Tenterfield (a converted scheme) at £61. Many towns under £20 per consumer are enviously noted in the "Bulk supply" section.

An apparent paradox exists in that the Capital Cost, at £95 per consumer, is the highest and the price per unit sold for all purposes, 2.2d, is the second lowest in the State. This is the one qualification where bulk supply to Byron Bay should be included to get a true value for the average.

The capital cost per consumer is the highest for two reasons,—

(a) The scheme is a Hydro-oil-electric one. Being Hydro-electric it has the inherently high costs of construction, a dam, head race, tunnel, pipe line, transmission line, and being designed to operate on a flow higher than the minimum, it is necessary to work partly on oil during the dry seasons.

In this regard it might be mentioned that the plant capacity, or ratio of effectively used plant, to installed plant is 33 1-3 per cent., for in dry weather the effective capacity is limited to the oil-driven set, the water-driven plant being, then, virtually useless.

The plant factor is probably a record low figure, and in any case further emphasises the paradox of a "highest capital cost" and a "second lowest selling price."

Further complications to the capital costs were caused by the enforced scrapping of the original 200 h.p. oil-driven generating set, a third hand job, before it had been placed in commercial service.

(b) The supply from the plant goes to the towns of Byron Bay and Bangalow in addition to Mullumbimby.