PRESIDENTIAL ADDRESS.

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In accordance with the usual custom of our Society, I have now the privilege of addressing you before vacating the office which I have had the honour of holding for the past twelve months.

The Society has now completed its tenth session, and although its progress during the last year or two has been to me disappointing, it is now firmly established; I hope on a sound basis. In this connection I would draw attention to the splendid work which has been done for the Society by Messrs. Bradfield and Boyd; the former as President and Member of the Council, and the latter as Secretary, have worked hard and consistently for the welfare of the Society, Mr. Bradfield's financing and Mr. Boyd's organising having contributed in a great measure to its success. It is to be regretted that Mr. Boyd is unable to continue the secretarial work this session. To the whole of the Council I wish to tender my thanks for their work during the year, of which evidence has been given in the Annual Report.

In this report their are several matters mentioned, to which I would draw special attention. The titles of the papers which have been read during the past session are detailed in the Annual Report and need not be repeated here, but I would specially mention that by Dr. Tidswell which was one of the most interesting papers I have had the pleasure of listening to; Mr. Gibson's paper is of special interest to student members, and it is proposed to make such student papers a special feature in future sessions, with beneficial results it is hoped, both to students and to the Society. I would suggest that undergraduate members should furnish the Council with a list of subjects for students' papers.

Our object should, I think, be to make our journal a record of the engineering progress of New South Wales, and eventually as our members become scattered throughout the Commonwealth, of Australia. This may appear ambitious to some of our members, but it is not, I think, too distant a goal to aim at; if we keep this object in view and work our way towards it the Society's Journal will become of great value, and it is by its publications that a Society like ours is chiefly judged. Again, if a member makes a special study of any one subject in the course of his work, not necessarily by experiment, let him share the knowledge he has thus acquired, with his fellow members through the medium of the Journal. Above all I should like to see the Society's Journal made the medium for publishing all the experimental work of value done in the Engineering School. In this connection it is hoped that students will be afforded greater facilities for doing original work; as, so far, no effort has been made to win the President's prize. This is a matter which at our University as well as at many others, has not received the attention it deserves. One of the functions of the scientific school of a university is to provide facilities for original research, and it is by the quality of the research work rather than by the number of its graduates, that such an institution is judged by those whose esteem is best worth having. It seems to me a very short sighted policy to put obstacles in the way of the students in carrying out research work, as more credit is naturally given to the university and its teaching staff, than to those who actually carry out the experiments; for the best work in this line is due, not so much to painstaking experiment on the part of the observer, as to the inspiration and ideas he gains from his teacher. The leading universities in Europe and America afford a wholesome object lesson in this respect.

It will be seen that in matters affecting the interests of the graduates and undergraduates the Society has not been idle, and though the results so far have not been very great, there is no doubt that suggestions from the Society will in time carry greater weight and meet with more success than if they come from an individual member of the school, be he undergrad., graduate, or teacher.

At the beginning of the session it was hoped that the Journal could be published in time for presentation to the members at this meeting, as there is no doubt that the finances suffer through the late publication of the Journal, as was the case with the last, the printing of which was delayed by the difficulty of setting up Mr. Hawkin's valuable paper. The balance-sheet shows that it has been necessary to exercise caution during the past session, and the Council would not commit the Society to heavy expenditure for the Journal before a reasonable balance was in hand.

It has at times been suggested that the subscription should be raised for graduate members; but till it is proved that we cannot get along on our present subscription, with a reasonable proportion of our members financial, I for one should oppose any proposal to make the burden fall unequally on different members, With our 150 members financial, and with economical administration, we could carry on and produce a good Journal from year to year, but I should like to see the discussions included in the journal in addition to the papers.

In the past a good many members have been allowed to fall into arrears, and after having received no replies to the repeated applications for back subscriptions, the Council has felt that it is only due to financial members to strike the names of the worst offenders off the roll, as they only increase the expenditure and have hitherto given very little or no return. Thirty-eight names having been thus struck off, and only five having joined during the year, the membership at present stands at 172, of whom eleven are honorary members and eight life members; of the remaining 153 only seventy-seven have paid their subscription for this year.

Naturally, graduates in distant centres are kept in touch with the Society only by means of the Journal, and unless this is published with some regularity, there is some excuse for that lack of interest which is only too noticeable. The proposed additions to the Constitution, to allow of the formation of branches, were designed to prevent this loss of membership, and it behoves every member to pay his subscription promptly, as by doing so he increases its value—*bis dat qui cito dat.* The papers could then be printed soon after they are read, more especially as the recent appointment of Editors lightens the Secretarial duties and facilitates the printing.

As I was mainly responsible for the proposal to form branches, I would like to make a few remarks on the subject.

We have now a fair number of members in distant centres, such as Broken Hill, Coolgardie, and Mt. Morgan (and it must be remembered that our Constitution allows the admission of graduates of other universities), and it has been thought that, by the formation of a branch in such a centre, having on the spot a member empowered to collect subscriptions and call meetings to discuss papers, the graduates in such centres would be kept in touch with one another and with the Society, and new membership would thereby be increased, and as papers would be written for local meetings and then forwarded to Sydney, there would be less difficulty in getting papers for the ordinary meetings of the Society.

The great source of our strength in the past has been the constant influx of students, but at the present time we appear to lose more than we gain; at all events the number of financial members has not kept pace with the increasing numbers of graduates and students. There seems to be a lack of that *esprit de corps* which was so noticeable in the Engineering School some years ago. This is probably due, to some extent, to the increase in the number of students, and to the fact that, being scattered in different buildings, and attending different lectures, they do not get to know one another so well as former students did; but the Society to a great extent supplies this want of a common meeting ground for the students, if they would only take advantage of it. Then again, the teaching staff does not appear to take the same interest in the Society as formerly, and this is to be regretted, as it must react unfavourably upon the students, as it certainly does upon the Society.

The undergraduates should bear in mind that the Society was founded by undergraduates, and that they necessarily derive more benefit from it than do the graduates, one of its main objects being to give the undergraduates a closer insight into the practice of the profession than they can gain from the lectures. I think I am right in saying that the authors of most of the papers write them with the idea that the majority of their audience will consist of students; and, having been undergraduates themselves, and having attended the same or very similar lectures, they are able to look at the subjects from the students standpoint, and at the same time to illustrate it with the knowledge they have gained in practice.

I have no hesitation in saying that, if properly supported, our Society will become the leading Engineering Society in Australia. Many of our graduate members now occupy important positions in the Australian engineering world, and in the course of time most of the positions of importance in the engineering profession in New South

Wales, at all events, will be filled by graduates of the Sydney University Engineering School, and thus potentially by members of our Society.

One graduate said to me only a few weeks ago—and he only voiced the short-sighted view taken by too many—"The Society can never be of importance, as it is too small." I say, how can it become large and important unless it is supported by those who can and should join; and moreover, I say it cannot fail to be of importance if a large proportion of our students join and remain active members. Why should it be considered sufficient to join the Institutes of Civil or Mining Engineers? There are large and important engineering societies in other parts of the world which have had small beginnings and are now of importance not only locally.

We have in Australia to deal with engineering problems peculiarly our own, and have developed, and will have to develop our own methods of dealing with these problems. A discussion of such questions by men with local knowledge and experience is surely better worth listening to or reading than one by men without this local knowledge.

Do we not as students find that our text-books do not deal with the particular local questions in which we are naturally more interested, and with which we have afterwards to deal in practice. What is the good of learning the methods adopted for getting gold in the Klondyke and neglecting those in use in Australia?; What is the good of learning how to design trestles of Georgia pine, when you are to use ironbark?

I do not say that we should not learn the engineering practice of other parts of the world, because I am well aware of the value of such knowledge, but I do say that we should learn the practice of our own world, and where else should we learn it than here.

It may be thought that, I take an exaggerated view of the possible future importance of the Society; but having been one of its founders, taking the chair at the inaugural meeting, and having been a member of Council every year when I have been in Sydney, I naturally feel a very deep interest in its welfare, and have always looked forward to the day when I should occupy the Presidential chair. I regret that when the time came, I was unable to devote a larger portion of my time to the duties of the position, but I have given to it the little spare time I have had at my disposal, and I hope that as the years go on I shall be able to say with ever increasing pride "I am a past President of the Sydney University Engineering Society."

It is a time-honoured custom for the President of an Engineering Society, in his annual address, to traverse the progress of engineering during his year of office: but the engineering profession now covers such enormous ground that it is well nigh impossible for one man to keep in touch with its multifarious branches.

With the little leisure time I have at my disposal I find it extremely difficult to follow in any detail the developments in Electrical Engineering alone, and I therefore propose to confine any attention to matters with which I am more in touch, and to deal with the more striking of recent developments in electrical traction. As our membership is at present constituted, this is a subject which will perhaps not appeal to a great number, but those who have to deal with the various details of railway work are really concerned in this matter, as the possible conversion of steam line to electric working is frequently discussed at the present time, in fact this conversion is in not a few cases an accomplished fact.

Although it has long been recognised that a suitable development in alternating motors would lead to their more general use in traction work, until quite recently in practically all electric tramway and railway work, direct current series motors were used on the cars, and as far as regards their efficiency, starting torque, speed characteristics, and ease of control, with the series parallel arrangement, they leave little to be desired in the actual work of starting and propelling the car or train, except for the losses due to the unavoidable rheostatic control.

The growth of the tramway systems in the large cities, and the consequent necessity of transmitting power for the cars to distances at which it ceases to be economical to transmit at the highest voltage hitherto considered suitable for direct current motors (*i.e.*, 600 volts), led to the development of the system of transmitting alternating currents at high voltages, and transforming down and converting to direct currents, 600 volts, by means of rotary converters placed in sub-stations suitably located, this system which is that adopted in Sydney, as described in a paper last session, is practically the standard at present for all traction work, and will I think long remain so for tramway lines in cities and their suburbs.

In many cases in the United States, the suburban systems of neighbouring towns have been extended to meet, and there has gradually sprung up a system of so called interurban lines, in the number of which there has been an enormous increase within the last few years.

The eastern interurbans were as is natural from the process of development, merely extensions of suburban lines running along the highway and stopping where required, but the later lines more nearly approach the standards of ordinary steam railways, having their own right of way, a substantial road bed and permanent way, and fixed stations, while the cars are large and operate at high speeds, and often carry freight as well as passengers. Not only do these lines act as feeders to the railway systems, but in many cases they compete seriously with them.

In nearly all these lines, cars are operated singly and not made up into trains, the cars weighing up to 50 tons when fully loaded.

As on such lines the weights of the cars and the running speeds were increased it became necessary,—still working at 600 volts—to devise some means by which the heavy currents required to propel the heavy cars at high speeds could be collected from the working conductor, and this necessity gave rise to the third-rail system in which the working conductor consists of a steel rail, often of special section and composition, laid generally outside, but occasionally between the two running rails which, as before, serve as the return conductor, though in one or two converted steam lines in England, a fourth rail has been laid between the running rails to serve as a return. The current is collected from the rail by two or more shoes sliding along the top flange.

The third rail system has been largely used, but can of course only be adopted by lines which have their own right of way, and it is at all times a source of danger and difficulty, especially at crossings and in yards and termini, or again in northern climates, where sleet collects on the rail.

It is of course particularly suitable for elevated lines as in New York and Chicago, and has been adopted on many converted steam lines in England, notably the Mersey River Railway, the Metropolitan in London, the Great Northern Extension Underground into London, the Liverpool and Southport, and is in use on many interurban lines in the United States.

As already mentioned, most of the interurban lines operate with single cars at intervals as may be required, but in suburban lines such as those just mentioned, it is of course necessary to run trains consisting of a number of cars, at frequent intervals. In the case of the New York Elevated it was necessary, in order to cope with the increasing traffic, to produce more rapid accleration than had been possible with the steam locomotives in use, as by no other means could the carrying capacity of the line be increased, the headway being as short as was possible with the rates of acceleration possible with the steam locomotive. To use a heavier and more powerful locomotive would have necessitated expensive alterations to the overhead structure and track.

By converting to electrical working and putting motors on all the cars, the whole of the paying load was made to produce adhesion, and high rates of acceleration were possible.

To overcome the difficulty of controlling such a train, made up as it is of a number of independent units, each with its own motors and controlling mechanism, there was devised, what is known as the multiple-unit system, in which the cars are so coupled electrically that their controlling gear is all controlled from a master controller at either end of the train or indeed on any car.

The two best known systems for producing this result are the General Electric or Sprague multiple-unit system, which is worked electro-magnetically, and the Westinghouse system which is worked electro-pneumatically.

In these systems the place of the ordinary car controller in cutting in and out resistances, and putting the motors in series or parallel, is taken by a number of automatic switches, placed underneath the car, the corresponding ones on all the cars being worked simultaneously from the master controller, in the one case by electro-magnets and in the other by compressed air.

As the controller on any car can be used as a master controller, it is possible to couple the cars as may be required, into trains of any length, and thus avoid shunting at termini, or the construction of such loops as those placed at the ends of the "Twopenny Tube" in London, which was worked by electric locomotives. Another advantage of the omission of the locomotive, is the decrease in the cost and maintenance of the track.

In connection with the foregoing, the following table showing the comparative results on the "New York Elevated" for its last full year of steam working, and its first full year of electric working, will be interesting. The costs are given in dollars.

	Electric, 1904	Steam, 1901	Per car mile 1904	Per car mile 1901
Maintenance of Ways & Structures	646,164	406,739	·01047	·00927
Maintenance of Equipment & Plant	818,372	571,851	·01325	·01304
Power Supply	4,013,979	3,967,516	·06501	·09046
General Expenses	367,534	307,122	·00595	·00770
Total Operating Expenses	5,846,049	5,253,228	·09468	·11977
Passengers	286,634,195	246,587,022		
Operating Expenses / Receipts	41·2	51·7		

These figures bring out clearly not only the decrease in the working expenses per car mile, but the increase in traffic which always results from the conversion of steam lines to electric working, and which is all the more notable in this case, as prior to the conversion the number of passengers was actually decreasing.

Were it only a matter of operating expenses, there would be no necessity to hesitate in choosing between steam and electric working; but the conversion to electricity involves a very large outlay in generating plant, feeders, and motor equipments, and the comparative economies will depend upon the conditions of the line.

Although the multiple-unit system above described seems to offer so many advantages, it naturally involves a much greater initial outlay for car equipments and motors, and in many cases, especially for freight trains, the cost of working with an electric locomotive proves cheaper. The most notable development in this direction is the huge locomotive recently designed and manufactured by the General Electric Co., for the New York Central and Hudson River Railroad.

This line, which has its terminal at 42nd Street in New York, passes through a long tunnel in the city, and owing to the public agitation, legislation was passed compelling the company to use electricity for a motive power on this portion of their line, a certain time being allowed for carrying out the work.

After due consideration it was decided to adopt electric locomotives with direct current 600 volt motors for the work. The reasons which led to this decision cannot be detailed here, but they afford a most instructive study of the subject of the conversion of existing steam lines to electric working.

The first of the locomotives has recently been subjected to exhaustive tests on the New York Central tracks outside Schenectady, a special overhead line being erected, and even a special substation and transmission line.

This locomotive, representing as it does the highest development in that direction, is worthy of more than passing mention; it is described in the *Street Railway Journal* for November 11th, 1904, from which paper the following particulars have been taken.

The total length of the locomotive is actually 37 feet, and it has four driving axles on each of which is mounted a 550 H.P. motor. It is equipped with the multiple unit system of control before mentioned, and the motors are so arranged that they can be connected all four in series, two groups of two in parallel and series, or all four in parallel.

The special features of the arrangement of the motors are firstly, that the motors are gearless, without spring suspended quills; secondly, the shape of the pole pieces; thirdly, the direction of the magnetic flux.

As the armatures only are mounted on the axle, there is a dead weight of each axle of actually 11,000 lbs., and this fact, combined with the absence of reciprocating parts, is expected to decrease the expenditure on track maintenance.

In order that the armature in moving in between the pole pieces should not foul them, the pole pieces are made nearly flat, there being only two poles to each motor placed between the motors, and the magnetic flux thus faces through all faces and armatures in series and returns by the frame. In spite of this novel arrangement, the designers have been able to secure good commutation.

As to the performances of the locomotive, with an eight-car train weighing with the locomotive, 431 tons, the acceleration at starting was ½ M.P.H. per second, and the maximum speed attained was 63 M.P.H., though this would have been greater had the experimental track been longer (it was six miles). The efficiency of the motors is 93 per cent. which is very high.

It is noteworthy that of the total weight of 95 tons, 69 tons or over 72½ per cent. is carried on the drivers,—whereas the largest steam locomotives of the Company weighing, with tender 150 tons, have only 47 tons or 31 per cent. in the drivers, and available for producing adhesion. This comparison brings out clearly the advantage of the use of electric motors in traction in reducing the cost per ton mile, especially when it is remembered that lower rates can be paid to the crew of the electric locomotive.

The great disadvantages of the systems using 600 volt D.C. motors as above described, consist in the amount of copper it is necessary to use to transmit current at 600 volts without serious drop in potential, and in the first cost and operating expenses and losses in the rotary converter sub-stations, in which an attendant must be constantly on duty.

It has of course long been recognised that the limitations thus imposed would be overcome by the use of suitable alternating current motors on the cars, but the ordinary single-phase induction motor is totally unsuitable for traction work, as it is not self-starting. The polyphase motor has not this defect, it can indeed be made to give a high starting torque and has a high efficiency; it has moreover the great advantage of not requiring a commutator which is always the weak point in D.C. tramway motors. To get a good power-factor, however, it is necessary to keep the airgap very small, which is a great drawback in traction work, in which even with the comparatively large airgaps in D.C. motors, failures due to armatures rubbing on the pole faces are only too common.

A much more serious disadvantage is that there is no efficient method of speed control; for instance, if the speed be controlled by the introduction of resistance into the rotor circuit, the efficiency is proportional to the speed, being only 25 per cent. at quarter speed and so on, while at the same time its power factor is low; again, as with