point serenely with such laconic utterance as—what do you think of it? Such an attitude, tending to distend somewhat the pectoral muscles, and the sentiment of which it is the outcome are not altogether to be deprecated. Conceit, says the philosophic Holmes, is to human nature what salt is to the ocean,—it keeps it sweet; and, of all forms of conceit, pride of race, in its widest significance, is the most wholesome, yielding a perennial spring of patriotic enthusiasm, the motive power for great achievements. Let us then continue to pay respect to the past, keeping always in reserve this thought, born of a divine discontent, *we can go one better than all this—presently.* Nothing but the best should satisfy us, and the best is only so for a morsel of time. To quote again from an American philosopher, "let us hitch our waggon to a star"; in other words, let our ideal always be well ahead of the attainable. Thus do we apply a constant spur to our ambitions, curbing at the same time both the spirit of brag on the one hand and the spirit of laissez faire on the other. But "something too much of this," as Hamlet pithily remarks, and I turn from these rambling and somewhat trite observations to deal with matters more concrete and of more immediate importance.

During last year our State railway system attained its fiftieth anniversary, and the celebration of the event fittingly took the form of an exhibition in which its whole history, from the inception down to the present day, was interestingly epitomised. Fifty years of progress lay summarised before us, encouraging speculation as to what another fifty might bring. Even in the very brief period of ten years, covering the existence of this Society, the advance made is significant. During that time there was an 18 per cent increase in the population of this State and also in the capital cost of the railway system (including track and stock). Revenue, however, derived from the system, increased 28 per cent, the number of train miles run, 38 per cent, and the number of passenger journeys no less than 78 per cent. The comparatively low increase to the capital expenditure is due to the very low cost of all recent extensions, as the actual track mileage was increased by 30 per cent., not including some just completed extensions which bring the total present mileage up to 3,365, of which 8½ miles are quadruple, 1903 double, and 3,163½ single track. The population per mile of track is about 440, which is about the ratio in the United States, but only, roughly, about one-fifth of the ratio in the United Kingdom. From which it may be concluded that, whatever is the matter with the birth rate in this country, there is no doubt about the vigorous growth of the railways. At the present time some further 248 miles are under construction. The pioneer type of line, which was initiated in 1894, has proved itself thoroughly adapted to the requirements of the country through which it passes, and has been the means of extending the markets of the State, and of the world, to the pastoral, agricultural, and mining communities at a cost to the taxpayer which is more than compensated for by the value of the services rendered. The State generally has benefitted indirectly in diverse ways, the cash value of which it would be exceedingly difficult to compute. Up to the present, 1040 miles of pioneer single track have been constructed at an average cost of £3,500 per mile; previously, a line through similar class of country cost from £10,000 to £12,000 per mile. The saving has been effected by contour location with a maximum gradient of about 1 in 60, and a minimum radius of 10 chains, transition curves being used for all radii less than 20 chains; by using 60lb. in lieu of 71½lb. rails; by largely doing away with stone ballast and substituting suitable earth; by leaving the track unfenced; by the construction of timber bridges for spans up to 60ft.; and finally, by cheapening the type of structures required at stations. Where some of the largest rivers are crossed it has been found necessary to construct steel bridges up to 200 feet span.

An interesting feature in the progress of our railways is the constant attention devoted to the improvement of appliances for the safe working of the traffic. So important has this branch of the service become, that it possesses its own special engineer, drafting and clerical staff, and extensive workshops. In the new station, now approaching completion, an entirely new system will be inaugurated worked on the electro-pneumatic principle.

To the structural designer, the most interesting feature in railway development is the growth of the locomotive. This is a matter he has to watch with particular care, otherwise the safe design of to-day may find its way to the scrap heap to-morrow. To illustrate this point one has only to look at the progress in the locomotives of our own State. Number one, now resting on its laurels in the Technological Museum, weighed in steam 46 tons, had four coupled drivers with maximum axle load of about 10 tons. cylinders 16in. x 24in., and boiler pressure 120lbs. per square inch. In 1885, thirty years later, a goods locomotive came into operation weighing 72 tons, with maximum axle load of about 13 tons, six coupled drivers, 20in. x 24in cylinders, and a boiler pressure of 130lbs. Twenty years later, that is at the present day, we have an express passenger engine, class P, weighing 98½ tons in full steam, with the maximum axle load of 14¾ tons, cylinders 20in. x 26in., and a boiler pressure of 160lbs. per square inch. This engine has six coupled drivers, 5ft. diameter, with a leading bogie and a six-wheeled tender. The latest goods engine, class T, weighs 107½ tons in full steam, has eight coupled drivers, a two-wheeled pony truck, and a double bogie tender. The maximum axle load is 15½ tons, and the total weight on the four axles, which cover 15 feet centre to centre, from first to last, is 59½ tons. The cylinders are 21in. x 26in., and the boiler pressure 160lbs. A special interest attaches to the two lastmentioned types, as they represent the class of engine to be constructed by the Clyde Engineering Company under their special contract with the State Government. Thirty of each type have been ordered, equal to an increase of nearly 10 per cent. to the existing stock. The above data show clearly how a designer in 1855, with no thought for the morrow would practically limit the life of his structure to about thirty years. In fifty years the engine weight has increased one hundred and thirty-four per cent., and the axle load, which is the more important feature on spans of 20 feet and under, sixty per cent. There has also been a considerable increase in speed, entailing greater impact and vibration on structures, though, on the other hand, some compensation has been made by a better knowledge of the principle of balancing the reciprocating parts. The modern locomotive is a much better balanced and more flexible machine than its prototype, with a fairly uniform distribution of weight on the wheel base. The tractive force has increased by more than 220 per cent., that is to say, the T class engine will pull 3¼ times the load of the old No. 1, or, in the same distance, impart about twice the velocity to the same load. The question that arises out of consideration of these facts is this—how far will these weights go on increasing in the future? We may gain some insight into this matter by examining the stage reached elsewhere in the world in locomotive construction. The heaviest engines built in England to date weigh about 120 tons, with a maximum axle load of 20 tons, the cylinders being 20in. x 28in., the driving wheels 6ft. 10in. diameter, and the boiler pressure 200lbs. In the United States some engines of the duplex compound articulated type, modelled on the lines of the Swiss engines designed by M. Mallet, have been constructed for the mountain service of the Baltimore and Ohio Railway. The high pressure cylinders 20in. x 32in., drive one set of six coupled wheels, and the low pressure 32in. x 32in.—a similar but disconnected set—the boiler pressure being 235lbs. This, probably the most powerful engine in the world, weighs in full steam no less than 213 tons, with a maximum axle load of about 22 tons, and carries 7,000 gallons of water, and 12 tons of coal, which is just twice the capacity in each respect of our T class engine. From this it will be seen that this State has still a long way to go in the matter of heavy locomotives. Before leaving this question I should like to draw attention to a totally different type of engine used in America for rugged country, and very suitable for our own coastal districts, where it is desirable to construct as cheap a class of track as the conditions will permit. This is known as the Shay locomotive, and the principle on which it works suggests the marine engine as a model rather than any pre-existing railway type. There are three vertical cylinders (15in. x 17in., in the heavier type), which rotate a shaft running the full length of engine and tender, each axle being driven therefrom by means of bevel spur-gearing. Flexibility is obtained by means of universal and expansion joints. These engines, which will weigh up to 100 tons, will negotiate curves of 4 chains radius combined with much steeper grades than have usually ruled in this country. It is proposed by the State

Government to import one of these Shays, and conduct experiments, with a view to determining their suitability under local conditions. The tractive force is 36,000lbs., which compares more than favourably with the T class engine where the tractive force is 28,777lbs. (calculated with the same co-efficient), or 360lbs. per ton and 270lbs per ton respectively, a difference of 33 per cent. in favour of the American engine. If successful, these experiments will undoubtedly give a fresh impetus to railway construction in this country.

Another feature that looms very large in the eye of the structural designer is the improvement made from time to time in the materials of construction. On October 17, 1855, or exactly three weeks after the opening of the first railway in this State, Henry Bessemer patented his famous process for the manufacture of steel direct from pig-iron, the ingots of which without further puddling, hammering or working of any sort could be rolled at once into rails. In the early part of the same year, he had taken out a patent for the fusion of steel in a bath of pig-iron, melted in a reverberatory furnace, which anticipated in some respects the patent taken out ten years later by Emil Martin in England, for a process subsequently improved by William Siemens, forming the foundation of that other and equally famous brand of steel, now the great rival to its predecessor. The world's output of steel is roughly about 24,000,000 tons per annum, of which, approximately, two-thirds is made on the Bessemer, and the balance on the Siemens process. The enormous cheapening in the cost of production of steel rails that followed the Bessemer invention practically revolutionized the building of railways, so that our own were commenced at a most auspicious time. Practically Bessemer steel is made very much to-day as it was fifty years ago, and is used almost exclusively for the manufacture of rails, but great improvements have been recently effected in the Siemens open-hearth process, which has led to the placing on the market of a somewhat more expensive, though superior material, of fairly uniform quality, and of various grades of strength and hardness, which may be used by the designer with every confidence, and on the security of which he may initiate designs of the boldest character, involving structures of a magnitude previously undreamt of. In this matter the United States of America take an immense lead, their production being about twice that of the rest of the world, which means, practically, Germany and England. It seems probable, however, that a new and possibly a by no means insignificant rival will shortly enter the lists. Up to the present, Australia has been a laggard in this matter, though possessing immense deposits of excellent iron ores, limestone and coal, the necessary triple foundation for a native iron industry, which moreover occur not only in the vicinity of each other, but also of the railway system. Most important steps, however, have recently been taken to establish the manufacture of iron and steel in this State on a firm footing. The contract concluded, towards the end of last year, between Wm. Sandford, Limited, of the Eskbank Iron and Steel Rolling Mills, and the State Government, to this end, must rank as one of the most significant features in Australian engineering progress. The State guarantees to purchase all its necessary pigiron, wrought-iron and steel for a period of seven years, from the firm, or to the extent to which they are able to manufacture to requirement from time to time, payment being made at schedule rates, which are to remain unalterable, with one exception, during the whole period of the contract. The firm, on the other hand, undertake to use only local minerals in the manufacture, and to deduct from the cost of any material supplied to the State any bonus applying to such that may be granted at any time by the Federal Government; they will be allowed to import ten per cent. of the pig-iron required for the manufacture of steel, and any variation in the duty on such during the contract will be taken into account. At the outset a small blast furnace, capable of producing 500 tons of pig-iron a week, will be installed, which will about supply the whole State with such lines, including cast iron, as the firm can at present manufacture. The total amount of iron and steel imported into the Commonwealth per annum, including all items with the exception of machinery, averages roughly about 400,000 tons, out of which New South Wales requires about 120,000 tons. There is thus a great future before the native iron industry, once fairly established, and there is no doubt that, as this State contains the most valuable ore deposits, it will be here that the development will take place, providing in the future for the employment of a large number of persons.

In connection with steel, reference should be made to the enormous extent of the application of concrete-steel as a structural material. If Jean Monier could have foreseen the results that were to follow from his simple invention he would no doubt have been very much astounded. In this State the bulk of the work of this description has been carried out by Messrs. Gummow, Forest and Co., who manufacture at their workshops various materials for immediate use in construction. Larger works, such as aqueducts, reservoirs, and arched bridges have also been constructed locally on this principle, the most important of which is the recently completed bridge at Richmond over the Hawkesbury River, carried out by the Public Works Department, consisting of thirteen 50 feet arched spans; while the most recent example is a service reservoir 23 feet 6 inches diameter and 60 feet high at Corowa, which will be shortly under construction, the Monier type, in this case, having proved much cheaper than an all steel design. In America, which was somewhat late in the field in this matter, concrete steel has been applied to almost every conceivable form of structure, even down to post and rail fences and railway sleepers. The reason for such rapid and general acceptance of a new system is not far to seek. Here is surely the almost ideal material desired by the engineer, possessing the strength of steel with the durability of concrete, costing nothing for maintenance, forming a perfect preservative for timber against marine borers, protecting its own metallic constituent securely against rust, water-tight and comparatively cheap in manufacture or construction. A large amount of literature has been published about concrete steel, amongst which should be mentioned the papers contributed by Professor Warren to the Royal Society, dealing with a large number of interesting and elaborate experiments for ascertaining its physical constants and elastic properties, which were carried out in the Engineering School laboratory.

In conclusion, some brief remarks on our native timber will be made, and this somewhat rambling address brought to a close. Australia generally, and New South Wales in particular, are fortunate in the possession of a material at once so admirably adapted in its different varieties for all the purposes of construction, engineering and architectural, and of decoration. At present, however, we seem to be squandering a liberal heritage with very little regard to the future. The export trade is steadily growing, especially in the case of sleepers, of which some 654,000 were sent during the year 1904-5 to India, South Africa, and the Philippines, while about 1,625,000 super feet of hewn and sawn timber have been sent to various parts of the world. Owing to the high price and scarcity of ironbark, very little has been fortunately sent away, this being by far our most valuable timber for all structures requiring large scantlings. There is really only a very limited area in this State where good ironbark can be obtained, which is in the country watered by the Northern Rivers, and our own requirements in the future will make quite sufficient inroad into this supply. Experience seems to point to the diminished use of timber in the future in important structures, more especially in railway viaducts, and trusses of a composite character, and the substitution therefor of steel. Although considerably cheaper in first cost than if constructed in the latter material, the timber bridge costs a considerable amount more annually for maintenance and renewals, and its life is very much shorter. The shrinkage continually going on in the timber and the expansion of the metalwork, is a source of weakness and expense, requiring constant attention in the way of tightening wedges and bolts. It would seem advisable to restrict the use of ironbark to simple beams, sleepers and piles, and to adopt, generally, hewn in preference to sawn material.

With regard to the testing of local materials, a large amount of useful work has been done and will no doubt continue to be done in the Engineering School laboratory. In the case of steel, however, in view of the fact that a much larger and probably a steadily increasing amount of locally manufactured material will be in the future placed upon the market, it becomes a question whether the general physical constants, now usually ascertained, are sufficient, and whether it would not be advisable to occasionally carry on a much more minute and subtle examination by means of special apparatus for the detection of micro-flaws. In this way only can the future career of the particular metal in question be approximately gauged, when subjected to such severe treatment as arises from impact, vibration and varying stresses, and the necessary factor of safety reasonably determined. Much valuable work in this direction has been carried out in England, and the time seems almost ripe for pursuing similar investigations in this State.

It leads to an interesting speculation on the limitations of the human mind to realise how very little we can gauge the achievements of the future, whatever be our particular outlook on life. Did Watt in his most imaginative hour conceive the possibility of a Carmania, or Brunel the practicability of a Forth Bridge? Did the mechanical engineers of even twenty years ago, in the infancy of the steam turbine, realise the enormous expansion latent in that simple machine, or the revolution it was destined to effect in the mechanical world? Can anyone of us now, looking forward, say, with certainty, what will be the prominent developments of the next twenty years? May we even hazard this opinion, among others, that the steam engine, in its reciprocating variety at all events, already tottering to its fall, will be by the expiration of that term, a museum exhibit and nothing more? Benjamin Baker summed up the position truthfully and with much charm of diction in a neat aphorism uttered many years ago. "Experience is like the stern light of a ship, illuminating only the path over which we have already travelled."

I have nothing further to add, gentlemen, except the expression of a personal note of appreciation for the cordial co-operation of the Council with me in dealing with the Society's business, and for the able and energetic way in which the Hon. Secretary and Hon. Treasurer and their assistants have performed their duties during a somewhat arduous year. I wish to thank you all once more, for having elected me to this privileged position, and to welcome to it our new President, Mr. G. A. Waterhouse, B.Sc., B.E., F.E.S., to whom and the Society I wish a prosperous New Year.