

SOME PROBABLE EFFECTS OF THE WAR ON THE AUTOMOBILE INDUSTRY.

PRESIDENTIAL ADDRESS.

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It appears to be usual for each of your successive Presidents to take as the subject for his Presidential Address a branch of automobile engineering in which he has had special experience. I propose, however, to depart somewhat from this practice, and to put briefly before you one phase of a subject which, it appears to me, is now probably uppermost in the minds of many of those present and, in fact, of most automobile engineers.

We all realise that the War (there is only one War in present considerations) is going to have a permanent and considerable effect on the conduct of most of our industries, and the automobile industry of this country will be no exception. I therefore propose to discuss to-night *some of the probable effects of the War on the automobile industry.*

I am most anxious to avoid speaking from the point of view of a prophet, but by looking round us and comparing conditions as they are to-day with those obtaining four years or so ago, it is not difficult to foresee the effect which various developments, that are mainly results of War activity, will inevitably have on the industry in which we are interested.

I propose to consider more particularly, although not exclusively, those aspects of the subject that affect the Institution in which I am more particularly concerned, and to which, as most of you are aware, I devote most of my public activities, namely, *Standardisation and Research.*

I am to-night addressing the representatives of the technical side of the industry, so naturally propose to confine my remarks as far as possible to technical matters, but much of our work

affects the commercial side as well, so a few brief allusions to the commercial side of the industry will be unavoidable.

The present War has been termed an "engineers' war" (1), and whether or not that term is fully justified, it is certain that engineering has during the last four years of war taken a greater part in warfare than ever before, and not only a greater part, but an ever increasing part, just as it is taking a greater and ever increasing part in our daily life in every direction, in our business, pleasures, and home life.

The land war has provided great opportunities for the use and development of the products of the automobile engineer, and I think I am justified, without risking criticism, in saying that the automobile engineer of this country has fully risen to the occasion, and met in a most gratifying manner the demands made upon him.

The experience of automobile engineers, in many ways different from that of engineers in other branches of engineering, has been especially useful in connection with many of the operations of the land war, which frequently required new machinery to be designed and made in the least possible time to meet new conditions of warfare as and when they arose.

Almost exclusively during the War, and largely on account of the War, a new industry, that of the manufacture of aircraft, has sprung up, mainly out of the automobile industry, and this new industry promises quickly to become almost as large as its parent. This latter industry, which, as regards its scientific and constructional side, is very largely the product of a combination of effort between the automobile engineer and the physicist, has been as regards its engineering requirements mainly provided for from the personnel of the automobile industry, so that when we consider this and also take into consideration the transport lorries, staff cars, tanks, motor boats, and petrol engines for wireless and all manner of other purposes, that have had to be supplied to the armies and maintained, we begin to see the magnitude of the effort that has been made and is now being continued by the automobile engineer and his associates. It is, however, not so much this aspect of the matter that I wish to consider to-night, but the effect from some points of view that all this effort and development is having, and is in all probability going to have, on our industry.

I have therefore endeavoured throughout this address to put on record the present views of one who is intimately associated with the changes that are being wrought, the ideas that are gene-

rally held and as far as they can well be known, the factors that have governed the course that has been immediately pursued. At a later date the various issues, and the results of the action that has been taken, in connection with the various matters arising out of the War that affect our industry will be able to be viewed in a clearer light, on account of the improved perspective provided by the lapse of time.

It can now be seen that the War will vitally affect the conditions of industry in almost every direction, and it is impossible to think that at the end of the War, when our normal industry is re-organised, I might almost say re-started, we shall revert to pre-war ideals and methods, either in connection with commerce, manufacture, or design. Much has happened during the course of the War to change our ideas on those, in common with other, subjects, and without doubt the automobile industry will with most industries, and in fact, it is to be hoped, with the country and the world in general, ultimately reap much benefit from these changes in idea and method.

It does not fall to the lot of everyone to have their legitimate business made illegal by Act of Parliament, and it is curious to contemplate that at the present time the automobile industry is in the extraordinary position of being prohibited from carrying on its customary business, and may not make or sell its normal product without a Government licence.

It was early found that once the armies were supplied, the automobile industry could with accelerated production, quite within its capacity, turn out more vehicles than were required, and fortunately many firms were able to turn their attention to the manufacture of machinery that was within their capacity and badly wanted for the use of the armies, namely, aircraft engines and aircraft.

With the development of the use of aircraft in war, it was soon clear that the facilities for their manufacture would have to be materially increased, and many firms that normally produced nothing but automobiles had the honour of teaching the special points of their business to engineering firms that had hitherto been manufacturing in other more or less similar directions, so that they might devote all their own energies to the aircraft industry, or other work that was within their capacity, and badly wanted for the prosecution of the War.

It was exceedingly fortunate for us that the automobile industry in this country had developed to a high degree of proficiency, methods that were essential to the rapid production of the more complicated munitions. I refer to the accurate production of complicated machinery out of high grade materials on a manufacturing scale, so that large quantities of such parts could be produced on an interchangeable basis rapidly and economically, both as regards cost and man-power employed, and it is probable that this system of manufacture was, at the time the War commenced, more highly developed on a large scale in this country by the automobile industry, than by any other.

The introduction of similar methods into kindred industries where they were not generally employed previously, has been accelerated by the necessities of the War, and will undoubtedly have a great effect on production in this country after the War. The dissemination of information as to essential methods in regard to the interchangeable and accurate manufacture of machine parts in large quantities that had been accumulated, principally in the automobile industry as regards this country, not necessarily because that industry was far-seeing, but because the production of automobiles necessitated such methods, will not handicap the automobile industry by having caused it to lose its so-called secrets, but will benefit that industry by increasing the general prosperity of the country and by enabling it to enlarge its markets for the supply of products it will require. It will also directly benefit the engineering industries of the country by enhancing the possibility of an increase in output without any essential increase in the man-power employed.

This same matter can be considered from another point of view. It would appear certain that those firms who have had to take up manufactures that were foreign to them to the exclusion of their normal productions, will ultimately find that they have had a most valuable experience, an experience that they will never forget, and one that will be reflected in their post-War products, greatly to the benefit of themselves and their supporters, for a very long time after the return to normal business. On the other hand, those firms who are perhaps looked on as fortunate in that they are still able to continue with the manufacture of their normal product in much the pre-War way, will, after the War, if they do not exercise the greatest care, be at a considerable disadvantage, in fact, to indulge in analogy, they will

be in much the same position as neutral nations compared with the successful belligerents.

Other directly beneficial effects will be produced throughout our industry by the co-operation and interchange of ideas that this change in and interchange of products has necessitated, and which has brought the engineers of the industry into close touch with each other with a common object in view, a closer touch than would have been possible without the incentive of the War or some other great danger. Interchange of ideas is always beneficial, so while individual firms may feel they have lost by so much dissemination of information, I think they will find that on the whole no one has lost, but all have gained, some more than others, but this is naturally inevitable, and from a broad point of view perhaps not regrettable.

It has been feared in some quarters that the tremendous expenditure of money during the War will seriously handicap British industries after the War, and as the automobile industry is looked on as a luxury trade, it has been suggested that after the War, when various restrictions are removed, there will be no sale for any but cheap lorries and the cheapest of cheap so-called "pleasure" motor cars. I find it impossible to take, this pessimistic view, as it seems to me quite rational to take an optimistic view of the situation and to consider the effect of the conditions that have arisen during and on account of the War, in that trade in general has been greatly restricted, in many cases, in fact, has practically come to a standstill, for a period of years, and in addition, in the War area, there has been tremendous destruction, as compared to normal times when the world goes on producing a little more than it requires to maintain its standard of living, thereby accumulating so-called wealth. We have during the War been to a large extent living on this accumulated margin, and after the War shall be compelled to make up the shortage. During the making-up process it is, I think, obvious that there will be no lack of work, and to enable our wealth to be again accumulated it will be necessary to devise and utilise every possible means whereby everyone can produce more for the same amount of labour. We are, I believe, all agreed that one of the factors that enables this to be done is rapid, economical, and convenient transport, and I am at a loss to find anything that provides this better than the various classes of automobile.

At times we hear the suggestion that no one will be able to

afford motor cars after the War, and this argument is so persistently advanced that I am sometimes tempted to wonder what degree of truth there can be in such a statement. The motor car has long since developed from being solely a vehicle of sport, and while it still suffers under the undesirable name of "pleasure car" it is now recognised on all sides as essential means of transport for passengers as the lorry or motor van is for goods.

After the War we shall doubtless suffer from severe taxation and high cost of living, but as the automobile is a time-saver, it seems that the adverse conditions of life will accentuate rather than diminish the necessity for it, and it will be more than ever a necessity and money-maker. Therefore, although high cost of living will mean high costs both for material and labour, the motor car business must and will flourish notwithstanding.

The transport of men and munitions of all kinds by motor lorry and the use of motor cars of open types where horses were used in earlier wars, in fact were thought essential in the earlier stages of this War, has been a tremendous object lesson as to the utility of motor transport by road. Men who will ultimately return to civil life, have had this lesson before them for a number of years, and when conditions render it possible we shall surely see, as the result of this education, a great extension of the use of motor transport in this country.

The question of the types of vehicle for which there will be a market will have to be carefully considered; undoubtedly there will be in the future a market, and a large one, for the cheap car, but in the automobile industry, as in every other branch of life under normal circumstances, a man gets what he pays for; therefore, as long as proper value is given for money, as we have seen that there will be a big demand for cars for all purposes, it follows that there must be a market for every class of vehicle for which there was a market before the War. Naturally there may not be a market for the same proportion of vehicles in every category as there was before the War, but, it will be necessary for the industry in organising itself, to proportion its output as a whole in such a manner that it will meet the needs of the buyers; a statement that is easily made, but it will probably involve a lot of hard thinking and possibly some bitter experiences, before the industry will have so adjusted itself to meet the needs of the public.

Fortunately this country will not be alone in high costs, as the

high costs here and in other belligerent countries will mean high costs throughout the world, which will in a very great measure tend to balance matters, and will largely prevent the industries of this country being at a disadvantage in comparison with our foreign competitors.

Doubtless the temporary high cost of labour and materials and the, in all probability, permanent reduction in the value of money will make the price of post-War vehicles appear high judged on a pre-War standard, but value can only be considered in relation to the cost of other commodities, and it appears that if the increased knowledge of manufacturing and the higher possible efficiency of cars consequent on increased knowledge obtained during the War be taken full advantage of, post-War motor cars ought to compare very favourably with other products on a basis of comparative cost, post-War with pre-War in each case.

The financial side of the matter cannot be more than briefly referred to in a short address, but naturally the War, although its cost in actual loss, which is after all the real cost, is nothing like so great as the various National expenditures would lead us to suppose, has got to be paid for. The only way to pay for it is to make up for lost time, and whatever assists in making up this lost time will be in demand. Seeing that the automobile, as shown earlier in this Address, is an important time-saver, it will be in demand, and, if the automobile industry should require financial assistance or protection in order to enable it to put itself in a position to cope with the demands upon it, speaking from first principles, it is bound to get it in accordance with the ordinary laws of supply and demand, which will again become operative when the artificial restrictions necessarily imposed on account of the War, are removed. For this reason I do not fear the institution or continuance of unduly restrictive taxation or any of the other fearful spectres which we have been regaled with, and which some of us perchance have been frightened by, in the Press and elsewhere, during the past few months.

After the War the personnel of all branches of the automobile industry will have to make great efforts to put the industry on a proper basis once more, and the result of these efforts on the part of the technical staffs of the various factories will undoubtedly be to effect great improvements in the motor vehicle in many directions.

Representatives of all branches of industry, commercial as well

as technical, will have learned many lessons under that stern master, War, and these lessons are of course all going to be used to the utmost advantage in industry in the future.

It yet remains to be seen to what extent it will be policy for the automobile engineer to take advantage of his aeronautical engine experience. We are all aware that the aeronautical engine has a much higher mean effective pressure, higher mechanical efficiency, and lower specific fuel consumption than even the most advanced pre-War automobile engine, but the requisite characteristics for the two classes of work are so different that while aeronautical engine experience can with advantage be used to some considerable degree in the automobile engine, it is difficult to say just how far results will warrant this utilisation.

Mr. Coatalen (2), in a paper recently read before the Aeronautical Society of Great Britain, has already pointed out the great and in his estimation, growing, divergence between aeronautical and automobile engine practice, and the fundamental reasons for this divergence, but in my opinion much of the aeronautical engine experience that has been gained by our automobile engineers during the War will be found to have a profound effect on their post-War automobile productions, and an examination of the extent of this effect, when such a course becomes possible, will be extremely interesting. I am looking forward to great strides in the development of automobile efficiency (using the term efficiency in its broadest sense of meaning more useful for its ultimate purpose) as a result of the War experience of British automobile engineers.

Great changes will in all probability be noticeable in the organisation of our factories, and some of these changes will have far-reaching effects.

I think it will be obvious to all careful observers that owing to experiences in the management of factories during the War the technical officials of our engineering industries will after the War be more appreciated than was frequently the case before the War and will continue to exercise greater powers and carry greater responsibilities than formerly, and the effect of following well-considered technical advice will in the future be noticeable to a greater extent in industry generally in this country than has been the case in the past.

We in this country are very conservative, but if we look back only a few years and consider conditions as they were before the

War we shall see that what has rapidly come about in connection with factory management in this country was before the War already beginning to take place in America and Germany, both of which countries were in general ahead of us in respect of the utilisation of, and recognition of the importance of, science and scientific technical training to engineering.

It is not many years since the man who handled a slide rule, or had a knowledge of how to do things, was looked down upon, and in some quarters in consequence of his knowledge was considered a "common fellow," but technical knowledge is rapidly coming into its own on all sides, and there are already signs of the "boot being on the other leg," namely, the man who does not possess technical knowledge of some sort is beginning to be looked down upon.

In the past the technical man in the engineering industry has always been subordinate to the equivalent commercial man, perhaps because it was supposed that the technical knowledge could be obtained from books, whereas so-called commercial knowledge was composed of some indefinable sort of rare instinct coupled with experience; but it is not difficult to discern that the change is taking place, and it is certain that in years to come the technical positions will cease to be subordinate in the same way as formerly. The application of more and more science to all branches of business, by increasing the necessity for scientific knowledge, will render such knowledge more general; also in future the workshop trained man who has had no real scientific training will, because of the more general existence of scientific knowledge, no longer be able to pose as scientific. The requirements of the higher positions on the scientific side of industry will necessitate the employment of many more highly-trained scientists to fill them, and it is to be hoped that ultimately all management positions in our engineering industries will be filled by men possessing scientific knowledge as well as business experience.

This change which is rapidly taking place cannot help but have a far-reaching effect on the automobile industry in particular, as well as on the economics of the country in general.

The automobile industry has shared in no small way in helping to provide the conditions that are bringing about this change of view point. The provision of motor cars for every-day use has in the past gradually created the necessity for a knowledge of how they work, i.e., engineering, and now the art of flying is carrying

on the same good work, so that in this and in other ways a knowledge of engineering is becoming essential in everyone's daily life. The heaven that was formerly confined to the few in the engineering world is doing its work, and as such knowledge spreads it continues to do so at an accelerated rate.

Sir Dugald Clerk in his "Trueman Wood" Address, entitled "Discovery and Invention," read before the Royal Society of Arts on December 5th, 1917 (3), has very aptly divided human progress in science and its application into three categories: Discovery, Research, Invention.

In dealing with day to day progress of industry—and in this Address we are considering the automobile industry—we have to deal principally with the third sub-division, but it is necessary for our purpose now to sub-divide it still further, and convenient further sub-divisions may be Invention, Investigation, Standardisation, and Testing.

Taking these in the reverse order, and turning our attention first to Testing, I need not do more than state that it is obviously a necessity in all engineering to test a device or machine thoroughly before it is put on the market, and it is certainly a legitimate duty of every firm to do this for itself. This will involve a certain amount of investigation or practical research, and the section under this head may be conveniently again sub-divided into two parts, the investigations that concern individual products, and are therefore solely the concern of the individual firms, and investigations that are more far reaching, and are on occasions approaching in scope to Sir Dugald Clerk's second division, namely, Research. This latter class of investigation is usually interesting to, and applicable to, the whole industry, and it should therefore be economical and conducive to rapid progress for such investigations to be carried out co-operatively for the benefit of the industry as a whole.

We must realise, and I believe most of us do realise, that in the stage of civilisation in which we find ourselves placed we cannot live to ourselves alone; that we have to consider our duties to others, to our contemporaries, in some cases less fortunate contemporaries, and to the future of our industry, and so conduct ourselves as to work out the maximum good to the greatest number and in this way the maximum benefit to ourselves, as well as taking into consideration our rights and the duties of others towards us.

In many circumstances, and I have noticed this to be the case

in most arguments for betterment of conditions, the rights of man are given more prominence than his duties, and in connection with research it is, in my opinion, the duty and privilege of the larger firms to help the smaller firms, and I believe in consequence that ultimately the large firms will not be the losers by what appears on the surface to be their magnanimity.

In the early days of the industry every automobile works was in effect a Research Laboratory, or an experimental shop on a commercial scale, but as design and practice became more stabilised and manufacture came to be carried out on a larger scale, this naturally came to be less and less the case. In stabilising design we must, however, not overlook the fact that research is still as necessary as formerly, perhaps more necessary as improvements become less obvious, but it has to be carried out in a rather different manner. Most large firms now have a research laboratory of their own, but it is impossible for the smaller firms to go to this expense, and this is where it is the duty and privilege of the larger firms to help the smaller ones. Naturally the firm that has its own research laboratory and can develop and consequently first put into practice its own ideas reaps the first benefit from those ideas, but in connection with unpatentable improvements it is impossible, and in my opinion undesirable, for the general good and ultimately for the individual good, that a firm should be able to confine the use of such improvements exclusively to its own products.

The research laboratories of most large firms in this country—all those that I have had any relations with—are fully occupied, usually more than fully occupied, in carrying out investigations directly connected with the firm's particular products, and have little or no time to give to pure research, or in fact to any researches that are not rendered absolutely and immediately necessary by current happenings, or to carry even such researches any deeper than is absolutely necessary, so that the establishment of means for co-operative research would not in any way reduce the amount of work done in firms' existing research laboratories, but would be additional thereto.

I need not refer in any detail to the Government scheme for the establishment of State-aided Research Associations under the ægis of the Department of Scientific and Industrial Research, except to emphasize this, which I firmly believe to be the case, namely, that in the event of the automobile industry establishing a Research

Association of its own, as I sincerely trust it will, it will not cause any reduction in the amount of research work to be done in the private research laboratories of the various firms, but will enable researches of a more far-reaching character than can be attempted individually, to be carried out on a co-operative basis—researches that would otherwise be left undone—and thus directly benefit the industry as a whole.

I should like to bring to your notice some most important statements on research in industry in this country, recently made by Dr. John Johnson, Secretary of the new National Research Council of the United States of America (4), in discussing the advisability of co-operation in Industrial Research, by quoting a very brief extract from his most interesting Address; he says in part:—

“ One of the most striking consequences of the War is the increasing general realisation of the primary importance of scientific research to the whole question of National defence, as well as to the successful prosecution of industry. . . . The commanding position held for so long by a large number of British industries had created a deeply-rooted feeling of security among a large body of (British) manufacturers; this, coupled with a National conservatism and with the circumstance that the heads of many industries had not been educated in such a way as to enable them to appreciate scientific knowledge was a hindrance to the adoption of proposals for research work in industry there (in Great Britain). British scientific men had for years been pointing out the necessity for the greatly extended application of science to industry, but no definite action was taken till about a year after the beginning of the War, when the white paper on ‘ research ’ well known to us ‘ appeared.’ ”

I would like here to refer to this white paper (5), and the pamphlet issued shortly afterwards by the Department of Scientific and Industrial Research (6), as these publications mark an epoch as being, I believe, the first official recognition on the part of the heads of industry and the Government of our country of the supreme importance to industry of science and pure research.

As regards the classes of research which it is desirable should be carried out co-operatively, I would cite the research in connection with standard automobile steels that is now in progress, which I shall have reason to refer to again later in this Address, and also

call attention to the great advantage that would accrue to the industry as a whole from researches such as the following:

- (1) An investigation to establish the most economical application of the laws relating to conductivity, heat transference and diffusivity, as affecting motor car radiators, so as to enable the smallest or lightest radiator for a given case to be determined, including the most suitable proportions for the provision of air draught, the most suitable rate of air draught, and rate of flow of the water.

It does not take much consideration to see that for the most efficient cooling of the circulating water the radiator should be maintained at the highest possible temperature equally all over; how to attain this ideal is not so obvious. It cannot, of course, be completely attained in practice, but present practice does not approach anything like as near to the ideal as it might do.

- (2) An investigation to determine the factors making for comfort in suspension, including the inter-relationship between such factors as:—
 - (a) Vertical periodicity of the front and rear springs respectively in relation to each other.
 - (b) Rolling periodicity.
 - (c) Pitching periodicity.
 - (d) Metacentric height (to adopt a term well known in naval architecture).
 - (e) Wheelbase.
 - (f) Weight distribution.

Referring now to Standardisation, as we are all aware, all serious engineering standardisation in this country is carried out by the British Engineering Standards Association, with which Association this Institution co-operates, by means of a most admirable working arrangement, in connection with all standardisation work which affects the automobile industry either directly or indirectly.

The late Sir John Wolfe Barry, who was Chairman of the then "Engineering Standards Committee," the title of which has lately been changed to that of the British Engineering Standards Association, has very clearly pointed out the advantages of standardisation in engineering in a lecture he gave before the Institution of Engineers and Shipbuilders in Scotland in 1908 (7), and showed by logic and the results of experience that many of

the fears that had been expressed as to the advisability of the publication of standards were wholly unfounded.

In this lecture, from which I do not propose to quote, but to which I would refer all those who still harbour any doubts as to the advisability and benefits of standardisation, the shipbuilding, cement and electrical industries were particularly dealt with; the automobile was then in its infancy and our industry had not progressed far enough to require standardisation, otherwise it might have been given direct attention.

I should like at this stage to call your attention to the work that has been accomplished by the British Engineering Standards Association for the automobile industry, with the co-operation of this Institution. Through its Sectional Committee on Automobile Parts the British Engineering Standards Association has so far published nineteen reports, useful to the automobile industry, as shown in the following table:—

TABLE OF BRITISH ENGINEERING STANDARDS ASSOCIATION REPORTS AFFECTING THE AUTOMOBILE INDUSTRY.	
Report No.	Title.
18	Forms of tensile test pieces.
20	Screw threads.
21	Pipe threads.
27	Limit gauges for running fits.
28	Nuts, bolt heads and spanners.
32	Steel bars for use in automobile machines.
34	Screw threads.
38	Limit gauges for screw threads.
45	Sparking plugs.
46	Keys and keyways.
54	Screw threads, nuts and bolt heads for use in automobile construction.
57	Heads for small screws.
69	Tungsten filament glow lamps for automobiles.
70	Pneumatic tyre rims.
71	Wheels, rims and tyre bands for solid rubber tyres for automobiles.
74	Charging plug and socket for electrically-propelled vehicles.
75	Wrought steel for automobiles.
80	Magnetos for automobile and aircraft purposes.
C.L. 2582	Ball Journal bearings.

In calling attention to this useful work that has been accomplished in the publication of standards for the use of our industry, many of which are already in general application, I would urge on all the members of this Institution the necessity for continued and loyal support of the British Engineering Standards Association, so that the great work of standardisation, which has been up to the present time only in its infancy and still lies almost wholly in the category of future effort, may proceed at a greatly accelerated pace, and so that by its aid the automobile industry of this country may maintain—no, more than maintain—its position in the world, and be looked up to as a model of system, order and uniformity in connection with its designs, conceptions, and methods.

Bearing in mind that the main guiding principles of the British Engineering Standards Association are, that it only acts on request from an industry, that when it acts it only does so with the co-operation of all interested parties representing the particular industry, designers, producers, and users, and that its Committees are permanent, while its publications are all issued in the form of recommendations, subject to revision on adequate representation of the advisability of such a course, not as unalterable laws, it is easy to see that there is much to be gained by standardisation in this broad sense, and no risk that standardisation so understood and practised will have any adverse influence on progress or in any way handicap development.

In fact, on the contrary, by establishing the “state of the art” in defined directions it is a direct incentive to development, by showing what is the best practice in any given direction at any given period so that those possessing originality of conception can introduce improvements, having seen that they are improving on the best known practice instead of perchance wasting effort by going over old ground to no good purpose.

According to a brief dictionary definition the word *standard**

* Dr. Johnson in his Dictionary of 1785 defined a standard as “that which is of undoubted authority; that which is the test of other things of the same kind.”

Similarly Webster, in 1853, described a standard as “that which is established as a rule or model by the authority of public opinion, or by respectable opinions, or by custom or general consent.”

Richardson, in 1855, defined it as “that by which quantity or quality is fixed or regulated, rated, estimated” (8).

(Extract from Sir John Wolfe Barry’s “James Forrest” lecture before the Institution of Civil Engineers, May, 1917.)

means "that which is established," and while standards according to this definition are common enough in every-day life it is obvious that engineering in general, and automobile engineering in particular, would greatly benefit by far more standards being "established" than we at present possess.

In general, engineering standards can be divided into two main categories, dimensional and qualitative. Most of the standards so far published by the British Engineering Standards Association come under the former category, in fact, until lately the British Engineering Standards Association does not appear to have so seriously applied itself to the establishment of standards of quality as it has to the establishment of dimensional standards, and when qualitative standards have been published they have been generally less satisfactory, because less absolute and more difficult to interpret than most dimensional standards.

As a preliminary to the establishment of dimensional standards for parts it was necessary to establish standards of measurement and methods of measurement, but much of this work was done, and in many ways well done, many years ago, some of it many centuries ago, and only needed recording; in establishing qualitative standards, however, the position is generally somewhat different, and it frequently becomes necessary to define the quality, and not only the quality but in addition the method by which it shall be measured, as well as the desirable value, so that the establishment of standards of quality is frequently a much more difficult matter than the establishment of dimensional standards.

It is, however, an equally important work, and the greater magnitude of the task must not deter us from co-operating in the undertaking of it, or cause us to be discouraged or dissatisfied at the slowness of the progress made by those we entrust with the work.

The War has been the means of causing almost every British pre-War motor car factory to be greatly enlarged, and it is therefore to be expected that after the War the output of each factory in this country will be greatly increased, and this will mean that greater standardisation will not only be possible, but profitable. It is therefore highly desirable that we should all, in our mutual interests, do everything we can to forward the work of standardisation for the automobile industry.

It is unnecessary to say much about the first of our sub-divisions—Invention. The Institution does not, however, forget the in-

ventor and his interests, and, as evidence of this I would point out, is at this moment negotiating with other Institutions with a view to promoting Government action to remove the hardship that has been inflicted upon many inventors, owing to their inability to work their patents during and on account of the War.

The automobile industry, as is necessarily the case with all other new industries, has been largely dependent on inventions for improvement, whereas now, although the inventor pure and simple is still highly important, he shares the responsibility for improvements with the more systematic research and production engineers.

Closely associated with invention is design, and it is now appropriate to consider some probable effects of the War on the design and probable performance of the post-War motor car.

We could perhaps tell the probable tendencies in the development of design by plotting curves of the tendencies of recent years and extra-polating these curves. If this method were adopted it would, however, be difficult to decide how best to treat the years of the interval occupied by the War, so that I doubt if we should get much useful information from the process. I have not attempted to plot such curves for the above reasons, and also for the reason that it would be necessary to assume average design, and it appears logical that averages of diversities can have no real meaning; for example, the average of, say, ten designs, some good, some not so good, and some perhaps bad, does not represent the best or the mean, or to my mind, anything at all.

Design may be conveniently divided into two categories, Pure and Applied. Pure design is much the same for all the mechanical engineering industries, and may be broadly divided into two main groups, static and dynamic.

The pure design side of motor car engineering has to deal principally with the dynamic portion, but some of the considerations overlap into the static.

The War, particularly perhaps in its earlier phases, gave great impetus to individual metallurgical research owing to the necessity for greatly increased output of machinery of the highest class from the plants of the country, and also owing to the necessity for the whole of the output to meet stringent Government requirements, whereas previously only a select portion had been required to such high standards. (Whether these high standards which most of our Government departments demanded were really

necessary is not within my province to discuss to-night. One of the immediate results of this work will be to give automobile engineers after the War an adequate supply of materials superior to what they had available before the War, and also superior means of ascertaining the quality of those materials. A reaction on the part of engineers as a result of this can already be seen in so far that at any rate the more advanced technical members of the industry are looking round for means of turning the possibility of better materials to advantage in still further increased reliability, in weight reduction, in cost reduction, and in many other desirable directions.

One of the direct effects of this metallurgical research work has been to show how slight our knowledge of pure design really is, and it is most encouraging to see attempts to add to our knowledge such as are exemplified by the work of Dr. Coker (9) (10) in connection with the measurement of stress distribution in elastic structures under tensile and compression stresses, and Messrs. Griffiths and Taylor in stress distribution under conditions of tension, both of which have already been made public, and other researches, that for reasons connected with the War, have remained unpublished. One metallurgist, in commenting on what he called "the ignorance of the engineer," met with the retort that while engineers were fully aware of their comparative ignorance concerning the behaviour of the structures they were dealing with, it was probable that they knew as much about them as metallurgists did about their structures. It is, however, an undoubted fact that, as previously mentioned, one effect of the War will be to increase materially the interest of engineers in matters affecting pure design, just as it has increased the interest of the steel maker in metallurgy.

Perhaps it is not realised sufficiently generally that all the basic engineering formulæ assume rigid structures, and that in its behaviour a structure departs from the results obtained by the aid of these formulæ as soon as ever any deflection takes place. As there cannot be stress without strain, it is not difficult to appreciate that departure from the values found by means of the usual formulæ that assume rigidity begins to take place as soon as ever a structure is loaded. In automobile engineering, and in fact in connection with all light engineering work, such departures are sufficiently serious to be worthy of the most careful attention and investigation.

In the static division of pure design the corrections to cover errors due to distortion are perhaps not so complicated, as the correction values or departures from the theoretical "rigid" conditions remain constant for constant loading, but in moving structures the stresses, and consequently strains, vary from instant to instant, thus introducing very great complications into the resultant effects, in fact, as has been remarked, the parts of an aeronautical engine when it is running are behaving very much like a jelly which is being agitated. Unfortunately, or perhaps fortunately, our eyes are not so constituted as to enable us to visualise what is taking place.

The development of means for the accurate and simple determination of the value of microscopically small measurements and differences of measurement, and the more general application of magnifying and other optical apparatus to analytical engineering are all doing, and will continue to do for the engineer in connection with pure design, what the development of somewhat similar optical and also pyrometric apparatus is doing for the metallurgist, in connection with his work, and the more closely the metallurgist and engineer co-operate the quicker our advance in this somewhat new but vitally important branch of engineering should be.

In dealing with applied design, we must of course to-night confine ourselves to the motor car and its units. It is probable that the examination of post-War models will, as previously referred to, show that the motor car engine has absorbed a lot of the practice that has been developed for the immediate advantage of its sister—or shall I say child?—the aeronautical engine. It must be considered, however, that the requirements of the aeronautical engine, apart from the necessity for lightness, partake more of the character of the marine than of the motor car engine, although the development of power-weight ratio in aeroplanes, resulting in more rapid climb and greater altitude with its consequent reduction in atmospheric pressure, now practicable for regular flying is bringing the conditions of operation of the aeroplane engine into closer analogy with the conditions that obtain for the motor car engine. It is now no longer true to say that the aeroplane engine operates mostly at full load, in fact, it seldom operates at the maximum h.p. it is capable of for two reasons:

1. It is seldom flying at such altitudes that the volumetric efficiency approximates the maximum.

2. The full power, excepting in some military operations, is seldom required except for climbing.

From this and other considerations it seems to me that except for the high power required to drive an aeroplane as compared to a motor car, there is a tendency for aeronautical engine requirements again more nearly to approach motor car conditions, but owing to the number of requirements on the part of the automobile engineer for his peculiar products that do not, and probably never will, obtain in the aeronautical engine, such as silence and smoothness of operation over a considerable speed and torque range, it is to be hoped that designers will not run away with the idea that everything that is good and even essential for the aeronautical engine, is necessarily equally good for the automobile engine, otherwise the public may get a false education and have to be subsequently "uneducated" again at the expense of, and to the disadvantage and loss of prestige of, the automobile industry. Alternatively, by taking advantage of the increased knowledge particularly of materials, of distribution of stresses in engine parts, and of flow of gases, gained from research primarily on behalf of aeronautical engine development, there is no doubt that the post-War automobile engine will embody great improvements, perhaps more particularly as regards power-weight ratio, economy, and improved power performance at lower cost without serious corresponding disadvantages.

The mechanical transport of armies has afforded an excellent opportunity for gaining experience of the behaviour of cars under extreme conditions, but it must not be assumed that the car that can behave best under extreme conditions that it was never intended for, is necessarily the best for private or general use. For example, I should not consider a touring car chassis that is capable of carrying an armoured body weighing several tons without breaking down, was necessarily a well-designed vehicle for carrying four or five passengers.

On the other hand, when, as was frequently the case in the early stages of operations, it was found that a certain model of car always broke down under extreme conditions at some particular place, it showed either a weakness at that place, or unnecessary strength at other places, thereby giving designers an opportunity to arrive ultimately at a design of car providing a better distribution of material, which, quite independently of the

possibility of using improved material, should result in a saving of weight in future.

It is to be regretted that there has in all probability been less thought given to automobile design during the War period than in previous years, particularly as regards the inventive side and in connection with the development of accessory improvements, and we must therefore not look for too much advance in such directions, but in all probability the post-War car will carry forward with a considerable step the same developments that were continuously in evidence during the ten years, 1904 to 1914, in which period we can trace certain more or less well-defined continuous, even if comparatively slow, developments.

In engines the trend has been continuously towards obtaining more power from less weight of metal, and in cars towards reduction of tare weight for a given load, the main underlying objects being presumably improvement of performance coupled with reduction in cost for a given performance.

This double development has gone through a number of phases, some more acute than others, during the period, and a comparison of the vehicles of 1914 with those of 1904 show great changes, most of which can be claimed as improvements; notably, reduction in the size and weight of engine and car to obtain a given performance in passenger miles per hour, obtained mainly by higher volumetric efficiency in the engine, resulting in higher revolutions being obtained without corresponding torque losses or undesirable vibration, and perhaps most important of all, greatly enhanced reliability both of the engine and the complete vehicle, notwithstanding the higher duties imposed by the more strenuous performance.

In fact there is to-day no "fun" in motoring compared to the days when the time at which a destination would be reached was a matter for the wildest speculation, and when the motor car was a toy with great possibilities; now it has been with us long enough to have proved the truth of that well-known old and always amusing phrase, "Yes, it has come to stay," and is recognised as a necessity in most branches of life and a civilising influence of no mean order.

To enable the scientific development consequent on the War to be taken full advantage of in the up-to-date post-War factory, will require some little re-organisation of departments as compared to the usual pre-War British method.

It was becoming usual before the War for the organisation of the British automobile factory to include a "Chief Engineer" in charge of the technical and scientific organisation as distinct from the production departments. The laboratories that will in the future form an essential part of all up-to-date factories will of course be subordinate to the Chief Engineer and the chiefs of such laboratories will be responsible solely and absolutely to that official.

Usually it will be found advisable to arrange for the test house, in which the physical tests for the passing of production material will be made, to be under the control of the Inspection Department, and also to deal similarly with routine analysis, so as to avoid the upset and delay of research work that inevitably results from introducing "output" work into Research departments.

It is too much to expect that one man can be at the same time a fully qualified metallurgist, chemist, physicist, and experimental engineer, and therefore the research work must be sub-divided among several "scientists," each, under the general control of the Chief Engineer, taking care of his own branch of the work, and co-operating closely with the others. The terms metallurgist, chemist, and experimental engineer are now comparatively well-known in connection with the organisation of an engineering works, but outside of educational establishments the term "physicist" is perhaps not in common use.

The studying of, and necessity for, the more general use of methods for investigation of causes of fatigue, of distortion of structures under stress, of stress distribution, of factors of safety, of strength of materials under special conditions, and such like matters, has introduced work outside the ordinary scope of either the chemist, the metallurgist, or the experimental engineer. This comprises in the main a form of analytical engineering, and in all probability the gap can only be filled by introducing into the works organisation a further position requiring a distinct title, which I have for convenience called the "Physicist." Whether this title will stand the test of time remains to be seen, but in my opinion all large engineering works dealing with highly-stressed structures will find it necessary to have the functions filled if they are to keep up to date.

The relations between the various portions of the Chief Engineer's staff and the means adopted for interpreting the findings of the laboratories into works practice have been more or less completely dealt with at various times, so although proper

arrangements to enable the works to take immediate and full advantage of the work of the laboratories, where such exist, are often sadly neglected, I do not propose to discuss them in detail to-night, but instead have prepared and appended two charts, illustrating by way of example one typical arrangement. In these charts, which must be considered to give only a general indication of a convenient application, and are not by any means universally applicable, direct responsibility is shown by full lines in the usual way, and the responsibilities of subordinates for reporting or transmitting information to other departments by dotted lines. My object in appending these diagrams is solely to make clear the character of the relationship that in my opinion should exist between the research departments and other parts of the works. I do not for a moment suggest that I show the only satisfactory solution of the problem, neither do I propose to refer to this matter further, as a full consideration of the relations that must of necessity exist between the many departments of an engineering works would be quite outside the scope of to-night's subject.

During this Address I have, I believe, been successful in avoiding the temptation to indulge in prophecy, but I have endeavoured to put a few thoughts before you in what may be a new light, with a view to lead you to see that the tremendous upheaval, both tangible and in ideas, which will inevitably affect every industry in the country will not be without its effect on our Institution and the ideas of those who direct and control its destinies, and the destinies and activities of the industry it represents.

It is presumably the primary object of the Institution, that is, I assume, never lost sight of by those appointed to control it, that it should benefit to the greatest possible extent the industry it has the honour to be associated with, and in this connection I should like very briefly to review some of its more important activities during the past years of unprecedented national War.

First I should like to congratulate my predecessors in this Chair for their broadmindedness in the interpretation of eligibility for membership, particularly referring to the admission of metallurgists to membership, and in this way to their giving practical recognition of their appreciation of the importance of the metallurgical side of automobile engineering, and the close relations that should exist between the metallurgist and the engineer.

I should also like to congratulate the Institution on the great

work it initiated—work which will in the future benefit almost every branch of engineering in the country—when it proposed and carried out by co-operation with the British Engineering Standards Association the standardisation of steels for the automobile industry. The practical and immediate outcome of the work was the issue of the British Engineering Standards Association's Report No. 75: "British Standard Wrought Steels for Automobiles," and the inauguration of the comprehensive research set forth in the programme prepared by a Committee of the Institution to establish the physical properties of the Standard Automobile Steels. This work, the full magnitude of which will never be known outside the membership of the Committee responsible for it, is now approaching completion, and I have hopes that it may be completed and published during my term of office as President of the Institution. The result of this work, although it is yet uncompleted, has, however, been much more far-reaching in many ways than was originally contemplated, in its influence for good in regard to the pioneering of qualitative standardisation in this country.

The question of strength of materials and standardisation thereof, together with standardisation of methods of testing, is by no means exhausted; in fact, in this country we still lag behind in some directions, and I am of opinion that the interests of the industry could be furthered by development in this direction. This will need the co-operation of several existing Societies, and I am of opinion that this Institution could usefully co-operate in the formation of a Society that would further the interests of testing and specifications for testing and the supply of materials somewhat on the lines of the Society for Testing Materials in America, but with a different organisation to meet our totally different conditions. In the past the great handicap to all such activities has been want of funds, but I have hopes that everyone will have developed qualities of broad-mindedness that will overcome these difficulties, at least very largely, if not altogether, in the future.

Before concluding, permit me to thank you for the great honour you have conferred on me in electing me your President for 1918—1919 Session. I feel it is really a great honour, and I assure you that I shall spare no effort to serve you and your interests to the very best of my ability throughout my term of office, and do my very best to hand over the guidance of the Institution to my

successor twelve months hence, feeling that during my term of presidency one more successful year has been added to the useful career of the Institution.

I beg also to acknowledge with thanks the assistance obtained from various writers, and append a list of the books and proceedings to which I have made reference in the text.

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Mr. L. H. POMEROY: It is my pleasant duty to ask you to give a hearty vote of thanks to our President for his very able Address to-night. He has covered the subject very widely and comprehensively, and although he has tried to put aside his prophetic functions I am afraid they may be held up to him later on.