

THE TRAINING OF AUTOMOBILE ENGINEERS.

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IN introducing this subject for discussion, the authors feel that some apology is necessary for embarking upon a course which it is believed is unique in the annals of similar Institutions.

That they have introduced it must not be taken as evidence that they are unconscious of the insufficiency of their experience, outlook, or standing, in the profession they have adopted. They realise fully the difficulty and boldness of their task, and the innumerable aspects it presents, and they are well aware that many attempts have already been made to find a general solution of the problem. They venture to add this further effort, in the hope that a definite scheme may be formulated from a discussion based upon the consideration of one branch only of the engineering profession, namely, that dealing with the automobile.

The very fact that the authors are junior members of the profession gives them many advantages in initiating a discussion on this subject. They have emerged comparatively recently from their training, and can, therefore, the better describe how far that training suits their requirements. Remembrance of the process is quite fresh in their minds, and they can at least claim to have up-to-date information on their subject. By joint authorship they have endeavoured to overcome any want of breadth of view, and by comparing notes as to the details of the training of which each has had personal experience they have sought to place themselves in the position of being able to point out the deficiencies which appear to them to exist in the various courses of instruction which are at present open.

The industry is as yet in its infancy, and hitherto the most eminent men connected with it have perforce been drawn from other spheres, where the problems are largely of a different order. By trial and error these men have succeeded at a time when no guidance from prior experience was possible. Now that the industry is well established, the men who have yet to achieve distinction must have their educational wants recognised right at the start, and the technical education authorities must realise the need for a common standard in place of the somewhat sporadic efforts made at the present time to cope with the general demand for special instruction in automobile engineering. At the present moment, therefore, when the educational apparatus for the production of automobile engineers is in process of being developed, the subject is specially opportune. The authors believe that this Institution can be made to form a natural link between the industry and the educational establishments, and they think that it has great opportunities for influencing in a marked degree the courses of instruction provided therein. It therefore becomes highly important to consider the question carefully at an early date, so that when the occasion arises the policy may not be found to be wanting.

The influence of the Institution, however, need not be limited to the field of purely consultative work. In the capacity of employers, many of the individual members are already brought into contact with the subject, and have formed opinions and gained experience thereon, which the Institution in its capacity of a clearing-house for ideas could use as a basis upon which to formulate schemes and to encourage public-spirited action in regard to conditions of training.

THE NEED FOR SPECIALISED TRAINING.

Automobile engineering covers such a wide field that it is almost impossible for one individual to possess a complete knowledge of all the subjects necessary for the design, the manufacture and the selling of a car. Therefore, although an automobile engineer should know the fundamental principles common to all branches of engineering, he must specialise after a certain point has been reached.

Automobile engineering as a profession automatically divides itself into the three branches above referred to, but more conveniently dealt with in the inverse order—selling, manu-

facturing and designing—in which order they will be considered. Each of the three branches requires a somewhat different training from the others, and this should be realised at the start, but the actual choice should be made as late as possible, say after two years' preliminary training, and until it is made, no complete course of instruction can be specified. In choosing which one of the three branches to adopt, due allowance should be made for the particular desires and abilities of the aspirant, the facilities available for the necessary training, the number of vacancies available, and the possibility of obtaining one. Unless this is done, a vague or indefinite course of training is apt to leave the young man in a condition unfitted to carry any responsibility, so that the remuneration which he is likely to receive will not accord with the time and money spent on his training. It may be mentioned here that those who obtain employment only through the influence of personal friendship must be taken as outside the scope of this paper.

The requirements of the three branches may be specified as:—

1. Commercial ability, supplemented by a certain amount of technical knowledge, which may successively develop salesmen, demonstrators, sales managers, agents and managing directors of engineering undertakings.
2. The combination of technical and business abilities which would lead from apprenticeship to the drawing office, thence to shop or department management, and ultimately to works management, and to the position of general manager.
3. The purely technical, which after apprenticeship tends to produce draughtsmen, designers, consultants and specialists in the various details (of which chassis, magnetos and carburettors are familiar examples) which go to compose an automobile.

It appears fairly obvious that the same training cannot be suitable for all three objectives, and that a man with a training so general that he could hold a position in any one of the three branches would not be nearly as valuable to his employer as one trained specially for his position.

The first branch involves real commercial ability combined with a certain amount of technical training used *as an auxiliary*.

The second branch needs a sound works and commercial educa-

tion, combined with a good college training, and it is the branch which secures the largest number of entrants.

In the third branch the college training should be considerably longer than in the others; in this branch also the number of vacancies is more limited.

A large number of very promising young engineers gravitate into the first branch by reason of the comparatively remunerative positions which can be obtained as salesmen and demonstrators almost immediately on the termination of their training. After having been a salesman for some years, it is somewhat difficult to return to the technical side of the industry, while the higher positions in this branch are quite as difficult to obtain as in the other branches, since the field is also open to those who have not been trained as engineers.

The problem resolves itself, then, into an attempt to frame basic courses of training, including technical college and workshop experience, which may be modified to suit individual requirements, and which will fit men for positions in the particular branch of the industry which they may select. The three broad classifications are:—

Branch 1. The Salesman.—It is almost obvious that a technical college training is not of vital importance in this branch. The rudiments of science will have been learned at school, and experience of automobile workshop practice should be obtained during apprenticeship. Such knowledge as is required of the applied sciences, such as machine drawing and design, mechanics, heat engines, etc., can be obtained in evening classes taken concurrently with the works training. The shortcomings of such a training do not appear to be on the technical side; in fact, one of the authors who followed these lines chiefly felt the want of instruction in correspondence, advertising, and such commercial subjects. An additional course of commercial training would appear, then, to be desirable in the training for this branch.

Branch 2. The Works Manager.—A college training and a long apprenticeship are necessary for the production of a good works manager. Probably the most valuable part of this training consists in the knowledge of workshop methods and processes; not only must a works manager be well up in all branches of machine tools, machining, fitting and erecting, but he should possess a very good knowledge of pattern making, jig and tool making, founding, hand and drop forging, pressing and copper and tin

smithing. It would appear that a general engineering shop provides better opportunities for an apprentice to obtain a knowledge of these diverse subjects than one devoted to the construction of automobiles alone or to any specialised manufacture.

A two years' college course, if evening classes be attended during apprenticeship, will probably provide a works manager with sufficient theoretical education, but a number of subjects will remain on which he will not be sufficiently well-informed, such as estimating, costing, recording, wages systems, and production scheduling. These appear to be entirely neglected by educationalists, although their importance in all large works is manifest.

Branch 3. The Consultant.—The commercial and executive qualifications necessary for the other two branches are not so important for the purely technical man. It is, however, necessary for him to have sufficient theoretical knowledge to enable him to suggest new methods and to improve old ones, to control the experimental department and to act as a pioneer in designing and other directions. To enable him to produce a good design, it is necessary for him to be familiar with all the processes used in its manufacture; consequently, the amount of works training required is much the same as for the second branch. As designing is the chief work, it is doubtful if a general engineering shop will afford an apprentice opportunities for obtaining such valuable information as will a purely automobile factory, where he can be constantly handling automobile parts and obtaining insight into the class of design he will eventually be called upon to produce.

THE NEED FOR THEORY.

The need for works training is so generally appreciated that it is unnecessary to discuss it, but the value of theoretical training is not so readily acknowledged. It is true that in many cases a certain amount of resourcefulness on the part of the man without theoretical training will often disguise his ignorance of the correct method of meeting a difficulty; for example, if two men desire to produce, let us say, the lightest possible connecting rod, one a rule-of-thumb man and the other a theorist of little experience, the first named will always gain at the start. He will always produce an article while the other man is discovering his limitations by a process of exhaustion. Finally, however, the theorist must arrive at the position at which he possesses all the other man's virtues plus his own. He will, therefore, automatically

turn out solutions according to circumstances, while his rival can never hit upon the best solution of a case except by accident. The principal advantages of extended theoretical training are two in number. The first is the mental flexibility which is required in obtaining solutions of set problems; the second advantage lies in the increased fertility of ideas which the trained man must always possess, due to his wider knowledge of facts. Thus he is favoured both in the range of information he possesses and in his experience in using it.

A weak point of any scheme is the employer who will not encourage the theoretical training of pupils or apprentices on any ground. These men are unfortunately too prevalent. Mostly they lack any sort of theoretical training themselves, and succeed solely through perseverance and energy. Technical education is to them a disqualification for any position which they may have vacant. Two of the authors have special experience on this point. One found, when seeking an appointment, that the advantages of a six years' works training were outweighed by the disadvantages of a further three years' college course, the other, who was just commencing a three years' college course, was told by his future employer that it would be a waste of time and money, and that by concentrating his attention on works training, he would be equally well equipped for any position in his employ.

The record of past members of the Graduates' Section shows that for a similar reason many men of theoretical as well as practical ability have been obliged to sacrifice their training and to adopt the following among other occupations—organ building, teaching, journalism, manufacture of printing machinery, electric generating station control, general steam engine practice, balloon building, and the Civil Service. Such losses are worth serious consideration, and it is suggested that if they are to be stopped, the members of the Institution must use their influence to secure a footing in the industry for those who are doing their best to fit themselves to follow in their steps. The length of time spent at college is also an important factor of its usefulness, as the commercial instinct in American industries has led, in the opinion of a distinguished educationalist, to the tendency to cut down college training to the smallest possible compass, with the result that the American engineer outgrows his training within three years of leaving college.

THE RELATIVE POSITION OF WORKS AND TECHNICAL TRAINING.

There is great diversity of opinion as to whether college instruction should precede or follow the works training, or whether the two should proceed concurrently. To take evening classes alone is not sufficient for branches 2 and 3, and the "sandwich" method of alternating a year in the works with a year at college does not appeal to a works manager, though it appears to have advantages if his objections can be overcome.

Some of the authors are in favour of taking apprenticeship before the college course, the advantages of which appear to be that, by evening classes during apprenticeship, the student can keep up the science groundwork learned at school, and can apply it in the shop. The change of occupation will cause him to be deeply interested in his practical work at the beginning of his apprenticeship, and he will therefore make the best of his opportunities, so that when the time comes for the college course he will have arrived at a more mature age and study will be less irksome, as he will be able to see the bearing of science upon his practical work. Against this is the possible disadvantage that during part of his apprenticeship his time will not be used to the best advantage, as the *full* reason for many of the things he is doing will not be apparent to him.

On the other hand, if college training precedes works training, the student's theoretical knowledge will be partly forgotten by the time his apprenticeship is finished, because the evening classes are not sufficiently advanced for a graduate from a technical college, and, besides this, indentures must be completed before the age of twenty-one.

AGE FOR COMMENCEMENT OF TRAINING.

It is hardly to be expected that a boy will put the whole of his attention on his training until he is at least seventeen. It would appear that if technical college training be taken first, it should not be commenced until after this age is reached, as the instructors consider, and rightly so, that they should teach those who wish to learn, and not drive those who are indifferent. Boys should therefore be under the care of those who can make them work until they are old enough to appreciate the object of their training. It may be mentioned that to remain at school to the age of seventeen is not a very great disadvantage to those who are anxious to commence their training, for quite a satisfactory

number of subjects dealing with the groundwork of engineering are contained in the syllabus of the modern side of many up-to-date schools. Great attention is paid to mathematics. Graphical methods, contracted methods, use of calculating rules, etc., are now dealt with in many schools in a thorough and practical way. Drawing, chemistry, heat, light, sound, magnetism and electricity, also receive a fair proportion of the pupil's attention. Other subjects not taught in technical colleges, but which are, without doubt, as valuable to the engineer as the above, include English (essay writing and the preparation of *précis* and digests), book-keeping, and commercial geography. It may here be added that the ability to write, for instance, a terse and clear report, or give in a few words the pith of another man's report is a very valuable asset to any young engineer. That the modern secondary school provides excellent groundwork for the study of engineering is confirmed in part by the recommendation of the Institution of Civil Engineers, which says:—"A boy who intends to be an engineer should receive a sound general education at school, without any attempt to specialise; he should remain at school until he is about seventeen years of age; his curriculum of study should include advanced teaching of history and geography, sound instruction and practice in essay writing, and at least an introduction to English literature; Greek should not be required; an elementary knowledge of Latin is desirable, but in the later years of school life the study of Latin should be discontinued in favour of modern languages, especially French and German, which should be taught colloquially, or in such a way as to give the pupils a practical knowledge of each language, sufficient to enable them to study its literature and to converse in it with some degree of facility.

"In mathematics, the geometrical side should be especially cultivated; boys on leaving school should be familiar with the use of logarithms and the elements of trigonometry. In practical arithmetic, pupils should be instructed in the use of contracted methods, and encouraged to express results with only such a degree of numerical precision as is consistent with the known degree of certainty of the data on which they are based; and operations in mental arithmetic should be encouraged. The study of science at school should be confined to an elementary knowledge of physics and chemistry, and not extended to the detailed study of any one branch of science. Special attention should be given to freehand, geometrical, and curve drawing; and instruction should be given in practical mensuration."

WORKS TRAINING.

The authors are entirely in favour of the abolition of the "pupil" or "gentleman apprentice," who is not subject to the ordinary routine of the works. He usually wastes his own time and often that of others, and by his superiority to the ordinary shop rules he weakens the discipline of the works. All students' work should be done under the same commercial conditions as that of the mechanics; in fact, since all work is being done for a profit, the way in which the sources of waste of time and material are constantly being discovered and abolished or checked forms not the least valuable part of the works training.

The length of time necessary to be spent in the shops will, of course, vary with each of the three branches, and according to the aptitude of the pupil. Of course, the periods of training stated are for a lad of average ability, and should be modified to suit individual requirements, and although it may seem obvious that an employer is not doing the best for his own interests by keeping an unusually bright boy the normal period in each department, it is so little appreciated that it will bear pointing out. As a complete training for a normal pupil studying for the second branch, the following is suggested. The first three years should be spent entirely in the machine, fitting and erecting shops. A short time might, with advantage, be spent in the stores at the beginning, as this does not require the same amount of application, forms an easy transition from school life, and is useful in familiarising the lad with the parts which, latter on, he will be called upon to make; but where a number of apprentices are taken on simultaneously it is not always possible to arrange for this.

The fourth year could profitably be spent in the "round of the shops," which should take in the pattern shop, foundry and smith's shop, followed by a year in the drawing office, or *vice versa*. The sixth year should be devoted to testing and to the administrative departments.

As a rule, the bulk of the apprentices will leave school in May or June, and the practice is sometimes to put half of them on the bench and half on the lathe, and to change over at the end of the first year. A good practice for the first three years is for each apprentice to receive instruction in his trade from a mechanic who receives an extra weekly allowance. These mechanics are selected from among the best workmen, and usually

take a strong personal interest in their charges. Their work does not fall off in quantity, in fact as a rule it is increased, as the apprentice is, as often as possible, put on the same kind of work as his instructor, and the mechanic has the advantage of a more intelligent mate than the ordinary labourer. In constantly working hand-in-hand with a skilled workman the apprentice rapidly becomes proficient.

During the first three years the study time can be pressed into two afternoons a week, and on such days it is no great physical hardship for the student to continue his studies in the evening till 8 or 9 o'clock.

Where a college course is taken, it should follow after apprenticeship, the usual period being for three years. This, again, is only possible for the third branch. During the college course the practical side can be kept up during vacations. In most colleges students have four weeks at Christmas and about fourteen in the summer, with smaller periods at other times. The Christmas and summer vacations might well be spent in practical work, and it is the experience of one of the authors that such practical work is a welcome change after the continuous study of the ordinary session.

English firms have not, as yet, been very keen on vacation appointments, though the plan works well in the United States. Where the student is new to the works the great advantage is that the employer and employé are able to form an opinion of each other with a view to permanent employment at the close of the college course. Though there are some slight objections, there is one great advantage in vacation employments. An employer will take on, say, half a dozen men during a vacation and set them doing mechanic's work in various departments, the only difference being that they can be given some freedom of speech with their employers. The employer who has any power of discrimination has thus a splendid opportunity of choosing from actual experience the man who is likely to make the most suitable works manager or technical expert later on. Indeed, from every point of view, the question of vacation appointments on the American plan is well worth consideration by English firms.

THEORETICAL TRAINING.

The practice of automobile engineering, probably to a greater extent than any other branch of industry demands width of

outlook, and nearly all of the departments of pure science are of direct interest to the automobile engineer. His scientific training for the first three years after leaving school, when concurrent with apprenticeship, should consist only of theoretical subjects. They will form to some extent a continuation of his previous school work. Mathematics, elementary science and modern languages can be taken first, with theoretical mechanics, freehand drawing and practical geometry to form a preparation for the drawing office. During the first two years only these theoretical subjects are necessary. The forces and stresses dealt with should be purely imaginary in their action; that is to say, they act at theoretical points, and strain and friction are left out. In the third and fourth years the work should become "technical," a word which has become greatly misapplied. The practical discussion of heat engines, applied mechanics, the principles of machine design as well as applied electricity will come in at this stage. Students who are not taking a full training can substitute the principles of works organisation, salesmanship, or the allied subjects of the commercial type here, but the works manager-to-be will probably take these in his fifth or sixth year. The college course (only intended for the third branch) will be best reserved for the most difficult theory and the higher branches of science. Chemistry will be useful in studying the qualities of petrol and kindred fuels, and their behaviour during cracking and combustion. It also forms an introduction to metallurgy, which should be studied with reference to the common workshop metals. Physics is of immense value to the engineer. Heat, electricity and magnetism are particularly useful, but the study of vibrations in sound is so important that engineers of standing cannot afford to be without it. Thermodynamics is, of course, vitally necessary. Some subjects, which are bound up with mathematics of a higher order, are of direct application to the automobile. For example, the study of hydromechanics leads to the discussion of stream lines which affect the shape of the body, the form of induction pipes, valves and pockets, and even such a point as the construction of the petrol jet. The theory of elasticity, though abstruse, is the only guiding line in problems connected with power for least weight, and so the list may be extended almost indefinitely. One criticism of this list is likely to be that some of the subjects are unnecessary, but it can be proved that this is not the case. Men who are already in the front rank of automobile engineers, such as the past Presidents of the Insti-

tution, are men who possess this range of information, and use it. The coming men must at least have the chance of being equal to them.

A fair test of what degree of education is necessary is to consider what would be required of a man to be able thoroughly to understand all the articles dealing with his branch of the industry which have appeared in the periodicals devoted to automobile engineering in England and the chief producing countries.

A probable objection is that such a course, lasting in all about nine years, is far too long. According to present English standards it is too long, but in Germany this is the rule, and German manufacturers rate theoretical proficiency much higher than their English confrères. But whether the training shall be completed under apprenticeship conditions or while the student is doing useful work and earning money, is beyond the scope of this paper. It is sometimes possible to obtain the knowledge which would be gained in the "round of the shops" while doing work, such as costing or progress control, which in an open market would command reasonable wages. Again, the work done in the drawing office should be worth at least the salary of a junior draughtsman, while the year for testing and administrative departments also might be spent as an assistant to the works manager. That the training shall be complete is one of the needs which the authors of this paper wish to indicate, and they feel sure that even if this is not recognised now, the future will show that some such course is necessary to retain national supremacy in automobile construction, which, after all, involves more of the features of an exact science than of trial and error methods, or of rule-of-thumb mechanics.

Thus it is felt that, not only may the Institution be of great assistance by prescribing a definite course of instruction, but it is here that the Graduates' Section might also become of such great value as a link between the educational establishments and the industry. This section helps to correlate technical and commercial considerations, and to convert the product of technical training into useful engineers by the discussion of matters of real importance which are neglected elsewhere, and by the visits paid to engineering works, which give opportunities to examine the methods and processes used in manufacture. There is no doubt that it is of the utmost advantage to the industry for embryo engineers to be able to discuss among themselves, under expert guidance, the difficulties they meet with in their daily

work and the larger problems agitating the automobile world which they individually will be called upon to face.

The fostering spirit towards the Graduates' Section which has animated the Council, is producing, and will continue to produce, more resourceful and more reliant engineers—for a Graduate to feel that his efforts at solving problems, at widening his own outlook and grappling with the difficulties of his work, are being backed up by his principals is calculated to urge him to greater effort.

It has been thought that if it could be made a *sine quâ non* that all pupils in automobile works controlled by members of the Institution should join the Graduates' Section, a very great impetus would be given to the work of the Institution, which would benefit the profession as a whole.

With the assistance of the principals, the Graduates' Section could be made of exceptional educational value. A pupil may feel shy of expressing an opinion before his seniors and superiors, but does not hesitate to do so before his equals and fellow-students. The general tone and trend of the discussion on the papers can be directed and controlled by the chairman, and errors which may not be picked up by the Graduates themselves can be pointed out at the same time. The competition of brains that takes place at a meeting causes a good deal of private work on the part of individuals, and a point of the utmost value in connection with these meetings is that the preparation of a paper makes the author collect and arrange the pros and cons of a subject in such a way as to stand the criticism of fellow Graduates who may be either at college, in works or in drawing offices, or even in positions of some responsibility, but all of whom are deeply interested in the subject, and are only too keen to find a weak spot in the armour of the author of the paper. The Graduates' Section, in the opinion of the authors, should be of value to students of all sections of automobile engineers. In one branch of the section at least, that ideal has been the leading thought of the committee in drawing up the syllabus of subjects for the present session. The result, so far, has been an increase in the interest of the members, and the experiment appears to be quite successful. Many engineers of note have signified their approval of the change in terms of highest praise. In conclusion, the authors hope that the discussion of this subject will lead to a closer connection being established between college courses and works requirements, and between students and works managers, to their mutual advantage.

THE DISCUSSION.

Mr. L. H. POMEROY, in opening the discussion, said: This meeting is probably unique in that I believe it is the first time upon record in which Graduates have addressed the members of the parent institution, and I think most of us will agree that the way in which the paper has been prepared and delivered shows that the Graduates deserve the highest credit for the efforts which they are making. I speak with a certain amount of feeling on this subject of the training of automobile engineers, because it has been my experience, since I have been engaged in the profession, to be engaged also in the task of trying to keep alive the interest of very sleepy evening students who have already done a hard day's work in the shops. I expect many present have also experienced this, and that it will be realised that such men as the Graduates of this Institution, and other students throughout the country, show by their very attendance at evening classes that they are determined to get the greatest amount of information, and I wish to emphasise the necessity for all the assistance possible being given to them to acquire such information. The first thing in connection with the question of the education of automobile engineers is to find out which things are certain, and when those are known it can be seen how far the existing educational courses have to be made to fit these certain things. One of these certainties is that the average apprentice has parents who are not blessed with any too much money, and who find it impossible to spend a lot of money on sending him to a college for two or three years, although in many cases the lad may have quite a lot of brains. It is also a *sine qua non* in the majority of cases that he shall be able to earn his living when he is 21 years old, and he also finds, when he comes to look for a job at this age, that unless he can claim five years' shop experience, the ordinary manager looks very coldly at him. If we take it that it is essential that he shall show five years in the shop, including the drawing office, that brings us to the fact that he must start his apprenticeship at the age of sixteen, which also brings up the question of the sandwich system. The reason why most works

managers look coldly upon students who come to their works during the vacation under the sandwich system is that it is impossible with the ordinary human nature, such as we find in engineering apprentices—and it is a very highly developed human nature as a rule—to make them concentrate their minds upon the job when they come into the shop at the end of June, knowing that they are going out at the end of August, and so far as I know, the works managers who have tried that system do not like it because it is not possible to make the students look at their job seriously. It is quite excusable, because the average lad, accustomed to getting up at 7.30 in order to reach the college at 9 o'clock, does not take kindly to getting up at 5.30 in order to get to the works at 6. It seems to me that the process of training which I have experienced personally, and which a lot of men have been through with more or less satisfactory results, is quite a good one, and it is that a lad shall start becoming an engineer at a very early age indeed. He should go to a technical college, day school preferably, at the age of 13 or 14, and should work hard until he is 16. When he is 16 he should go into a motor manufacturer's works, if he is going to be an automobile engineer, and these works should be in a fairly big centre, as the lad will then stand a much better chance of getting a good technical engineering education in the evening than he would in a smaller town. If a lad goes to a technical school at the age of 13, and works hard until the age of 16, he should be able to leave with the advanced certificate of the Board of Education for such work as practical mathematics, machine drawing, practical geometry, applied mechanics, heat, electricity, and magnetism. That I know many keen boys have done, and done with a fair amount of ease. It means that when he starts his apprenticeship he can go to evening classes, and be prepared to take them on with a fairly light heart. Of course, the first year means getting up at 4 or 5 in the morning in order to go to the works, but if he has enough grit in him to become an automobile engineer, then he will be keen enough to get on with his work in the evening, so that by the second year of evening classes he will be able to tackle practically the higher stages of any subject, and whether he becomes a designer or works manager, or in other cases a foreman or mechanic, simply depends on the amount of information he can acquire. If he is clever, he will find that the information he can acquire will fit him for practically any position to be

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obtained, and the position will be in proportion to the information he acquires. I think there is one great duty that engineering employers have before them, and that is to give every facility they can to apprentices to attend evening classes, and I have such a scheme in operation myself. I first of all lay it down as a rule that no apprentice who is attending evening classes shall be required to work overtime, not only on the nights he is at evening classes, but on the nights when he is not, because if he has to work any overtime at all it is bound to interfere with his home studies: and I think the ordinary apprentice, if he wants to become anything at all, should be prepared to put in evening classes three nights a week, for two or three hours each night, and on the remaining nights he should be prepared to put in two or three hours' homework; if he is up at 5 in the morning and knocks off at 6 at night, and puts in this amount of work at evening classes, he will not have very much time left for himself when the hours of rest are taken into account, but unless a lad is prepared absolutely to devote himself to the profession he does not deserve to get on. The trend of this paper would lead one to think, at any rate, so I understand it, that the training to be given to an engineer, and an automobile engineer particularly, is one which should deal with the details of the work as applied to automobile engineering. I do not think that is quite right, because, after all, the average engineer's life is a succession of temporary jobs, and I think that in such an uncertain profession as engineering, when you may be designing motor cars one year and a patent wheelbarrow another year, it is better to acquire general principles, and it is possible to teach general principles, and to use automobile illustrations of them. For instance, a lad will have to learn the relation between force, mass, and acceleration; it is just as simple to deal with it in the terms of a motor car going up a hill as it is to picture a block on an inclined plane, and a pulley weight; it certainly makes it more lively, and helps the teacher to keep his students awake. There are very few teachers who are lively enough to keep their students awake, and it is excusable for them to fall asleep whilst they are listening to some of the lectures they hear. There is considerable evidence in the paper that lads who have studied hard during their apprenticeship find difficulty in obtaining jobs at the end of their time. I have a vivid recollection of writing for my first job, and although I had obtained a certain amount of academic success, I wrote forty

or fifty enquiries before getting a job, and experience shows that the people I wrote to were right in not giving me one. I used to write letters saying that I had a tremendous number of certificates, etc., but no one used to take any notice of it at all, so after a short while I tried a new tack. I wrote saying that I had had a respectable workshop experience, together with some acquaintance with technical matters, and could I have a job as a junior draughtsman? After four or five of these letters I got a job. Once a man has got his first job, then it is simple to get others afterwards, but it is with regard to the first one that my advice to young engineering students is to be modest to start with, and not to write letters which suggest that from the theoretical point of view they know four or five times as much as the works manager.

MR. MAX. R. LAWRENCE: In treating this subject, the authors have left out what, to my mind, are the chief controlling factors, namely, friendship and money on the one hand, and capacity and character of the individual on the other. I would like to draw attention to the following quotations:—Page 133.—“It may be mentioned here that those who obtain employment only through influence of personal friendship must be taken as outside the scope of this paper.” Page 139.—“The length of time necessary to be spent in the shops will, of course, vary with each of the three branches, and according to the aptitude of the pupil. . . . The fourth year could be profitably spent in the ‘round of the shops.’” In the last paragraph on page 139.—“A good practice for the first three years is for each apprentice to receive instruction in his trade from a mechanic who receives an extra weekly allowance.” Page 142.—“But whether the training shall be completed under the apprenticeship conditions or while the student is doing useful work and earning money, is beyond the scope of this paper.” And page 143.—“With the assistance of the principals, the Graduates’ section could be made of exceptional educational value.”

Now here, to my mind, is the whole key to the situation. The coin of the realm is the medium generally accepted by the community by which to reduce the relative merit of things to a common denominator.

In dealing with this subject, therefore, I feel that the value of money must never be lost sight of. Do not misunderstand me. Our social scheme makes money a means of exchange, and when one member of the community sets out to supply the wants of

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others, he must clearly keep this in mind, and remember that what he sets out to do must be sufficiently desired by others to make the work pay, otherwise he will be wasting effort, either by doing something wastefully, or something that his fellows do not desire. This is one, and probably the chief, mainspring of all action, but there is also another very powerful one, namely, friendship. A man will do for the good of others many things that cannot be bought with money or hope of gain. There, character and individual ability come in. I, myself, have been fortunate enough to have had good friends who have helped me vastly with my education, and many things that I required to know for my profession and in my training as an automobile engineer have been told to me and taught me gratuitously by good friends, many of them members of this Institution, and often by complete strangers before they were appealed to, and merely from the goodness of their heart and with no hope of personal gain.

It has been my good fortune, while in control of various automobile factories, to have under me quite a large number of young people who were learning their profession, and hoping to become automobile engineers in one or other of the branches mentioned in the paper. Unfortunately their education at the time of their entering their professional life in some instances had been anything but satisfactory, and however good their teachers, they had not assimilated sufficient knowledge, neither had their character been sufficiently formed to appreciate the opportunities that were given them in the works under my control. This is the chief difficulty that I have encountered in dealing with the education of young engineers. I like a lad with spirit who likes a bit of fun and means to have it, but there are limits, and I have often purposely administered punishment in the way of keeping a lad on some uninteresting work until he has shown sufficient capacity for doing distasteful work because it has to be done.

It is well-known that you cannot put an old head on young shoulders, but I think that if the remuneration of teachers was higher, better men would be attracted to the profession, and we should hear less of the waste of energy in our schools. This, of course, would mean higher school fees, and here, again, money enters into the matter and becomes the ruling factor.

Quoting from page 138 of the paper, and the recommendation of the Institution of Civil Engineers:—"A boy who intends to be an engineer should receive a sound general education at school,

where he should remain until he is about 17 years of age; his study should include advanced history and geography, English literature, Latin, conversational German and French, which should be taught colloquially, to give the pupil sufficient knowledge to enable him to study the literature and converse in it with some degree of facility." I quite agree with this, but unfortunately many good men are debarred by financial considerations from attaining thereto.

Then, of course, the individual character of the student must be taken into consideration. All great engineering businesses have, in my experience, been founded mostly by one man or two men working together, and how far they have room or money to employ expert assistance is for them to judge in their scheme of supplying the wants of the rest of the community.

The authors lament that some of the Graduates of this Institution have found an outlet for their services in other trades, and they also point out that the leading men in this profession did not start in it, but created it. Doubtless the professions they left have suffered, but surely the community, and I hope the men, have benefited.

The whole crux of the matter, to my mind, is summed up in the old well-worn saying that "You can take a horse to the water but you can't make him drink," and if the engineering ability, characteristics and special circumstances of each individual are not taken into consideration, it is very hard to generalise. There are many ways of arriving at the same result, and I have found that most men in the world will help others who help themselves, and to my mind it matters little when and how a lad receives his training so long as he has character enough to stick it out, and make himself obliging and willing; if he has the right characteristics he will always learn.

I shall never forget one thing that happened to me at Birmingham when I was with the Wolseley Company. I realised that when lads are working full hours in the shops it is quite impossible to expect them to attend a technical school in the evening and do another two hours' head work. I therefore got the directors to agree that all the apprentices in the works should be allowed to come in at 9 o'clock and leave half an hour earlier on the days that they attended the technical school, the two hours thus lost in the works being paid for upon the headmaster certifying their attendance at the schools. I had a deputation of lads from one

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department who were on piece work—and I may say as far as possible all apprentices worked piece-work, the object being to teach them the value of money and to make them appreciate the value of work done, and also if they were clever and industrious it enabled them to earn more money—and the object of this deputation was to say that, as they were earning time and a quarter in the factory, would I pay them time and a quarter while they were at technical school?

Briefly, then, to sum up, what I want to convey is that the authors, in dealing with this subject and criticising employers of labour and those who have to control businesses, have not taken into account the three most important factors, namely, money, friendship, and the capacity of the individual who has to receive the training. It is easy enough for a lad to wish to be the head of a large concern; it is also possible, if he has the money, for him to get all the opportunities for the training that may be desired, but it must be remembered that unless he is naturally endowed with the necessary character, brains, health and tact which will fit him for such a position, he will never find himself there. He will probably never know why he is passed over, employers have a way of not communicating the unvarnished truth in such cases; it is not wise or kind, and, any way, serves no useful purpose. All that the individual knows is that he has not got the appointment and is disappointed. He is sure to consider that he is much more fitted to fill the post than the successful man.

I have purposely directed my remarks to this side of the subject because I think it is so important, and is so often, as in this case, entirely left out of such discussions. I feel sure that others will speak of the details of many excellent schemes of training, and by having many varied ways clearly set out, the individual will be able to choose that one which is best suited to his particular case.

Dr. R. MULLINEUX WALMSLEY (Principal of the Northampton Polytechnic Institute, London):—The Chairman has asked speakers to indicate as far as possible some definite course for the training of engineers, and I shall try to do what I can to confine myself to that line of argument. I might perhaps, first of all, congratulate the authors upon the very lucid way in which they have put a good many points which are difficulties, and have been difficulties for many years, to those of us who have been studying the question of engineering education. It goes without saying

that no single speaker in a discussion like this can touch upon all the points in the paper. There are certain points that I may have to leave unfinished and incomplete, owing to the exigencies of time, which inevitably intervene in discussions of this kind.

I should like first to direct your attention to page 137 of the paper, in order to make a few comments upon the opening sentence on that page, which is as follows:—"There is a great diversity of opinion as to whether college instruction should precede or follow the works training, or whether the two should proceed concurrently." The answer to that question is probably the kernel of the whole matter, and it occurs to me that neither the authors of the paper nor the preceding speaker have realised that there are other variations of the sandwich system than those which have been mentioned. My solution is that to some extent works training should proceed concurrently with the college training, and let me say parenthetically, that by college training I mean all kinds of technological training and not simply training at a university college. In my opinion, after many years' experience of the subject, college training should precede works training for several reasons. In the first place, it is not so big a wrench from a schoolboy's previous experience to go to a technical college or technical institution and commence a period of training there. It is a great wrench for him to go into a works, and he loses at once weeks, if not months, of his time in feeling his feet and beginning to understand anything at all about the works.

There is, however, a much more serious point to be considered. Boys say they want to be engineers, and I have asked boys of 16 and 17 dozens of times "Why do you want to be an engineer?" and I have never got a satisfactory answer. You have first to solve the problem as to whether the individual is fitted to be an engineer at all, and to throw him into a works and let him sink or swim for months, or even years, and then find out that he has not the aptitude to become an engineer, appears to me to be a very serious matter. I suggest, therefore, and for ten years or more I have carried my suggestions into practice—though I have worked for more than twenty years at the problem—that the first step is for the boy to enter college, not simply to be taught, but to be under observation. He will be taught, of course, but he will be put under close observation as to his aptitude for engineering.

Here I should like to enter a very strong protest from the

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educationalists' standpoint against boys of any grade of society being asked to commence specialising at 13. It is depriving them of their educational birthright. Boys who specialise at this age do not know the science of the subject well enough to be completely educated when men; they cannot be, and they find the want, not in the years between 13 and 21, or perhaps between the years 13 and 30, but they will find the want when they get on to be older men, and you should not deprive the boy of a sound general education by asking him to specialise at the age of 13. The Institution of Civil Engineers has put down 17 as the proper age, while in other countries it is 18. I did not intend to express an opinion, but perhaps I had better, and say that I think 16 should be the lower limit of closing the general education and commencing the special education.

At this age, as a minimum, the boy should go into the technical college and pass through a four-years' course (not a three-years course) on the sandwich system. With regard to vacation appointments, I know that such appointments are not, very justly, in favour with works managers, if they commence at the beginning of July and finish at the end of August. Therefore, the works part of your sandwich system must not begin and end then. The system I have adopted, and I have every reason to be satisfied with its success, is that for the first year an ordinary college course in physics, chemistry, and mechanics and engineering drawing should be followed, taking special care that the student shall be put under observation, so that at the end of the third term, in July, it should be possible for the instructors to say whether that student ought to go further or not. If not, the student should be rigorously excluded from going any further, in the interests of those who remain, if for no other reason, but there are other reasons which are obvious.

The student, having qualified, can in the second year enter upon a much more specialised course. That second year I terminate at Easter, and from Easter to October or September is the works period. I have not yet had any difficulty in finding works managers to take students for that period, at any rate, up to the number of students I have had to offer them. The third year is like the second; two terms from October to Easter, and then another period in the works. The final year is to be a complete educational year from October to July, and then the course, so far as the college is concerned, finishes, but it is not pretended

that the student is trained by that time, for he still wants more works experience.

I would next point out one or two advantages of the system. In the first place you get a weeding out of the wasters and slackers and the unfit, which I consider very essential, with the consequence that the men sent into the works at the Easter of their second year are men who can be relied upon to do some credit to the college. The works to which I have sent men have almost invariably asked for more. Then, again, action and reaction are continually at play. These men go into the works with some knowledge of engineering. They have handled tools in the technical college, not in the sense of works tools, but they are familiar with the tools, and they are familiar with certain processes, and they begin from the very first day to acquire training in the works. When they come back in October they are not the same men that they would have been had they stayed in the technical college for the whole period up to July and had the usual vacation either in the works or outside. They are different men; their training is now real engineering training for the rest of the college course, and for the second period in the works, and for the fourth year at college. Also you will notice there is no loss of time. There is only one vacation, that is the vacation at the end of the first year. All the other vacations are simply of the order of works holidays only, as they should be, with the exception of the very brief Christmas vacations of two or three weeks, when really you must not attempt to put a youth into the works. As I say, there is no loss of time; in fact, the training approximates to professional experience, where we all know that two or three months' holiday can never be obtained by any professional man who is in good work, and I must simply repeat that I have found the system I have just outlined to be most successful. There are ten terms of actual college work in the four years instead of the nine in the three years. The last five terms, including two works intervals, are real engineering training in works and college, and that is one of the most important points of the system.

The authors of the paper divide the training of engineers into three classes: salesmen, works managers, and consultants. I say training of engineers, because I consider that salesmen should be trained engineers if they are engineering salesmen, and it is probably familiar to many of you that this is generally recognised throughout the United States and Canada. I have had it from

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the works managers of large engineering concerns there on the spot that they cannot take even into their salesman branch a man who has not had a good technical college training.

I am not quite in accord with the authors of the paper, that the selection of the type of training is not to be made immediately on leaving school. I go further than them, because I say that the more fundamental question of whether the youth shall be or shall not be an engineer at all should not be decided so early. I say you cannot decide it at 16, and how you can pretend to do so at 13 is a mystery to me.

Then it is said in the paper, on page 139, "The authors are entirely in favour of the abolition of the 'pupil' or 'gentleman apprentice.'" I should have liked them to have gone a step further, and to have said they are absolutely in favour of the abolition of the "premium" apprentice system. That system appears to me to be an excrescence on the engineering industry which is only known in this island. I shall never forget the polite incredulity with which I was listened to on my first visit to America when I described the English system of premium pupils to the works managers and practical men there. I am confident that 90 per cent did not believe what I was saying. They were too polite to say so, but you can always tell when a man is not believing you; it is not necessary to tell you in so many words. I strongly desire to see the abolition of the premium apprentice system, because it is in my opinion vicious.

The system in the States is to take graduates from technical colleges and pay them at once. I should like to point out that the fundamental evil of the premium apprentice system is that when the principal has taken the man's £300, or whatever it is, he is bound to carry the bargain through, whether the man is shaping to be a duffer or an engineer. He cannot make any selection after that. In the States, even those who are put on the commercial side of the organisation, as I have already said, have to go through technical colleges. They take the students from technical colleges into the works for their works training, and later on they grade them into the authors' classes, but they give them from the start a living wage. On the other hand, it is our experience in England that employers will take highly trained men from the colleges for works training, and offer them wages less than those of a labourer to make a start on. Within the last month I have had a letter from the States offering that if

I would send over to a certain firm certificated students of the Northampton Institute, which is the Institute in London that I am talking about, they will start them at not less than 20 cents an hour as pupils, and to exceptionally good men they will give 25 cents an hour.

There is one other point with which I may conclude, and that is, the authors of the paper do not seem to know that the Technical Institutes are not quite so backward in catering for the commercial side as is represented in the paper. There are classes in costing and estimating, and works management, and things like that. Perhaps you may say that teaching in works management at college is like trying to teach swimming on dry land, but there are classes in those subjects at the present time, and salesmen also can get training in their part of the work if they will only go to a place where it is offered to them.

MR. HENRY C. DEVINE:—I must say that the gentleman who opened the discussion positively appalled me when he stated that his idea of the best method of education for an automobile engineer was that under no circumstances was a lad to remain at an ordinary school after reaching the age of 13. That, I say, positively appalled me, because after all our object in life with boys is to make them not only engineers, barristers, doctors, or whatever particular profession it may be, but we also want them to be educated men, and I do not see how it is possible if we take boys from school at 13, and cause them to specialise in any career at that age, to make educated men of them, or even men possessing those qualifications which are necessary for material success in any profession. I think it is an excellent idea for the Institution to try and set forth, as far as may be, the methods of training for the different departments of automobile engineering, and I hope that as a result the necessity for very prolonged theoretical as well as practical training for all but the purely commercial side of the profession, will be recognised both by parents and by employers. A great many parents come to me and seem to think that an automobile engineer can be made in a night. They appear to grudge the time and money necessary to make their boys successful professional men, but without the expenditure of that time and money I do not think it can be done. An employer is not running his business for the fun of the thing, but for a profit: but it is only when employers in this country realise more than they do to-day that it is to their material interest to have a good supply

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of capable men with a thorough theoretical knowledge of their profession, that they will encourage that length of training that is necessary to turn out a good engineer. There is another distinction between boys that I should like to mention, namely, that between poorer and richer ones. I should like to see every boy have the best opportunity, according to his capacity, to get on, but we cannot hope to give every boy an equally good professional training. For certain boys, the sons of rather poor parents, there is only a certain amount of education to be obtained, but there are a great many other boys who are able to go either to municipal secondary schools or to public schools, and afterwards to colleges or universities. It is certainly out of the question for these boys to enter the profession, unless they can do so after completing their secondary school education, that is at the earliest at 17 or 18. If it is laid down authoritatively, however, that in order to be a successful engineer a boy must leave school and begin specialising before that age, it would practically mean that for a large body of capable boys there is no room in the profession. I do not believe that this is so, and the writers of the paper certainly do not say it. I think 17 years of age is quite early enough for a boy to leave a secondary school and begin to specialise. After that the question is whether he should go to a college or works, or *vice versa*, or adopt some modification of the "sandwich" system, such as was explained by Dr. Walmsley. I think the suggestions which Dr. Walmsley made are very practical, and that if they were adopted they would be very helpful in training boys from the secondary schools for the profession of automobile engineering.

Professor W. MORGAN:—Some of the experience of the Daimler Motor Company in dealing with their pupils may be of interest in this discussion, and perhaps also some of my experiences at Bristol in teaching the University Course in automobile engineering there. The Daimler Company have avoided any very rigorous agreements as far as possible in dealing with their apprentices, or I should say, boys of the apprentice class, and their pupils. It was found that the indentures of the apprentice at times rendered things unpleasant, when, for instance, it was desirable to get rid of the youngster on account of unsatisfactory conduct. Then with regard to pupils, it was found that a rigorous agreement for two or three years did not always operate to the advantage either of the Company or the pupil wherever a differ-

ence of opinion arose. Practically there is now no rigorously binding agreement, either with the boys of the apprentice class or with the pupil class. The agreement is prepared in such a way that it can be broken at a moment's notice if desired. If a pupil is tired of the work he has only to say so, and a proportion of the premium is returned to him, and he is permitted to go. No attempt is made to hold the individual pupil by compulsion. With regard to boys of the apprentice class, although there is no binding agreement, the boys almost invariably stay on and complete what is practically an apprenticeship. The education they receive in the shops depends very much upon themselves. If they are bright and smart, and show any desire to get on, the boys are promoted from shop to shop and generally well looked after. With regard to technical training or theoretical training, the brighter boys are selected, and have granted to them two half-days a week to attend the Coventry Technical Institute. Coventry is extremely fortunate in possessing that Institute, for the Principal has arranged a series of day classes suitable for boys of the apprentice class. It is the general practice of the engineering firms of Coventry to give their apprentices leave to attend these classes on two half-days a week, and in many cases to pay the fees at the Institute for these boys. I think it is very necessary that some arrangement like that should be made, or, as was suggested by an earlier speaker, boys should be excused from early work on certain mornings in the week, and allowed to leave a little before time in the afternoon. My experience of evening-class teaching has shown that short of something sensational it is almost impossible to keep the pupils awake. Youngsters who have been at work from 6 in the morning till 5 or perhaps 6 in the evening, simply accept what the instructor has to say and quietly go to sleep over it. With regard to those of the pupil class, some condemn them entirely, but I think a great deal depends not so much on the pupils as on the way they are handled. If they are led to understand at the start that they are coming into the shops, that there they will be treated like anyone else, that no privileges will be given in the way of leave, and that they will be subject to workshop discipline, there will be very little difficulty in dealing with them. If a pupil proves difficult he had better go home. I know, however, that these youngsters, one way or another, do manage to get privileges. I do not know whether it is due to their winning little ways or not, but the privi-

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leges they get in the way of leave do very little harm. I have had very little difficulty from this class. Youngsters who have been brought up quite soft very shortly get really to enjoy the work in front of them. The shop discipline is really a good test of the stuff the pupil is made of. If he cannot face workshop practice he had better go. In selecting pupils, it was felt that a good education was required, but it was also felt to be unwise absolutely to dictate whether the pupil should have a college education or not, so the minimum age for a pupil was fixed at 18. It was felt that a boy could get a good general education, and possibly have put in a year or two on subjects dealing with engineering, or a pupil could have gone to a university and have completed a three-years' course in mechanical engineering, or, as it is possible to do, a three-years' course in motor car engineering. It was also felt that if money has been spent on a boy's education in that manner it was very unfair to ask from him a premium, and so later on it was arranged that what we call works scholarships should be offered for competition. These in effect are free pupilships, of which about five are offered each year. The men who win them are usually men who have had two or three years at some university, although the conditions are so arranged that a lad who has been through the workshops and spent a fair amount of time in an evening technical school may obtain one of these scholarships and get on to the higher grade, as it were. It may be necessary to make some alteration in remuneration to pupils, because at present this does not exceed £25 a year, and that is not sufficient for a lad who has to depend on his own efforts. So it is desirable that youngsters who are winning their way upwards, and who have to depend very much on their own efforts, shall be able to handle a little more money in the way of wages. In addition to those who win these scholarships we also accept premium pupils, not that we desire to do so, but because they are practically forced on the works. You know what influence is. When there was an examination alone influence would be used to make the examination as gentle as possible. It was felt that perhaps it would be wise to offer a greater barrier to the prospective pupil in the shape of a hundred pounds or so, which really makes a man think twice before putting a protégé forward. I am referring to the danger of having pupils thrust into a works by influence. The presence of pupils who win their pupilship in competition reacts to the advantage of the premium pupils,

because in taking the man who desires to enter as a pupil without competition, it is pointed out to him that he will have to compete against men of very high intelligence, who have high qualifications, and who, at the end of the pupilage, will, probably from sheer merit, take any vacant jobs which may be about, and that the same kind of competition will be met with in the open market. The consequence is that men who have come forward with a half-idle intention of becoming engineers by some miraculous means, reconsider the position, and usually find some other opening for their activities.

The further theoretical education of these pupils is arranged for. It is not felt that when a man comes out of college he knows everything of engineering; although he may have obtained a great deal of information, he is usually very ignorant of the best means of using this information. That generally is the fault of his instructors. The drawback, of course, to college education is that so much of it is given from text-books. It is given by men who have left the works for perhaps something like ten years. Ten years, in engineering, is a generation, and so the youngsters are frequently sent from college with knowledge out of date, and unable to apply this knowledge to the best advantage.

I notice that the writers of the paper rather fear that the pupils or young engineers will forget their college work after a three-years' shop course. There certainly is great danger in that, and our pupils were at first given one or two half-days a week for technical studies, but experience soon showed that studies of the text-book order were absolutely useless. A set lecture, unless it was made on some point actually dealing with automobile construction, such as the peculiarities of carburation, or something like that, was received with politeness and indifference. I do not blame the men; the problem was to make these men work, and incidentally save myself trouble. Our present scheme is to have a paper read each week by one or two pupils. That paper is read on a Friday morning before the other pupils, who then proceed to dissect the unfortunate reader of the paper. It is remarkable to note the amount of time and trouble these youngsters will spend in the preparation of a paper, some of which are of an extremely high order of merit. In some cases, on my advice, the papers have been shortened, and have then been published. In this way there is not the slightest difficulty in getting the men to take very great interest in the

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theoretical side of their work. The subjects are so selected that what in college have been mere abstract principles are now found to be of practical use in criticising current practice. In the end the men are revising their college work, and at the same time learning to interpret what is in front of them.

It is difficult to say what system of college and shop training is best. Circumstances are so different in different parts of the country. In the University of Bristol there is laid down a course of motor car engineering, and a student may take his degree in that subject. It has been objected that specialisation should not take place so early, but should only take place at the end of the three-years' college course. That is very nice if we go on the assumption that the students are wealthy and working for amusement, but unfortunately we know that the larger number of men who attend engineering colleges do so because they hope thereby to obtain a decent living in the future, and frequently they have to depend on gaining such a living pretty quickly, so that I think the suggestion of specialising at the end of a three-years' college course is out of the question, except for the few. Then again, much depends on what is meant by specialisation. At Bristol it is recognised that motor car engineering—automobile engineering—is merely a specialised form of mechanical engineering, so that any man taking this subject must be well grounded in the principles of mechanical engineering, so we adopt the following plan: The man attends lectures in subjects such as strength of materials, and mechanism, which are fundamental to mechanical engineering. The application of the principles that he studies in these lectures are illustrated from, and applied directly to, automobile engineering. Then, of course, there are additional special lectures dealing with the subject of automobile engineering itself. As a result, specialisation is more in name than in fact.

With regard to the attitude of the employers to college-trained men, I think the employers are not so much to be blamed as the people who have turned out the kind of youth that so often comes from various colleges and public schools. At the Daimler works I get men coming to me at the age of 22 or 23, who have had a university education of some sort, or, again, men near 18 to 19 from public schools; these, as far as preliminary training which will fit them for becoming engineers is concerned, frequently are worse off than the boy of 13 whom Mr. Pomeroy mentioned. They are men who are absolutely hopeless from the point of view of

engineering and practically everything else, and if they were not backed by money and influence they would have an extremely bad time. One can imagine the works manager who has had a few of these men thrust on him by influence getting so tired of them that he condemns the whole class. In addition, some young men go away with the impression that immediately they have finished their college training they have finished everything; instead of which they have yet to make a beginning, so that I think the attitude of employers is quite understandable. On completion of their time the pupils at the Daimler works are told in effect when seeking permanent work that if the boy who begins by going into the drawing office to wash the brushes can do a job better than they can, the boy gets the job. No notice whatever is taken of the preceding training. If the training is of any use it should show itself in results. If it does not, well, the pupil fails, and it is the best man who takes the job. It may be noted that the rightly trained college pupil almost invariably leaves the apprentice far behind in resourcefulness and capacity.

As to the time to be spent on the training of an engineer, it must be remembered that there is a factor which will tend to limit that to be spent in colleges. The college trained man has as his most powerful competitor the sturdy boy starting at the age of 15 perhaps, favoured with some of the concessions mentioned in the way of theoretical training. Such a boy, with his splendid shop experience, and being possibly a youngster of good mental powers, is a serious competitor to the college trained man. The college trained man cannot afford to spend too much time away from the shops, otherwise the less fortunate boy working through the shops will beat him.

Mr. C. E. LARARD:—I should like to state that I have had the good fortune to assist Dr. Walmsley in the working of the sandwich system, the outline of which he has placed before you, and I can say from personal experience that it is a system which has been found to work very well indeed. At the Northampton Institute it is organised in connection with the electrical and mechanical engineering courses, and for automobile engineering students as well. The value of the sandwich system I will not enlarge upon, seeing that Dr. Walmsley has dealt with it so fully. I need only say in addition that it is fully appreciated by many employers, and I think I am right in stating that when it became necessary last Easter time to place the students in the

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works, Dr. Walmsley had more positions available than he could fill. With respect to the technical training of automobile engineers, I think we have got to take into account the requirements of two totally distinct classes. We have first of all the poor working lad whose parents are not able to keep him and pay his fees for a full day course at a technical school. Then we have the other type of man whose parents are in a position to bear the expenses involved when the college training becomes necessary. I think that when the time comes for this Institution to consider the ways and means for training automobile engineers on sound educational and practical lines, full consideration should be given to the first class of individual as well as to the second. No course of practical training will be complete unless it is possible for the really smart though poor lad in the works to rise as far as his ability will take him. Employers should establish scholarships tenable at some Technical Institution. I know at first sight this seems an unprofitable thing to do, because engineering firms are run for the purpose of making a profit; but if each large firm would make a point of establishing say one or two, or even more scholarships, according to their means, then it would be possible for the really smart and well-above-the-average boy to get the best possible training. There is one argument which could be advanced against that. A firm might say that after having found the money for the scholarship they may lose the lad shortly afterwards; he might get another job. But if firms generally adopted the policy suggested, what was lost in one way would be gained in another. A particular firm might eventually lose a youth for whom they had paid the necessary fees, but they would probably secure another, equally well trained, in his place. Much has been said about the premium apprenticeship system. In my opinion it is a most unsatisfactory one. It is run with the idea that it is a source of profit to the employer. It is not beneficial ultimately either to the employer or to the youth whose parents have had to pay the premium. This is the opinion of many successful engineers, and certainly of most educational experts. I should like to congratulate the authors on their joint paper. They introduced it with diffidence, and then attempted to justify its *raison d'être*; I do not think any justification is necessary. They have done a right down good work in starting a discussion of this kind. Referring to the authors' schedule on page 133, and the remarks connected therewith, I think classes 2 and 3 would naturally fall

together, and the class in which a man would eventually occupy a position would depend on his ability in receiving and utilising training which should be common to both. Speaking of the employers, on page 136, the authors say: "Mostly they lack any sort of theoretical training themselves, and succeed solely through perseverance and energy." I think, in justice to the management, one ought to add to that that there is something more than perseverance and energy. There is *character*, and the ability to control men, as well as the commercial ability, which in itself is more often than not a natural gift. There is, however, a good deal of truth in what they state. Employers, particularly those of the old school, had not the advantages which present-day apprentices are getting, and human nature being what it is, they are prejudiced against things they do not understand. It is one of the functions of an Institution such as this to make them understand the advantages of a thorough technical education. There is another matter which has been referred to, and that is the dislike which college-trained students often manage to inspire when they get into the works. This is largely due to two reasons. One is that he makes the mistake of thinking that because he has a certain amount of theoretical knowledge he knows more than his employers. With the omniscience of youth, he overlooks the fact that his employer has a wealth of practical experience and business ability which he cannot hope to acquire for many years. Naturally, any employer will resent expression of that attitude of mind in one of his employees.

Mr. H. P. G. BRAKENRIDGE:—When I received this paper I thought I was going to learn how a man could be trained to become an automobile engineer and earn his living. I have not learned it so far, but it has occurred to me that a practical way of going about the business for an Institution of Automobile Engineers is to appoint a Committee. Call it the Education Committee, or whatever name you like, but it should be the business of that Committee to formulate a scheme, so that if a parent has a boy and wants him to be an automobile engineer he can write to the Committee, and the Committee should be able to place before him a cut-and-dried scheme which will tell him how to make his boy into an automobile engineer, according to his means. If a man comes into my shop and wants to buy a set of lamps for his motor car, I do not say "There are a lot of lamps,

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buy which you like"; I say "Here are three lamps, and this is the set you had better have for your particular car." He has no time to choose, and knows nothing about lamps; he comes to me because he thinks I do. You must bear in mind that the average parent is too busy, and has too little time to find out for himself the best way of educating his son. He wants somebody to come along and show him a route such as he can afford, and that, I think, is the particular business of this Institution.

ADJOURNED DISCUSSION.

THE CHAIRMAN, Mr. J. S. Critchley, in opening the meeting, said:—I think it would be well if the speakers would try and condense their speeches so as to include certain definite points in connection with the training of automobile engineers; for instance, the question of the age at which a youth should start his training, the sifting of the fit from the unfit, the extent of the technical training, and how that should be carried out, whether by day or night classes, the term of apprenticeship, the question of wages during apprenticeship, and the locality of apprenticeship, which is closely connected with attendance at the technical colleges. Of course, these heads are sub-divisible, but I think it would help the Council of this Institution if they could have the views of the members under these heads, and if it is possible, the Council, at a later date, may be able to issue some report which will be of benefit to parents and others who have boys they wish to make into automobile engineers.

Mr. C. WHEELER:—It was my intention originally to draft a memorandum and submit it as a supplementary contribution to the paper, for inclusion, at the Council's discretion, in the Proceedings, but in roughing out my draft I came to the conclusion that it might be more useful, and possibly open up one or two fresh avenues of thought, if I gave expression to my views this evening. The Chairman, in opening the meeting, expressed a desire that speakers should deal with particular phases of the subject, but I am afraid that my remarks will be more of a general character than special to automobile engineering. Dr. Walmsley has intimated that the "sandwich" system, so far as practically operated by him, has been quite successful. I am very pleased to hear it, for the system appeals to me, and for two or three reasons, the chief of which is this:—If a mistake be made in the choice of a profession, and some years be spent in the pursuit of specialised training, it is usually a matter of great difficulty to retrieve the situation. Here Dr. Walmsley's system scores, if efficiently carried out. At the end of the year, if it appears that the student has little chance of becoming an efficient engineer,

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the teacher switches him off that particular road, and the information and learning already absorbed by the student, being of a general character, is turned to good account in another direction. Again, the system—at least, so it appears to me—enables the student at the end of his first year to form some definite idea as to the particular branch of mechanical engineering in which he would like his practical knowledge to be acquired. What I mean is this:—When a student commences his practical work it is necessary that he should learn turning, milling, boring, etc., no matter whether he intends ultimately to make automobiles or, say, weighing machines. The sandwich system has another point in its favour, which I can best illustrate by mentioning my own experience, and it is that of many others. I had left school but three months when I wished myself back again, in order to learn certain subjects in which I found myself to be deficient. It was, of course, too late, and it meant a grind at evening classes, when the mind and physical condition were not at their best. The “sandwich” system enables one to find out what one *ought* to know, and provides the means of going back to school to acquire that information. Now, to make Dr. Walmsley’s system successful in its general application, there are two important factors that require very careful consideration: (1) the teacher, and (2) the employer who is providing the practical training. I propose to make a few remarks concerning each. With the teacher should be included the necessary educational institutions, but I dismiss further consideration of the latter, assuming that they actually exist, or that their creation will keep pace with the demand. As regards the teacher I do not feel quite so happy, although I believe matters have improved during the last decade. So long as the teacher’s remuneration and advancement depend in any appreciable measure upon the success of his students in examinations I do not think you will get the best and most desirable class or form of instruction imparted to the students. Dr. Walmsley has mentioned that his instructors carefully watch their pupils towards the end of the first year to ascertain their fitness for pursuing certain careers. Now, if we could make sure that such a practice were universal, and that the teachers themselves were qualified to judge, then we should be well on the high-road towards an excellent, if not a perfect, system. When I say “qualified to judge,” I do not, of course, pass any aspersion on teachers or professors, as such. What I mean to indicate is that

teachers and professors must have, in addition to their scholastic qualifications and ability to impart information, the power or faculty of judging human nature, and of controlling and directing the powers of the mind of the student. I think Dr. Walmsley will be one of the first to agree with me that many teachers are deficient in these most important qualifications, and it is not difficult to see the reason. A young man studies at college, takes his degree, obtains an appointment as teacher, and straightway proceeds to push into his pupils the book knowledge he himself has already acquired. Where and when has he had the opportunity of developing the study of mankind? There is also a class of teacher, who, in addition to scholastic qualifications in an equal or in a less degree, has much practical experience, and has been or is actually engaged in commercial life. Speaking from an engineering standpoint, that is the type of teacher to be encouraged, and whose numbers must be multiplied. But how? The wherewithal for the encouragement and multiplication of this class must, I think, come from the State, and will, I hope, form part of the new educational scheme which Lord Haldane has recently intimated is under consideration.

Now, with respect to the second factor mentioned, namely, "the employer who is to provide the practical training." Mr. Pomeroy made reference to the disorganisation caused to the employer, and Mr. Max Lawrence also testified to the difficulty that is experienced in engineering concerns by the arrival and withdrawal of a number of students at certain times of the year. Mr. Larard, in skirting this phase of the subject, suggested that employers might provide scholarships according to their means. I do not know exactly what he had in mind, or rather, what form he proposes the scholarship should take, but the problem is a difficult one however much the employer may be desirous of helping the country or the State in producing a higher class of engineer or craftsman. His business, whether of large or of small capacity, is primarily to make profits, and in this highly competitive age he is at some disadvantage if he admits a "sandwich" student, compared with the man who will have nothing to do with one. I am, of course, speaking broadly. There are, however, many instances where it would be profitable to an employer to possess "sandwich" students. The point I wish to make is this, that the resultant effect should not be a matter of luck to the employer if he admits "sandwich" students into his

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works. If it be recognised that he is doing beneficial work to the community, then he should receive recompense in some form—in other words, the admission of “sandwich” students into his concern should be considered as a part of the general system of State education, and should be paid for as such. I am well aware that if my proposal be agreed to there is the problem of State supervision where a public contribution is made, but this is, I submit, not a difficult problem to solve. The consideration given to an employer need not necessarily be a monetary one. I throw out the suggestion that all employers who help in the State education in this wise might receive favourable consideration or preferential treatment in all Government contracts. It would not be by any means a difficult matter to appraise the value of the employer's services to the State when considering tenders for Government work or stores. A scheme has been in operation for some time in all Government contracts which ensures the payment of fair wages to employees, and it is possible to devise means by which an employer could receive recompense or consideration for assisting in State education, or, at any rate, to see that he does not lose anything in competition with a non-State-aiding house. In conclusion, I would like to suggest that a copy of the paper written by our Graduates, and a full report of the discussion, be submitted to the Authorities who now have the question of State education under review, and I make that suggestion for this reason, that I believe the views put forward, and the opinions expressed, by practical engineers will be welcomed as material for tempering academic stock.

The CHAIRMAN:—I will ask Mr. Pendred to speak now. Mr. Pendred, as editor of “The Engineer,” has written a very sympathetic article on the paper by our Graduates, and I am sure we shall all be very pleased to hear him speak to-night.

Mr. L. PENDRED:—As I am neither an automobile engineer nor a member of this Institution, I can look at your work from a detached standpoint, and in the first place I want to say that I think you have done a very excellent thing in getting the views of students upon their own education. But it is desirable that you should now go a step further. We have heard *ad nauseam* the views of professors and of employers on the way in which young men should be educated, and now we have had the advantage of hearing from your own students how they think they should be educated. But there is another person to be considered,

and so far he has been forgotten in nearly every Institution, and that is the parent. The parent, if you could get him to come here and talk to you, and tell you his views as to how his son is to be brought up in the profession into which he elects to send him, would pose you with a whole lot of difficult questions. He would first of all ask you "How long is the training to take?" "How much is it going to cost?" and "What is my boy going to get in the end?" Some years ago I suggested £400 a year at 40 as the very minimum that any training should give. Now, I say again, that if the training that you elect to give to your young men is not going to make at any rate 70 or 80 per cent of them fit to earn £400 a year by the time they are 40, it is not doing what it ought to do, and you must revise it. There is something wrong with the system that does not enable men to make that amount of money after such a large number of years has been spent on it.

Of all the schemes that have been suggested for the education of engineers, there has been, in my opinion, none better than that which was put forward by the Committee of the Institutions of Civil and Mechanical Engineers, which is known as Sir William White's Committee. In the report of that Committee, as you are probably aware, it was proposed that the beginning of the training of an engineer should be a good public school education, and after that, at the age of 16 or 17, entry into works for a year. Personally, I do not think you can have any better plan than that. If you put a youth of 16 or 17 into a works you find out at once what his qualities are. If he is not able to stand the works, in three or four weeks you have found out that he is not fit to become a mechanical engineer, and you must switch him on to some other occupation; but here again the parents come in. It is one of the penalties of my position that I am asked questions about the education of boys, and I always use Sir William White's Committee's Report as the basis of what I recommend. The reply invariably is, "We cannot send our son to a works at 16 or 17 to mix with all those rough men, and learn bad language and get into bad habits; we really cannot do that at all, Mr. Pendred. You must suggest something else." Sir Frederick Donaldson has got over that difficulty very cleverly at Woolwich, and I think his plan is well worth considering by your big works engaged in automobile engineering. He has established, or has arranged, in the neighbourhood of Woolwich hostels and registered houses in which the students live, and where their life out of the works,

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their moral life, if you like to put it so, is looked after by thoroughly well-recommended owners and managers of the hostels or lodging houses. I recommend to your attention this system, and I am sure Sir Frederick Donaldson would give you full particulars.

There are one or two points in this paper on which I should like to comment. The first is the question of premium apprentices. Following the example of all the professors and a great many other people, your four students have condemned the premium apprentice without a word in mitigation. Now, I think there is a very great deal to be said for the system of premium apprenticeship. It is true that many men cannot afford to pay a premium for shop training, but to me it seems hard that those who can afford to pay for it should not be allowed to get the advantages which undoubtedly they reap. If you attempt, as I have done, to find positions for young men in works, you will find when you offer to the works no compensation for the trouble to which they are to be put, that there is the very greatest difficulty before you. The works say, "We do not want men; we have more than enough. We have got to take into our shops the sons of managers, foremen and chief-draughtsmen, and our own proprietors, and so on, and we do not want outside men. If you want to get outside men in you must pay us something for training them." That seems a fair and rational point of view; if they are asked to take a man in without a premium and without a limit to the training he is to get, they must be compensated. To get a thorough mechanical engineering training, a man should go through nearly every shop in a big works; through the pattern shop, the smith's shop, boiler shop, fitting shop, and erecting shop; indeed, if possible, through every shop that there is in the place. If you put a boy into a works under the conditions of the ordinary non-premium apprentice, they will not give him that training. He may be a fitter, and learn to fit; he may be an erector, and he will learn erecting; he may go through the testing shop, and learn to test, if he likes, but he will not get that all-round training that is required for a thorough mechanical engineer unless you are prepared to pay a premium. It is to be regretted that all men cannot pay a premium, but I think you must agree with me that those who can afford to pay should be allowed to have the advantage which accrues. I suggest to the four students who have written this paper that, if possible, they should revise their wholesale condemnation of

the premium apprentice. They have simply followed the usual custom and condemned the premium apprentice unheard. One argument they made against him is that he upsets the usual management of the works. Now, plainly, gentlemen, that is ridiculous. If a works manager is able to control 300 or 400 men, is it reasonable to say that he cannot look after half-a-dozen premium apprentices? You have one or two excellent examples to the absolute contrary. Allens, of Bedford, who make a strong point of apprentices, and divide them into three grades, have a large number, but they have not the slightest difficulty in controlling them. There is no real obstacle from the manager's point of view in the premium apprentice. I must now leave that point. I could go on all night, but I do not want to be tempted to transgress.

I want to touch now upon the relative importance of theory and practice in mechanical engineering, for I see your students have laid some stress upon the value of theory. There are, if I may so put it, two kinds of science with which we have to deal. One is the science of the schools, and the other is the science of the workshops. The science of the schools *alone* is valueless. The object of the mechanical engineer is the making of money, but pure science does not make money. The science of the schools is no use to you until you can translate it into the science of the workshop. Faraday was a pure scientist, but every one of his invaluable researches into electro-magnetic forces would be useless to us were it not for the men who followed him and made the dynamo machine what it is. Crookes and Hertz were two other men who were pure scientists, but what they did was useless to the world as a whole, until Marconi and Röntgen, and those who followed, turned the work they did to valuable purposes. There is no money in pure science; let me put it that way. 5 or 10 per cent of you, not more, may make money out of pure science. I am a mechanical engineer, and know perfectly well that as long as I stick to pure science alone I shall not make a brass farthing. I must learn to think of my science as supplementary to the workshop. I must convert pure science to technology before it is of use to me, and one of the very best things your students have done is to insist on the value of workshop training, for in the shop alone can he acquire that habit of thought and that instinct which leads a man naturally to think when he sees any scientific subject

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put before him, "What use can I make of it; how can I turn it into money?"

There are very many other points on which one could talk in this paper, but I will only say in conclusion, as I understand that you are going to draw up some sort of report from the result of this discussion, that whatever you do you do not forget to study the report of Sir William White's Committee. You may want to change it, and you may have to alter it to suit your own conditions, but I do not think, whatever you do, that you can fail to find help and inspiration in it.

Mr. L. A. LEGROS:—I think we ought to go back very far into the youth of the would-be automobile engineer, and start with his training from birth, so to speak. The training that one has at school is largely developed by men who have probably been brought up as schoolmasters or clergymen, and have no idea beyond training others for the same profession, neither of which are of much use to us as engineers. You probably have seen in the papers lately a long discussion about the value of Greek, and about the relative advantages of learning the dead and other languages. The old school of teaching begs for but one hour a day, but no mention is made of the amount of home-work which will be given to the boy from that one hour a day at school. I have taken the trouble to calculate the number of hours that I spent on languages when I was at school, and, including the home-work, I find I have spent no less than 3,150 hours on Latin, 1,500 hours on Greek, and 2,250 hours on French, making a total of 7,000 hours for languages, probably equal to the total amount of time devoted to all other subjects taken together. Now, gentlemen, is that fair? And all of you who may have done the same thing probably will remember how many hours were devoted to thumbing over the pages of the dictionary. You probably have an idea that from this you have learnt the alphabet from end to end. The alphabet begins with A, but ends with epperseand, or ampersand (&), and not Z. The real point is, which are most useful to us, dead or live languages? and, if the latter, when are foreign languages most easily learned? The answer to this is when one is quite young. Among the best linguists in the world are the Russians; the reason for this is that the Russians have a system of taking a foreign governess into the family and keeping her for only three years. During that time the children are taught the language of that governess exclusively, and at the end of that period of three years, instead of, say, an

English governess, they will take a French governess, and after a like period they will then substitute a German governess, and as the various children of the family grow up that system goes on, with the result that all the children of the better class families are taught four or five languages. Why should not our schools in this country arrange their training so that the teaching of modern (and of the most useful modern) languages is applied during some of the child's earlier years? The teaching of modern languages in schools is, almost without exception, execrably bad, and it is a great pity that so large an amount of time should be devoted to languages between the ages of 12 and 17 as is at present the case. I think we should do away with the teaching of the dead languages altogether for those who intend to work at science or engineering, and that we should retain French in all cases where two languages are learnt, that we should substitute for Greek. German, which would be a hundred times more useful, and if a third language be taken we should substitute Russian or Spanish for Latin, either of which might well be far more useful. Russian is more complicated than Latin, and German is quite as troublesome as Greek. I point these things out because I do not think the question has been at all fairly represented in any of the recent discussions that have taken place in the newspapers; it has certainly not received consideration from the point of view of people like ourselves, to whom the dead languages are of no help in enabling us to earn our living, which, as Mr. Pendred has pointed out, is the ultimate object of our early training.

With most of what Mr. Pendred said I am in complete agreement. I think that there should be a more careful arrangement of the early schooling and also of the subsequent schooling; that a boy should start at the age of 16 in the shops for one year, then have two years in a college; and that a rationally taught course of lectures on business methods and organisation should be included in this course. This should be followed by another two years in the shops, and then the serious business of life should begin earlier than at present. What did I do? When 17 years old I left school, where, by the way, they kept me in all the Wednesday afternoons learning "mechanical drawing," in a way that was "mechanical" and of no use to me, and it wasted valuable time which would have been better devoted to cricket. Then I went for three years to University College under Professor Kennedy, who was, I think, the best professor of mechanical

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engineering at the time. From him I learned more in three weeks than in all the years in which I lost my Wednesday afternoons.

But to get back to the question mentioned by Mr. Pendred, that of the capacity for earning money. I had three years in the shops, then another year at the City and Guilds College, and this brought me to nearly 25 years of age. What was I worth then?—the same number of shillings a week! and that is the amount I got, although I had previously been getting a good deal more as a workman.

Mr. H. ROTTENBURG:—Firstly I should like to suggest that the Institution should prepare a schedule of questions to be sent to and answered by people who have gone through different courses of training. An analysis of the answers given would form a very good guide to parents who had sons contemplating taking an automobile engineering course. With regard to the question of the premium apprentice, it has been said that there is no reason why works should take in an apprentice unless he is prepared to pay. I am afraid I am biased in my opinion, because I got my training in America, where there is no such thing as a premium apprentice, and it seems to me that it is simply a matter of supply and demand. There is such a demand in America for men who have had a college training that the works are only too glad to get them, and put them through different courses, according to the class of college training they have had, and I think in time it will come right of its own accord in this country. The editor of "The Engineer" was, I think, too hard on scientists. It is true the pure scientists do not make money, therefore there is all the more need for encouragement to get men to devote themselves to pure science. A missionary, for instance, does not make money, and therefore we want to encourage men to become missionaries if we agree with missionary work. There has been a good deal said about getting teachers with the right spirit. I teach myself, and I think, compared with the business side and the manufacturing side, there is no doubt that teaching does not pay to-day, and yet one speaker to-night has emphasised the fact that we want better teachers. It comes, then, to this. Can the colleges afford to pay really good salaries? If not, men must be encouraged to devote themselves to teaching for the pure love of doing what is necessary to advance the country as a whole. That is why I have made these remarks in support of scientists. The argument that science by itself is no good until a man has applied it in the

workshop is rather a dangerous one. After all, scientists are the pioneers in everything, and therefore I think we ought to encourage men to go in for pure science, and say to them, "If you do, do not expect to get all the money. You will, however, get a very great deal of kudos and satisfaction, which the practical engineer or commercial engineer does not get." There is one point in the paper, where the authors say, "some people will say, this list is too long"; that is, the list of things that an automobile engineer ought to study. I agree entirely that the list is not too long; on the other hand, I feel that if a boy who goes into a technical college to-day takes up all these subjects, he will end by trying to learn far too much, and I think that is one of the dangers we have to look out for and, if we can, remedy. The reason for it is, I think, that we teach subjects too minutely in detail. We go into far too many details. Take, for instance, a man who is studying history. He does not go into all the minute details as to what the soldiers of a particular army had for dinner before they went into battle, and yet it may be an important detail. In this morning's "Standard," Lord Avebury is reported to have said, on the question of people having breadth of education, "A great deal of nonsense is, it seems to me, talked about the necessity of knowing things thoroughly. In the first place, no one knows anything thoroughly." Take our present system of teaching. A professor lectures on one branch, say thermodynamics, or even a narrower one than that, say the thermodynamics of the internal combustion engine, and he feels he must make the most of it, with the result that he goes into too many details, and students are liable to be smothered in detail without getting a broad view of any of the different subjects before they specialise on any one. Then, again, take our system of text-books; it is rather difficult to see how it can be altered, but if a man writes a text-book he feels that he has to put in everything connected with the subject, and when a boy picks up a text-book on any subject he is simply overcome with the amount he feels he is expected to know of the subject, and therefore I think we ought to try and encourage future engineers to begin first with rather a broad system of education, and then later to specialise intensely on a particular line. I think it was Mr. Elliott, of Harvard, who once put the matter very instructively. He said: "What we want in technical matters is broad men sharpened to a point." It seems contradictory, but I think it sums it up well.

(Mr. H. Rottenburg.)

You want a man to learn broadly, and then when he has decided what branch to go in for, let him train for that particular branch.

Mr. Brakenridge, who spoke at the last meeting, suggested that a sort of cast-iron time-table, or plan of campaign, should be drawn up, and a copy handed to each parent who came to enquire. He said that what was wanted was a "cut-and-dried scheme." I certainly think the scheme should be cut. As for being tried, I think it would be fatal. What such an Institution as this ought first to discover is what kind of engineering education is common to all types of engineering. The authors of the paper say that they excluded from the consideration of this paper boys who got jobs through friendship, but there is another class of boy that I think they have not included, and that is the boy who, in general terms, intends to become an engineer, but does not know exactly at the beginning what type he is best suited for. If he starts with a general education common to all engineering, he will then get a much better idea as to what type of engineering he will prefer. Besides, I think there are a great many who have gone into one branch of engineering, and then through some perhaps entirely fortuitous circumstance they have had the opportunity of getting a good post in some other branch of engineering. If they have started with a good, broad engineering education, it is much easier for them to change over and to make themselves quite at home in some other branch of engineering, and therefore I think the first thing to do is to get an idea of what should be included in a general education for engineers, and then what is the training essential to automobile engineers. In regard to the number of hours spent on classics mentioned by Mr. Legros, I should like to say that I had the good fortune to be brought up under the late Dr. Almond, of Loretto, who was a classic, and yet he always admitted that, if we could get science taught as well as classics are taught to-day, it would be as good an education as classics; so that in his view it is simply a question of getting science well taught. The change will take time, and we must have patience, but I think in time we shall gradually arrive at a different system of education, and it will not have the stigma that is placed upon science by so many classical people to-day, namely, that all you want is the utility and not breadth of education. Lastly, with regard to preparing a scheme, which I feel would be a most estimable thing, I should suggest that the Institution should take, say, three types of boys in giving their general recom-

mentations; take first the type of boy who must earn a livelihood as soon as possible; secondly, the one who can afford to go through a reasonable college training, and, lastly, the one to whom money is no object. In any case, whatever the Institution may recommend, I hope it will be sufficiently broad and elastic to allow the parents who know their boys to decide the details of it themselves.

Mr. ARTHUR W. LOVERIDGE:—Although I do not possess much experience in connection with automobile work, I have had considerable experience in connection with the education of young engineers, more especially of those engaged in the locomotive industry at Swindon, where I have been Engineering Lecturer during the past ten years. My impressions, therefore, may be worth considering. I will concern myself more particularly with that portion of the paper which deals with the training of the designer. Considerable prominence is given to the theoretical training desirable, and yet one finds in many cases that advanced theoretical training is apparently nearly useless in the works drawing office. A man with the merest smattering of scientific knowledge will often turn out better designs and give better suggestions than the college man with his advanced training. It should be remembered that most so-called design is merely modification of existing types, and that, therefore, mental alertness and knowledge of practical conditions are in most cases vastly more important than a knowledge of higher mathematics. These, then, are the fundamentals for success. Scientific training is often discounted because of the absence of mental alertness or originality of thought in the individual possessing it. Science is simply systematized experience, and other things being equal, a scientific training must be an enormous advantage, but it is only in developing new ideas in construction and not in modification that its value is fully experienced. The scientific training is, then, an adjunct rather than an essential, and when present it should be such that it is thoroughly comprehended and ready for application. Any system such as a separate college training may even be detrimental in deadening the engineering enthusiasm and mental alertness of the student. The ideal system is one which keeps closely in touch with practical considerations, and is, in my opinion, best represented by that of part-daytime instruction. A boy should leave his public school or secondary school at the age of 17, and proceed to works, where, unless theoretical instruction is provided by the firm, he should join part-time day classes at the local technical

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(Mr. Arthur W. Loveridge.)

institution, and work through a suitable systematic course. I do not advise evening classes except as a last resort; much good work is done, but the general efficiency is low, and these classes must necessarily be run to suit the requirements of the majority, who will not be of the type referred to in the paper. The part-daytime system works excellently at Swindon. The Great Western Railway Company pays the fees of selected apprentices, and others are allowed time off to attend suitable courses at the Swindon and North Wilts Technical Institution. Most technical schools have sufficiently well-qualified staffs fully capable of giving all the necessary instruction, and a good teacher would be prepared to discuss and explain most of the difficulties the student meets with in thinking about his works experience. Four or five years of training under these conditions should be sufficient. It might be usefully supplemented by one or more sessions spent at a good university college, but in no case should the works be abandoned for more than a few months at a time. The Admiralty system of training their naval designers has been, in the past, initially a part-daytime course at Keyham, followed by one to three years on the sandwich system at the Royal Naval College, Greenwich. The success of the scheme is unquestioned. Referring to the practical side of the training of the automobile engineer, I would advise that, if possible, some time be spent in engineering shops other than those devoted to motor car work, and certainly experience should be obtained in connection with general motor car repairs. No practical work is more valuable than the discovery of the weaknesses and faults of existing types as evidenced by running conditions.

Mr. F. S. BENNETT:—I think that the best thing I can do is to give particulars of the system which is being used in the Cadillac factory, which is one of the largest in the world, and which is also famous for its efficiency. It was found at first that there was great difficulty in getting young men who could come into the factory and work with the new ideas which have grown up since the advent of the motor car, to get men who had not pre-conceived ideas as to the way things should be done. The factory for preference ignored the town men and got youths from the villages. They started in a small way, with about fifty of these boys, and opened a school, and finally they got a man, who is highly paid, and who now does nothing else but make selections from these young fellows who come from all parts. The lads are

brought down to the factory, and they are first interviewed by this man, who is an exceptionally fine judge of character, and who decides as to whether they are likely to prove suitable for the work. That is the first examination they go through. If he passes them they are then allowed to go into the factory for a month on probation. He watches them very closely during that month, and at the end of the time, if he is still satisfied with them, he gives them another extension for about three months. He is still watching over them all this time, and finally they are taken on permanently, and they go through the shops and are trained up right through the course. The important point to remember is that they are paid all the time for this. They are brought, in some cases, from hundreds of miles away, and they are paid sufficient money to keep them while they are being trained, and even if they give it up at the end of the three months they are not out of pocket. They have been paid and kept for the three months, and they have had that experience for nothing. That system was started a few years ago, and when I was at the factory last I asked the chief superintendent of the factory how it was working. He said it was working out most admirably, and that they were talking about extending it. They had then nearly 200 of these youths training, and he hoped to be able to extend it to about 400. All these men were constantly coming in, and constantly being trained in their particular methods, not the ordinary methods that are used in most factories, but to limits of accuracy which are much finer than those usually found in the ordinary engineering shops. It was to get these men who would work to these very fine limits that they started this system of bringing these young fellows in and training them and paying them. I need only add that it is very necessary for an engineer, when he is going through his time, to keep strictly in view the commercial aspect of what he is being trained for, because, after all, that is what he goes to the works for principally.

I would like to supplement the above remarks by stating that we have set apart a workshop which we call "The School," and in this school there are samples of all the different types of machine tools which are used throughout the factory. The youths who come are instructed in the use of the particular machine which they will have to operate first, and then after the school they are passed into the works on this particular machine. Each week they have to come and ask questions prompted by the

(Mr. F. S. Bennett.)

practical work which they have been doing, which are answered, and, of course, they go back to the machine again better armed for the efficient working of it.

When they have finished the period on a particular machine, they come back into the school and learn another one, so you will see that they are only instructed in one machine at a time. This has a better effect, and also protects the work from errors and mistakes. At the same time it keeps them up to an efficient standard of output.

This process goes on through the two years in which the youths are at the factory. They are paid at the rate of 14 cents per hour to start with, rising by one cent every six months. At the end of the time they receive a bonus of 100 dollars. There is no obligation to remain at the factory beyond a moral one.

Of course it might be thought that this is a pure training for mechanics only and not for engineers, but we find that we get such a high grade of men, who, I may say, come from nearly every country in the world, that there is always ample material to choose from for the training of the higher grade engineers.

Mr. E. A. ROSENHEIM:—This is such a very important question that I should be very grateful if the Institution could devise some scheme for the training of automobile engineers which could be printed and circularized. I receive many visits from parents who say: "We want to make our boy into an engineer; how are we to do it?" The first question which presents itself is to ask the boy "What branch of engineering do you want to take up? Do you want to go in for the commercial side of engineering, the theoretical side of engineering, or purely works management?" In nine cases out of ten the boy does not know what he wants to do, so that on the whole the only thing that one can advise is that the boy shall go to some technical college or university and have a two-years' general training in the first principles of engineering. I think that this is the first step, and a most important point to be attended to, to learn whether a man is going to be a civil, mechanical, automobile, or electrical engineer. All ought to be grounded in the general principles of engineering. Having received that grounding the boy can then specialise on any particular subject. Now, as regards the training to be given. It entirely depends on the circumstances of the boy who is to be trained. If he is in such a position that he has to start and earn his living right away, it is obvious that he cannot afford to go in for any

further theoretical training than that to be obtained at night classes. If, however, he can afford a good training, and is able to support himself moderately for four or five years, then, provided he is clever and has passed an examination of a certain standard, the firm to which he may be desirous of becoming apprenticed should be approached by the Institution to reduce the term of apprenticeship from five to three years; or, in other words, accord to him the same terms and privileges as are granted to premium apprentices. As the principals of many motor works are members of the Institution, I am of opinion that a suggestion of this kind would receive sympathetic support. At first sight it would seem that the firm is being asked to make a sacrifice of two years' service without adequate compensation, but it must be borne in mind that this type of apprentice, by virtue of passing the required examination, has proved that he has ability combined with theoretical knowledge. If he is then accorded facilities for passing through every department of the firm, he will be very valuable to that firm long before the close of his time. The trouble with our present system of apprenticeship is that a boy is turned into a highly skilled fitter, turner, machine hand, or erector, but unless he is able to pay a premium he does not get that general training necessary to make him an automobile engineer. Now come to the important point—what salary should this young trained engineer expect to receive? Speaking from my own experience, I had four years at a university, three years in the shops as a premium pupil, and one year in a drawing office. At the end of that time I was offered 24*s.* a week! Compare that with the status of a doctor. A doctor does not take any longer to acquire his training than does an engineer; but after seven years he can command a salary anywhere of five guineas a week as a *locum tenens*. It seems wrong that an engineer should only be offered 24*s.* to 30*s.* a week; and that is all a fully trained engineer can start at. Can anything be done to raise the status of the engineer, whose education and training have probably cost him as much as the average doctor's? That is one point that the Institution might devote its attention to. After a certain amount of time has been spent at a university and the degree has been taken, then it is absolutely essential for the budding engineer to decide which branch of the profession he is going to adopt. Up to that point of his general training and education, it seems to me immaterial which branch of the profession he adopts; but

(Mr. E. A. Rosenheim.)

when he has finished his technical training and has to go into works, it is of great importance to decide whether he is eventually going to take up the commercial, the practical, or the technical side. If he is going on the commercial side—and here the standard training fails—it is important that he should receive some commercial training, and that he should be allowed to pass a certain amount of time in the counting house, estimating, and correspondence departments of the firm. It is also essential that in his spare time he should study French and German. If he desires to become a works manager, then it is important that a greater amount of time should be spent in the works, the drawing office, the jig and gauge room, and in studying inspection processes between operations, together with prime costs and rates per operation, so that he will be in a position to state his experience in such matters and to obtain a position as assistant works manager at the close of his time. As a designer—I am afraid I do not know very much about the designing department—it is very important to gain drawing office experience, a knowledge of the stresses and strains of materials, together with a knowledge of machine tools. Several speakers and the authors of the paper state that they object to the premium pupil. They certainly are a nuisance in the works unless properly supervised; but, if a man is in a position to obtain material advantages by paying for them, I do not see why he should be deprived of those advantages, and it is obvious that a premium pupil working in all departments must gain more insight in three years into the working of a factory than an ordinary apprentice after he has been working for five years, say, in one department. The premium apprentice most probably will not be able to turn out any single piece of work as well as an ordinary apprentice, but he does not require to do this. He has gained the knowledge as to how the work should be done, and if he is placed in control of men he can see for himself if a man is not doing his work correctly; and that is really all that he requires.

Professor A. SHARP:—The few remarks I have to make will be devoted not to technical training, but to one item of this very large subject which has already been referred to by Mr. Legros. I mean the teaching of foreign languages. We are all agreed that a knowledge of French and German is desirable for automobile engineers. As to the instruction given during a course at a Technical College, I have a shrewd notion that one or two hours

a week devoted to foreign languages is time wasted. I may be wrong, but that is my impression. It is for this Institution to give advice as to how the time available for instruction can be spent most profitably. Why do we learn a foreign language? Is it for the sake of the language itself? Doubtless literary men do acquire foreign languages for the sake of the literature, but we here, I presume, are taking a more "bread-and-butter" view of the question, and bearing that in mind, our true object in learning foreign languages is to further the free inter-communication of ideas between peoples speaking different tongues. There is an easier way of achieving this result than that by which each of us tries to learn all the different languages of Europe, and that is by each one learning, besides his own mother tongue, an auxiliary international language. In the middle ages Latin was such a medium for international use, but Latin is quite hopelessly impracticable for the requirements of this century, as Mr. Legros' remarks fully bear out. I am stating a fact when I say that we have already existing such a language in Esperanto. It is quite easy to acquire a fluent working knowledge of Esperanto in one-hundredth part of the time that Mr. Legros has spent on Latin. In other words (I can guarantee this from my own personal knowledge), if anyone of average education spends 32 hours in studying Esperanto, he will have the means for communicating his ideas quite freely to a German, a Frenchman, a Portuguese, a Bulgarian, or a Japanese who has done the same thing, and fluency will come with practice. If I were to send one of the German-Esperanto "Keys," as they are called, to a German who does not know anything about Esperanto, together with a letter in Esperanto on the subject I want to discuss with him, the Key, with its grammar, vocabulary, and instructions, is so simple that he may reply within 24 hours of receiving the letter. If the majority of our members took this up, we should thereby encourage our confrères in France, Germany, and other countries to do the same, and our list of foreign members might be increased. Although Esperanto is a comparatively new language—it was only launched in the world 25 years ago—it is not merely a visionary scheme, but is already a real, live, active language, and within the last few years has acquired many adepts, particularly in France and Germany. In fact, "the little leaven that is going to leaven the whole lump" is already disseminated all over the world, literally from Japan to Peru. There are about 60 or 70 monthly

(Professor A. Sharp.)

magazines devoted to, or written partly in, Esperanto throughout the world. The subject is so important that I suggest that either the Graduates or the general body of the Institution arrange one of the nights devoted to special subjects for a lecture or paper on the utility of Esperanto for the technical and the commercial sides of engineering. Consider the salesman in an engineering business who has to distribute his goods all over Europe. Twenty languages may not suffice, while Esperanto may even now be a help, and in the near future, as its adepts increase in numbers, its value will increase greatly.

Mr. L. BOLLACK:—With regard to Esperanto, or any international language, it can be very useful, but if you want to sell a car to a foreign customer you will do much better by learning his language than by expecting him to learn Esperanto.

I should like to mention the French system of technical education, in which it is usual to study much longer than in England, in fact, until about 23 or 24 years of age. It might be said that this is a waste of time, and that a lad wants to go into works and learn workshop practice! That is true if he wants to follow the ordinary lines of design, but if he wants to strike out fresh ideas and new inventions, which the French seem very fond of doing, he must take up the whole field of engineering. To design an electric transmission for a motor car, he must know electricity thoroughly first.

As Mr. Legros has said, the best way to learn languages is to go to foreign countries and have some shop practice there. I intend going to Germany and France for some time to complete my training.

It has been said that if you have apprentices in works they don't do any useful work, but I want to mention the British Thomson-Houston works, where the whole of the testing is carried out by young men who have just come from the technical schools, with a few engineers to look after them. These young men get 20s. a week as soon as they come out of the technical schools, and not after ten years' work like Mr. Legros.

Mr. DOUGLAS LEECHMAN:—The first point I would like to mention is one which, I think, the authors of the paper and the Graduates generally would have some hesitation in touching upon. It is suggested that the youth from school of 16 or 17 years old, who has been in the habit of playing half the day and taking long holidays, should get up at 5 in the morning, work

in the shops until 6 in the evening, and then go to evening classes. I think a young man can hardly be expected to work really hard under these circumstances, and if he goes to sleep it is only nature asserting herself. The training should be such that the young man will be broken in gradually, and he should be given time to live. After all, though we are in engineering to make money, I take it we are not, most of us, living to do business, but that we are doing business to live. In connection with that, it seems to me that the sandwich system should be developed to a higher degree, and that young fellows who want to go into automobile engineering should be allowed, so to speak, to hunt in couples. One of the pair should be in the shops one day and the other at college, and *vice versa* the next day, and so on. That would not upset the works, because the machine the young fellows were working at would be in constant employment, and the lads would avoid losing their capacity to study, because they would be studying while they were learning the practical side. Do not work the youth too much, and teach him both sides concurrently.

THE CHAIRMAN:—It is now my pleasant duty to move a vote of thanks to the authors of the paper. I am sure that the Institution of Automobile Engineers have never had before them a more interesting subject, or one which has raised a better discussion than this. When this Institution was formed a few years back, many well-known engineers thought it was a useless Institution, and would never justify itself; that the existing engineering institutions were quite sufficient for all the requirements of the automobile industry. That opinion was expressed publicly by a very well-known engineer, who has not yet joined us, but I think he will one of these days, probably after reading this paper and the discussion, which clearly indicates the good work the Institution has accomplished. I think that the authors have given us a most excellent basis on which to come together and try and find out what is the proper training for an engineer, and particularly for an automobile engineer. The great difficulty in the automobile industry at the present time is to sift the fit from the unfit. A great many people have come into the automobile trade apparently with the idea of driving about in motor cars, and thinking only of having drives about the country, and who benefit neither themselves nor the industry. We, as members of this Institution, want to try and devise some means whereby we only get the very best men into the industry. Parents are somewhat in

(The Chairman.)

doubt what to do with boys who want to get into the industry, and they know nothing of the best procedure. I think all of us are inundated with applications, "How can I get my boy into this wonderfully thriving business?" They seem to think it is a gold mine to all who get into it. This discussion will be very helpful to the Institution, and enable the Council to draw up some suggestions which will be useful to those who are asked to give information on this point. In my opinion, a boy going into a commercial business—and engineering is a commercial business—should, at the age of 21, be able to earn his own living. I think that it is out of the question for most people to carry the training on to the age of 23 or 24. I was, unfortunately, a premium pupil, one of those despised individuals who played about and did not do any work, and at the age of 21 I was out of my time, and took the first job that came along. It was not a very pleasant one, boiler inspecting. Still, I was able to earn my living, and I think that we ought, in devising any scheme, to draw it up on such lines that at the age of 21 a boy can earn a living wage, and not after years of training be offered the very small sums that we have heard of from Mr. Legros and others. The young pupil, after passing through his time, should, as Mr. Pomeroy said, take the first job that comes along. Then when he is earning money and gaining experience he can look round and study the special subjects which appeal to him.

Mr. C. E. G. HOUSE, in replying to the discussion for the authors, said:—The task of replying to the discussion on our paper has been deputed to me by the other authors, and it happens to be a very pleasant one. We have been much struck by the kind manner in which the paper was received, particularly as we have attempted an audacious thing, and, with the rashness of youth, have dared to be dogmatic on highly contentious matters. We naturally expected criticism; I think we should have been disappointed if we had been allowed to get off scot free. One of our objects was to stimulate criticism, and we hope to profit by it without necessarily giving up any of the points which we have made. We do not propose to answer all the criticisms, for several reasons. Where constructive schemes have been put forward we feel that it does not become us to attempt to analyse or criticise them; that will be the duty of the Committee which, I understand, it is proposed to form to go into this matter. In regard to matters of opinion, we do not feel called upon to reply. We shall there-

fore limit ourselves to those matters which appear to have been misunderstood in the reading of our paper, and we propose to take them point by point instead of referring to the speakers personally. A great deal has been said about the instruction of apprentices who are not expected to reach any higher plane than the artisan. The educational requirements of this class are few, and fairly well known, so that we have limited our paper to engineers in the sense in which the word is used by the Institution. We do not, however, wish to deny the shop apprentice the opportunity of becoming qualified for higher appointments on the staff; on the contrary, we want to see such a scheme as will allow the apprentice, if of the right sort, to go to the top. With regard to the influence of character, friendship, and money, we are quite aware of the importance of these factors, particularly of the last two, but since they are not measurable they cannot reasonably be included in any scheme of education, and cannot be usefully discussed. Character is only subject to the laws of heredity, and the difficulty is to get it recognised when it is in danger of being kept back by the influence of friendship and money. Some of the authors have had the experience of being displaced by men whose qualifications were not sufficient of themselves to be any recommendation. Friendship and money are capable of abuse in this way, but the authors quite understand the other sort of friendship of which Mr. Max. Lawrence spoke. We believe that the interests of any firm are best served by making money and influence subservient to merit. If a man gets a berth because he is somebody's son, or grandson, or great-grandson, it generally happens that education of any kind is of secondary importance. That is why we refuse to discuss him in our paper. The age for commencement of training should, we think, largely depend upon the sort of preliminary training the student can get, but 15 to 17 years is very suitable. A year's probation in the works usually suffices to weed out the unsuitable candidates. They are still quite young for most of the higher professions, and we do not agree that their practical training is wasted. In law, for instance, a knowledge of mechanical matters is a great advantage. The authors wish to point out that they do not bind themselves to any particular scheme of education, that given in the paper being by way of example only. They would, on the other hand, insist upon a certain amount of elasticity in any scheme adopted, so that the needs of each candidate can be met, and exceptionally

(Mr. C. E. G. House.)

clever boys may not be hindered by hard-and-fast rules. This is a very important point. The method we should recommend is to feed a boy with such things as he can take as long as he feels inclined to take them and to stop when he has had enough. The amount of training to give a student will depend on the sort of natural appetite he has, which will vary from boy to boy, and the scheme should be elastic enough to allow this arrangement to be made. The suggestion that the apprentice should not work overtime is a most valuable one, and if all the employers who are members of the Institution could be induced to abolish overtime amongst apprentices it would be a very good thing for the students and for the ultimate engineers. The difficulty in regard to the students falling asleep has been mentioned by a good many speakers, and undoubtedly it is a drawback, especially when they have to get up very early in the morning and work nine or ten hours in the shop and then have evening classes, but on page 140 of our paper we have suggested what we think is a good way of getting over that difficulty at the cost of a slight sacrifice on the part of the employers. In the second paragraph on that page we say, "During the first three years the study time can be pressed into two afternoons a week, and on such days it is no great physical hardship for the student to continue his studies in the evening till eight or nine o'clock." The student can get twelve hours' training a week, and that is surely a fair amount for the first three years. The question as to whether the college course should come first or last or in thin slices is naturally a very difficult one, and the authors are not agreed on this point. The disadvantages of taking the college course first have been well shown by Professor Morgan in his description of the Daimler scholarship scheme. There he mentioned a student who is conceited enough to think that he cannot learn anything from the ordinary mechanic after having been to college. I know the type of man who has not had any works training. When he is at college he can never be convinced of the fact that he cannot see all round the problems that the other men are dealing with. There is scarcely a thing which comes along in any college course in which the man who has already had some practical training has not a tremendous advantage compared with the man who has not. Those of the authors who went from school to the works do not agree that the change was a severe wrench. It was far more in the nature of a picnic. Most boys are not usually so averse to roughing it as

older persons seem to think, and unless they are put on to sweeping up the floor of the shop or some similar duty, which some manufacturers make the most recent apprentices do, a boy will thoroughly enjoy the change, and his work will be intensely interesting to him even although it may be of very little use or profit to him in a theoretical sense. The boy will generally be delighted at the change from the school to practical work. He feels he is a man directly. We are rather pleased that so little criticism of our scheme of division into three has been forthcoming, because we regard that part of our paper as our own original contribution to this subject, and we think it will go far to remove the game of cross purposes which is going on between the colleges and the engineering concerns. We do not agree that the average engineering student has his attention drawn to the commercial and administrative branches, and even in Technical Institutes where both courses are given, as we have been reminded is the case in some places, these two sides, the commercial and the technical, are separated into different departments, and the connection between the two is entirely lost. There is usually no inducement for a boy who is being trained as an engineer to study works organisation and costing and estimating, but in our scheme we attempt to show that there is a connection. In the higher technological centres in London—I cannot speak for other places, but judging from the syllabuses it is the same—there is absolutely no commercial or administrative knowledge to be gained. It has all to be done outside. The London Graduates' Section have attempted to form a sort of bridge between the two departments by their syllabus this session. The whole of the syllabus is given up to all the subjects comprised under the general heading of works organisation, and we have attempted to do for the members who attend these lectures what we think has been neglected in other places, and we think that an Institution of this kind is the best place in which to do it. We believe it has advantages over the technical colleges, and it certainly has advantages over the learning of works organisation in the works itself, where a lad is scarcely ever privileged to see the inside of more than one department during the course of one lifetime. The suggestion of one speaker that it is necessary for a London man to go to Birmingham for his college training is not a matter which the London students can be expected to agree with. A lot of valuable criticism has been given us on the question of the premium

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apprentice. We still hold to our opinion. We would point out that in most cases where a premium is paid the parent is the dominating factor, and he demands very often that his son shall be shifted from here to there, and so on, and he disorganises the works, if he is allowed to, unless the works people have a very strong method and insist on having their own way. I do not think that has been mentioned before. With regard to the language question of course, engineers have very little use for Greek or Latin. Greek letters are used to a large extent, and I think every member of this Institution has heard of the magic combination πp , and so on. I have never found that it is necessary to learn more than the Greek Alphabet to be quite conversant with all that is useful in the Greek language to engineers. I believe there is still another auxiliary language, an improvement on that which has been described to us to-night. I understand that Esperanto is not the most recent development in that direction, and though it is supposed to be used by scientific people, I would point out that it is useless for many purposes for which an engineer needs a foreign language. For example, it would be of great interest to me if I could read portions relating to the subject I require in German periodicals, or German text-books, of which at present there is no translation. I cannot get along by learning an auxiliary language. To get at what these articles mean I have to learn the German language, and so on. Thus, probably the most important point in which an auxiliary language scores on ordinary occasions is lost when it comes to dealing with engineering requirements. In conclusion, the authors beg to thank the Council most heartily for the facilities they have granted them for the present discussion, and for the encouragement they have given them to express their views freely on the various points raised. From the very earliest inception of this idea they have received every encouragement, and contrary to what has been whispered in certain quarters there has been no restriction placed upon them whatever. The statements in the paper are entirely those of the authors. There is nothing whatever that has been cut out that they wished to put in, and there is nothing that has been put in that they have not written.

COMMUNICATIONS.

Mr. J. H. BELCHER, B.A., B.Sc., wrote:—I consider that the subjects which are most necessary for the three classes put forward by the authors are:—

(a) For salesmen.—A course in general engineering, mathematics, mechanics, heat engines, drawing, and some electricity and commercial subjects, all of which could most certainly be obtained at evening classes. French or German I consider most essential.

(b) Works manager.—A works manager should be a well-educated man all round. It would be useful for him to have had a full college training, but knowledge of workshop practice and surroundings, oversight of men, wages systems, etc., could only be gained in actual works. Economics and languages would appear also to be a decided advantage.

(c) The specialist.—No doubt here we should have a good secondary school training; mathematics, chemistry, and physics are a *sine quâ non*; knowledge of modern methods of treatment of metals, metallography, etc. would be most useful. The college training should, if possible, last four years; the last year should include some research work if possible. *All* the specialist's work would be of the nature of research when he is fortunate enough to get a post as a *specialist*. In reference to training of young people in mechanics and the like, I disagree with the authors in their advocacy of pure theory without reference to actual practice. I am certain, from actual knowledge, that the more practical elementary teaching is made, the greater the interest shown by young students, for when they are young they want to have their interest in such subjects as forces, stresses, etc. evoked; when older they can see for themselves the use of pure theory. I quite agree that college, and, indeed, most evening training ought not to commence before the age of 17, and that the "gentleman apprentice" ought to be abolished altogether.

The question of motor engineering as a special subject cannot be studied unless the student has already had a sound grounding in mechanical engineering subjects, physics, mathematics, drawing, applied mechanics, etc. Such being the case I deprecate

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the introduction of the very special branch of engineering as a *separate* subject. The motor car engineering part of their studies ought to be taken by students after at least a three-years' general engineering course. The syllabus of work might be incorporated as suggested in the work of the fourth year, but *not* as a special subject. We find the City and Guilds syllabus as a separate subject one of our special bugbears. Men think they can do well at it without *any* previous engineering knowledge, and much dissatisfaction is the result when they find that it is a subject which wants a good previous knowledge of physics, etc., in order to be able to treat it intelligently at all.

Mr. A. LUDLOW CLAYDEN wrote:—One of the most impressive points brought out by the authors is the great length of time necessary for a complete training. Of course, training is never complete in the absolute sense, but one can regard as "training" that period of life from the commencement of fully specialised study to the time when a sufficient income for reasonably comfortable self-support is obtained. Anything which would tend to lessen this length of time is an advantage to the student, and there is no doubt that the all-important period which must be spent in works is very often—probably more often than not—needlessly drawn out by reason of the almost total absence of attention under which the pupil or apprentice works. By this I do not mean attention in the way of supplementary theoretical instruction or discipline, but rather in the actual methods of teaching the use of tools that are followed. It has been my good fortune to be able to observe the progress of a number of apprentices and pupils working along different lines, and I have also for some ten years been in close touch with the working of the Manual School in connection with the University College, Exeter. This school was established for the training of boys whose ultimate aspirations were to nothing higher than foremen's posts, and instruction is given in the use of every kind of hand tool for both wood and metal, and the simpler machine tools for metal work. The hours of labour are not long, but taking the rawest of material at the age of fourteen, the average ability at the end of a year's practice is little short of extraordinary.

In an ordinary works, a boy knowing practically nothing of the use of tools is put on one machine after another and has often very small opportunity of getting a grasp of anything more than piece-work items. He is also, throughout, in the charge of ignorant

men who cannot explain the reason for any particular detail of procedure, if it occurs to the boy to ask questions, and for this reason I, personally, am tempted to disagree entirely with the recommendation that some mechanic should be given an inducement to pay special attention to apprentices.

Referring back to the Manual School system, where there are regular tasks set and the pupil is progressed from the manufacture of a very small and simple article to the construction of a small machine, the stages are so adjusted as to introduce a fresh operation or two with each. This gives, in the most rapid possible way, an appreciation of the value of different kinds of tools, and, judging by results only, the average Manual School pupil is a better workman at the end of two years' training than the average apprentice who has spent five years in a factory. Of course, the Manual School boy has no knowledge of works procedure, and I do not wish to suggest for a moment that the Manual School can be regarded as a substitute for works, but I do believe most strongly that really thoughtful manual instruction during school age can be used to shorten the works period very greatly. Supposing, for instance, that an entirely raw boy needs six months on lathe work only, a properly trained Manual School boy will get to quite the same stage in less than a quarter of the time, and so on throughout the shops, as far as actual making things is concerned.

I take it, however, that the authors of this paper have not been considering the needs of the beginner in a quite humble rank of life, so much as those of the would-be professional man who has usually a public school general education. Confining our attention, therefore, entirely to the latter, it seems reasonable that the time he needs to spend in works might be shortened if really good manual instruction was given in connection with his school. I believe I am correct in saying that most of the public schools to-day have mechanical workshops, but that the majority are under the control of an ill-paid man who is frequently quite of the working class and, moreover, absolutely devoid of any idea of teaching. To possess knowledge is one thing, but to possess the power of imparting that knowledge to others is quite a different matter.

If the same attention were given to manual work in public schools as is given to the ordinary class work, and if the same care were exercised in the selection of thoroughly efficient teachers,

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an immense amount of weeding out—which has been, I think, practically agreed upon as essential—would take place during school age, so that a boy of seventeen or eighteen would start his works or college course with a knowledge of the processes of manufacture equivalent to that now possessed by an apprentice of two years' standing.

Taking the subject from another point of view, supposing for a moment that it be granted that the Manual School curriculum produces the best craftsman in a given time, then it seems reasonable that something of that system should be adopted by owners of factories who make a practice of accepting apprentices. In a works where not less than twenty apprentices or pupils are habitually employed, it is my profound conviction that the cost of maintaining a regular school establishment would be repaid over and over again. To care properly for twenty apprentices, to see to their manual work alone, is quite sufficient occupation for a thoroughly competent teacher who is well up in the subject. I do not, of course, suggest that this individual should himself impart all knowledge to the apprentices; my recommendation is that they should work in the ordinary way, but under the supervision of a man whose sole business it is to watch their development very carefully, to see that they are not overtrained on one operation and undertrained on another, to supervise theoretical work, to decide when they shall be moved from one stage to another, and so on. Doubtless this would prevent pupils being used to much advantage as workmen, but to expect an apprentice to do useful manufacturing work during his apprenticeship seems to me rather like admitting a Law student to the courts on the off-chance that he may, now and then, more or less by accident, make a useful point.

I would again like to emphasise the fact that I am only considering the class of pupil who wishes to become something more than a superior workman, and I have not given any study to the training of machine operators. It seems to me that directly a youth who has had a good general education supplemented by sound manual instruction, has been long enough in a works to grasp the general scheme on which it operates, he ought to be able to do some sort of really useful work. The Daimler system, which has been described, I know to have been fairly satisfactory, and it was run on lines not very different from those for which I have expressed a preference.

I think there is a deal of truth in the suggestion that most engineering firms have so far regarded apprentices and pupils as necessary evils; it has occurred to very few to regard the question from the point of view of their own advantage. Undoubtedly, however, things are changing very rapidly in this respect, and I believe it is safe to anticipate that many of the difficulties which are at present most prominent will disappear as soon as the majority of firms begin to pay serious attention to the training of their staffs from school age upwards. This is just as much a branch of the teaching profession as is the teaching of the alphabet or the simplest arithmetic, and the youth who is taught intelligently until he becomes an efficient unit in an organisation will always progress faster and further than a boy who is carried so far and then left to struggle the rest of the way himself, which is practically what is done with the majority of engineering pupils to-day.

In conclusion, I would like to add that I am one only of those who have contributed to this discussion, with no interests or prejudices in the matter, and that I am neither interested directly in works, nor a professional educationalist. As a personal belief, I think that the proper time for a college training, which is absolutely essential to a man who wishes to hold any position of importance in engineering, is immediately after the school days, and that the works should follow the college, principally because the transition from complete dependence upon other people to almost complete dependence upon oneself is far easier by this system. I believe the educationalist will agree with me when I say that the most difficult period of a pupil's life is from seventeen to twenty on the average. I know quite well that in most engineering colleges the greater part of the first year is spent in teaching independence of thought rather than in concrete facts; the real training takes place during the second and third years when the boys have settled down a little. Amongst the speakers there have been some exceptional men who have risen to positions of importance by reason of abnormal mentality combined perhaps with sound physique. I think we may reckon that such a course as that outlined by Mr. Pomeroy is utterly impossible to average boys, and there is a great deal of useful work to be done by men not possessed of such unusual qualities. A boy who could start on such a course as Mr. Pomeroy outlines at such an early age would be bound to go far in whatever profession he took up, but

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in considering matters of this kind it is not necessary to pay much regard to the abnormally clever or abnormally industrious youth. They are usually quite capable of taking care of themselves.

Mr. S. H. DAVIES wrote:—With regard to the working of the Daimler system of apprenticeship, I was in the works before the scheme mentioned by Professor Morgan was put into operation. At that time there were in the works both premium pupils and pupils who had been placed there through the influence of some Director, and the scheme under which they worked may be somewhat interesting. In the first place a fortnight was spent in the shops as a probationary period, during which time no pay was given to the pupil, and at the end of that period the Company were at liberty to get rid of him or he to leave the Company. He was, moreover, free from overtime in any shop in which he happened to be placed. After the first fortnight, however, a small wage—somewhat on the same scale as that paid to the gang-boy—was given to the pupil, and thereafter he was supposed to be entirely under the discipline of his own shop foreman, and consequently he had to work overtime when it became necessary in the shop.

During my experience of this system I found that it worked in a very satisfactory manner for a short time, but that it speedily became apparent to the pupil that there was no one in the works who was taking any particular interest in him, or to whom he could apply when any difficult or interesting point arose in connection with the work in the shops. At long intervals a man connected with the sales department was deputed to make a sort of circular tour of the shops and to find out exactly what was being done by each apprentice, but this scheme does not seem to have been carried out with the thoroughness that perhaps it deserved. A short while later Professor Morgan came to the Daimler Motor Company, and with him was started the scheme which has already been outlined in the discussion. At that time, however, it took the form of collecting all the various pupils who were present in the works and arranging them in classes, so that technical instruction should be given to each class on two days in the week. Moreover, the times kept by the pupils were supposed to be sent to Professor Morgan, and thus, to a certain extent, he was responsible for their discipline and time-keeping instead of the shop foremen.

The technical training was very good, but one point struck me

as considerably above anything which I have hitherto encountered; this was the fact that Professor Morgan used to select a pupil, give him a subject relating to automobilism, and require him to write a paper which he was to read on a specified date before his fellow pupils. During the earlier part of the scheme certain pupils in the shops were also required to attend the Coventry Technical Institute in the evenings, but this was dropped for reasons which I will give later. Concerning the working of this particular scheme, it is my opinion that a considerable amount of harm was done by the presence of the premium pupil, or a pupil who came into the works by Director's influence. This, of course, does not apply in any way to all the pupils, but the trouble seemed to be that a number of these boys were provided with a considerable amount of money, and it was not absolutely necessary for them to earn their living with any great rapidity or certainty. Moreover, they were generally in possession of cars or motor bicycles, and the temptation for the other pupils to go out for a day's motoring instead of appearing in the shops or attending classes was very great. It is also my opinion that shop discipline is generally weakened by this type of pupil, as he is not affected by discipline to anything like the same extent as the boy who has his living to earn at the end of his shop time. This is probably because if he does get sacked from the shops it does not really matter to him, since he will probably go into another works or instantly obtain a job in the sales or some similar department.

It is my opinion that one of the points on which Professor Morgan's scheme failed, and always will fail, is the fact that he has not sufficient power over this particular type of pupil, and cannot send away a boy who has proved insubordinate, or who cannot be thoroughly relied upon. I believe it will be found that there are cases where a pupil has actually been dismissed from his shop only to be replaced through influence from outside. With foremen, and particularly with the older type of foreman who has served his time as an apprentice, this is a very sore point, and his feelings towards other apprentices who are not in a similarly happy position is embittered. Moreover, the apprentice himself does not care what is thought of his work or whether he does it or does not do it, and as the whole of the pupils in a works are very often formed into one little clique, this influence is likely to spread over certain admittedly weaker spirits and to influence them accordingly.

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The reading of papers before various pupils is an excellent idea, because a boy would take a subject such as Lubrication, and becoming interested in it—and in the hopes of providing a better paper than anybody else—would delve amongst all the data it was possible to obtain, and the increase in his own knowledge would be enormous. Moreover, once interested he would be likely to work for the pure joy of it instead of regarding it as a task which was more or less obnoxious. I have known even the gentlemen who were placed in the works by the influence of a Managing Director to produce papers which showed a surprising amount of research, and to talk of them in a manner which suggested that they were no longer bored with, what they termed, “their lessons.” At the time I am speaking of there was also another trouble, due to the fact that Professor Morgan became rather deeply engaged in the research work of the Daimler Motor Company, which took him away from the classes to a certain extent, and the pupils were thus left to their own free-will as to whether they spent the afternoon working out the problems which had been set, or took their motor bicycles and had a day in the country. The greater number of them took their motor bicycles, but there is this to be said, that a man who will not work on the technical side of his own free-will can be of very little use to the trade hereafter, and I believe in this Professor Morgan concurs.

After I was out of my time I was, of course, only able to gather information from hearsay rather than from actual experience, but the reports which I gathered led me to believe that the whole of the class system was rather going to pieces owing to the fact that Professor Morgan was unable to supervise or advise as thoroughly as he himself would have wished.

In the shops it is my opinion that a boy will get on purely by reason of his own personal qualifications. This is because the mechanics are naturally suspicious of the pupil. I found that for at least a fortnight they would leave him entirely to himself, merely giving him small and difficult jobs and watching him to find out what sort of stuff he was made of. At the end of that time they have a pretty shrewd notion of his capabilities, and if he will work with thoroughness, is not afraid of asking them for advice, refrains from attempting to show that he is a superior mortal, and above all does not mind the somewhat curious humour of the shops, there is nothing that they will not do for him. This, in my opinion, is particularly so with fitters, who I have

always found to be one of the best types of men that can be met anywhere. Men in the machine shops are not so much in touch with a pupil and seem to be of an entirely different class, which perhaps uses its brains less. In the particular gang to which I was attached in the beginning, there was a pupil who made rather a point of dressing in the extremity of fashion and of regarding his college training as placing him in a superior position to the ordinary workman, whom he insisted on regarding as a lower class animal altogether. The unfortunate time that this gentleman had during the short space which he stayed in the erecting shop will be remembered by him for the rest of his life. It is my opinion that a great deal of hardship is caused if a boy is sent into a shop without a knowledge of the tools which he will be required to use, and I have known a great number who have actually come into the erecting shop without the slightest knowledge even of the names of the various tools, with consequent discouraging results to themselves.

Another point in the Daimler works which struck me is that, although the number of "quarters" lost by a pupil was supposed to be reported to Professor Morgan, very little effect seemed to come from this; that is to say, the boy who, being enthusiastic, made a special point of losing no "quarters" found that others who formed a regular habit of remaining three "quarters" in bed were just as kindly treated as themselves, while the old difficulty of the amount which they should be under the shop foreman here cropped up.

With the Daimler Company, one of the great points was that it was possible to get an exchange from one shop to another. This, in my opinion, was a very real advantage, and it is absolutely necessary that the man who is in the position of a supervisor to the pupils shall arrange for a pupil to be transferred at intervals from one shop to another and from one machine to another of a different sort. This scheme is open to the disadvantage that it is not always possible to provide a vacancy in a shop into which a comparatively unskilled pupil will fit, but at that time there was a very excellent backwater into which pupils who had no shop could be drifted—the millwrights. This is a section that can always do with some more help, and it is peculiarly interesting in that the work necessary takes him all over the entire factory plant, that is to say, the morning may be spent gas fitting in the running shed, and the next day in attending to

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the suds in the experimental department or the machine shop. To a pupil who uses his eyes, these opportunities are invaluable, as it is perfectly possible to make a job of whatever work he is doing and to observe what is taking place around him.

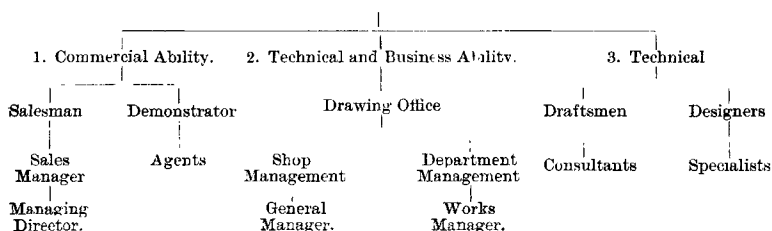
I am firmly of the opinion that a very great number of the pupils with whom I came in contact joined the Company with the express intention of obtaining as much driving as possible, and this was apparently the ultimate object of their existence. In the Daimler scheme, however, very few of them ever arrived at the running shed, and they accordingly drifted into the sales department at the very earliest opportunity which was open to them. A number of Daimler pupils seem to have drifted into the sales department, where the rate of pay is very low, so that they eventually became dissatisfied and left the Company and have disappeared, though in some cases I believe they have carried on sales work in other directions with a certain amount of success. I am certainly of the opinion that a broad engineering training is the best, since a man's success depends to a certain extent on his ability to judge a chance when it is put before him, and the variety in the jobs which are presented to a successful pupil from time to time is very great. In my own case I was particularly anxious to have something to do with the design side of a car, but as it happened the first real opportunity which came my way was an offer to join the purchasing department, which is responsible for the ordering, specification, and hurrying up of material. It is almost impossible to think of anything less connected with design in the sense in which I imagined it. Nevertheless, the job was very interesting, and enabled me to obtain a much wider knowledge than appeared to be the case when the job was originally presented to me.

I believe the scholarship scheme produces very much better men than was originally the case, although I am not at all sure what these men will get in the way of a living when their training in the works has been finished, and it is a point which seems worth going into.

Mr. T. C. HARRISON wrote:—In my opinion the paper is far too academic. As regards the part that personal friendship may play in obtaining employment, and which the authors dismiss so summarily, I submit that a friend is more likely to know when a man is fitted for a certain job as he knows his shortcomings. Following the authors' subdivision of the profession, I have

drawn out a table somewhat like a genealogical tree, which enables all these subdivisions and the relationship they bear to each other to be seen at a glance.

AUTOMOBILE ENGINEERING.



College Training.—Judging from general opinion it appears that (1) college training as at present constituted is no good; (2) the pace at college is that of the slowest student.

1. Salesmen.—These seem to me to require an elementary knowledge of manners. The writer has been to numerous motor shows and exhibitions, and the indifference, if not actual rudeness, with which prospective buyers are treated is astonishing.

2. Works manager.—It is absolutely impossible to learn work-shop methods in a technical college. The early rising necessary to get a man into the shops by 6 a.m. would weed out those who were too lazy for the work, and I suggest that those who are not early risers should leave engineering alone. Costing, estimating, etc. can only be learnt in actual practice.

3. The consultant.—The authors state that “commercial . . . qualifications” are not necessary for a purely technical man. There I differ, and if it were more developed there would be fewer wild-cat schemes launched on the market.

What *is* necessary is 35 per cent theory and 65 per cent practice. All embryo engineers should have a good general knowledge, and for this purpose the best examination is the London Matriculation. Finally, engineers are born, not made.

Mr. A. J. T. KERSEY wrote:—In their admirable paper the authors have rightly divided automobile engineers into three classes, but it must be remembered that at the outset very few pupils have any definite idea as to which of these classes they will ultimately belong to. The questions of the length of the technical college training and whether this training should be taken before

(Mr. A. J. T. Kersey.)

or after the practical training, depends (apart from the difficulty of entering a works at a later age) largely upon the nature of the college training. If the pupil is taught to ask "why?" instead of merely being told "how"; if teachers instead of following the line of least resistance and making statements which are swallowed by their students without question, try to elicit opinions and invite arguments; if they insist upon fundamental principles and accurate logical statements, there is little fear of their good students being unable to make rapid headway with their works training. Initiative and resource are necessary in either branch for success, and so far as the college training is concerned, the laboratory should play an important part, since here the student learns to modify his theories according to actual facts, to grapple with difficulties (and the help of the instructor should be by way of suggestions for further experimenting rather than by direct information), to see that apparently simple problems are often complex and that the simplest explanation of a set of observed phenomena is not always the correct one. I am of opinion that the qualities mentioned above can be more easily tested by the way a student tackles his work in the laboratory than by any other means. Patience, resource, the weighing of alternatives, the "organisation" of an experiment, practice in all these will bring out all that is best (and worst) in a student and prepare him for the exercise of these qualities in that larger laboratory, the works.

Employers have legitimate cause for complaint when they find that a pupil who comes to them after completing a college course is slipshod in his methods and has very few ideas of his own. Ability to see more than one side of a question and quick grasp of essentials are of far more importance in the eyes of an employer than a good memory, which is too often the chief factor in producing examination results and, incidentally, that bane of the works manager, "swelled head," for which, however, the teachers are mainly responsible. If employers will add a direct interest in the *methods* of instruction adopted in our technical institutions to the facilities which many of them now afford for instruction in theory, it will result in much benefit to those under their charge and ultimately to themselves.

I quite agree with the necessity for some instruction in the commercial aspects of design. So many considerations enter into the design of a piece of machinery, such as the relative costs of

different kinds of machinery, the saving of time (and consequent reduction of establishment charges), the saving of costly hand finishing, the provision of facilities for dismantling under awkward conditions, and so on, that every student who is working out a design in a college should be encouraged to work out weights and estimate relative costs as far as practicable. My experience is that much more can be done in this respect than is generally anticipated, even when the student has no previous works experience, and if teaching of this kind is supplemented by visits to works (not necessarily automobile works) pupils take a far more intelligent interest in shop operations and are much less likely to offer ignorant criticism of the designs of experienced men.

The authors mention instances of men who have drifted into other professions from want of opportunity in that of automobile engineering. I very much doubt whether any young man who possesses the necessary brains, keenness, and capacity for hard work, combined with a good theoretical training, can be prevented from eventually securing a good position in the industry, and it is more than possible that the individuals referred to were lacking in the necessary "grit." A knowledge of theory is only one of many qualifications required by the successful engineer.

Mr. F. L. MARTINEAU wrote:—The views expressed by the authors of the paper and those who joined in the discussion show considerable variance. To my thinking everyone overlooked the most important point to be considered in the training of any boy to fit him for his career. Provided the early training has been carried out properly there should be no need for anyone to specialize until he is 17 at least. My experience distinctly shows that it is the very early training which matters.

Parents are apt to depend too much on the schoolmaster and the latter too much on detail. Parents should endeavour from the earliest age to encourage and not destroy honest ambition, and should also try to train their offspring to think first and act on their thoughts, to trace the relation of cause and effect, and to try and instil general principles rather than details.

If this work is begun by parents and carried on by the schoolmaster, the student will find that by the time he reaches the age of 17 he will have a general knowledge sufficient for him to reap the benefits of any special study of any subject to which his inclinations may turn him.

The idea of an early apprenticeship is wrong, as before the age

(Mr. F. L. Martineau.)

of 17 a youth really does not know his own mind, and a lifelong work on a subject which is of no real interest will produce no good results to the community, let alone the individual. A boy worth his salt ought not to mind the workshop training, and with breadth of view and a good general knowledge he should acquire its teaching very rapidly.

The Institution can bring its whole weight to bear with great advantage to the community at large on the problem of early education. Here we have the youngster in the most receptive state, the critical period of his life which will make him a keen worker or a drone, and yet the men who have the threads of his existence in their hands are themselves so poorly paid that they have difficulty in keeping body and soul together; apart from this, there is no prospect of their being able to save for the period when old age forces them to leave their work to a younger hand. The Editor of the "Engineer" says that any system of education should fit a man to earn the pay of a Member of Parliament at the age of forty. How many of the scholastic profession whose daily life is given up to instructing the youth so as to fit him for this very part, can say himself that he has reached this position? Even so, his education will have cost him quite as much time and labour as that of the engineer.

Mr. R. SELZ wrote:—The authors of the paper mention on page 132 a "standard of education." It would be very desirable if this standard could be fixed before the means of obtaining it are discussed. I do not concur with the opinion of several speakers that specialisation is desirable. It is not fair on the student nor on the industry. Many of the most prominent men of all branches of the engineering industry have started in totally different branches from those in which they have gained their fame.

There are two sides to be considered in the education of an engineer, namely, the individual as bread earner and the industry as a national asset. In both cases it would be unwise to make a groove in which the newcomer must move. For the student, it is necessary that his working capital, consisting of all the knowledge he has gained, should be free that he may use it as best as he can. Only then will the keen competition for a limited number of places and the resultant lowering of salaries be avoided. The automobile industry itself will gain through being able to draw good engineers from everywhere, as the principle of a general education should be applied to all branches of mechanical

engineering. Specialisation also tends to draw the different branches of engineering still further apart, and this is not at all desirable, as the authors themselves declare that it is not possible for one man to master all the subjects which are connected with automobile engineering.

The chief point I wish to raise, however, is the following: What is an automobile engineer and what are the inducements to become one? Foreign countries and chiefly Germany have led the way; the result has been a remarkable one. The profession of engineering in general has not the recognition it deserves in this country. Put down a standard of general education and also a little special education; let the student pass an examination at the end of his training, to which is attached a degree similar to the M.D. in the medical profession and to the *Diplom-Ingenieur* in Germany. Protect this degree as it is done for the M.D., and the examination papers should be alike for the whole country. A student qualified like this will have no difficulty in making himself at home in any branch of engineering. The manufacturers will soon give the owners of these degrees the preference and pay them better. This will stop the loss of students before the end of their time through the allurements of higher wages at an early stage. It will also give the profession a social standing which will draw towards it a large number of ambitious youths who are now lost, because they wish to take up a calling which gives them a standing in addition to their daily bread. This step will further help to create a greater interest in the profession amongst those who are in the position to help with donations and scholarships.

Many people have not yet learned to distinguish a fully trained engineer from a fitter, and think that an engineer is just something in a workshop. The parents think that their bright and promising son is destined to get on, but how can he have a chance as an engineer? No wonder, therefore, that a father often grudges the expense for his boy's education when he wishes to become an engineer, while he will gladly pay for making him a doctor or a lawyer. A few years in the workshop (if possible, with wages) and some evening classes are enough in his mind to give him a start in life. Anybody who can handle tools can be an engineer, so why waste money?

With regard to those who cannot afford the expense of a full four or five years' training, the State should help as in Germany. There is not enough notice taken of the coming generations in

(Mr. R. Selz.)

this country. Let those who are up to the average and who show interest in their work be educated free as in Germany. The parents' income should be taken into consideration for all competitions for scholarships, and the examination should be open to all. The stigma of poverty will be absent, as the results will only be made known to those concerned. This system can be adopted in all schools, and I know of many cases in Germany where sons of poor parents have had every facility to complete their studies without any help from their parents' pockets. I think this matter is very important, as it gives an even chance to all and removes the necessity of keeping the standard of education lower simply because of the expense. Germany's enormous progress is due to the ease with which a poor man can get his talented son educated, providing the son takes an interest in his work, and to the fact that the student who has passed his examination has something to show when he is looking for work.

Mr. R. R. SMITH wrote:—This Institution being primarily a technical body, I suppose sordid commercialism is, strictly speaking, a little out of place; be this as it may, I have been sorry to notice that the all-important branch No. 1 seems to have been sadly neglected by the speakers, though I am glad to see that the authors have included the salesman among the various branches, for there is no doubt that this branch is as important as any. I quite realize that all will not agree with me here, but given the finest design that brains can evolve, the most perfect workmanship and factory organisation and, as the result, the most perfect product, what's the use of it when you've made it if you have nobody to sell it? It seems, therefore, that in any considerations of the best form of training for automobile engineers, that most suitable for the production of the first-class salesman should receive some attention

In the first place it is my firm conviction that the most successful salesman—and let me say in parenthesis that I am including sales mahagers under this head—is born, not made. I do not say that he is born a successful salesman, but that, just as you cannot make bricks without straw, you cannot, and never will, make a successful salesman out of a man who is not born with the necessary qualifications. Given the raw material, in my opinion the course of training most likely to produce a successful salesman would consist (1) of a sound general education, preferably at a public school, and let me say here that I am not in agreement

with Mr. Pomeroy, but should like to see this education carried on to the age of 17 or 18; (2) the boy should serve, preferably as a premium pupil, for a period of three years in the works. I say "as a premium pupil" advisedly, in spite of what has been said by previous speakers about the premium system, since you will rarely find an engineering works who will accept apprentices for a period of less than five years, and in my opinion five years is altogether too long for the man who has the commercial side of the industry as his ultimate goal.

I should cut out any technical college training, either by evening classes or by university, as I consider it unnecessary and useless. Instead, as soon as the man is out of his time he should at once get busy and get his first appointment in any capacity, and after Mr. Pomeroy's lucid explanation of how to obtain a first appointment I do not think that anyone need now have much anxiety about his success along this line. From this point onwards the completion of his training rests to a very large extent upon the individual. I may say that, personally, my first appointment was in the capacity of junior draughtsman, from which I eventually succeeded to a departmental management, and was at once placed in a position where I had to express myself on paper.

At this point I would just touch on correspondence. There are, curious as it may seem, very few men who can write a really good business letter, one which is not of a stereotyped order, and the best training I know of is one which I was fortunate enough to get, in having to write letters which were submitted before dispatch to my chief, who, I may say, was possessed of considerable literary attainments.

My next position was that of general manager of the works, and here I secured a most valuable insight into records by card system and the methodical following of a job through from raw material to finished product, which I am now able to apply as from the raw enquiry to the satisfied owner. From this position to that of sales manager is one of steady progress for the man who has the necessary capacity and qualifications.

I believe that the successful salesman has got to be something very nearly approaching a combination of all the virtues. He must have a strong personality, he must be a shrewd judge of men, tactful, of inexhaustible patience and tenacity, and above all must have the mental faculty of being able to seize upon the psychological

(Mr. R. R. Smith.)

moment when it is possible with any chance of success to suggest to the prospective purchaser that he puts his name at the foot of an order form. It will be said, I have no doubt, that such men as I have described must be few and far between; they are. There is not the least doubt that if it were possible by training alone, apart from innate qualifications, to produce successful salesmen, many of our biggest manufacturers would start up a school of training to-morrow.

In conclusion, let it be clearly understood that, in my opinion, the best salesman is the man who has a sound knowledge of the product, gained by actual experience in manufacture and use, and who can sell.

Professor J. WERTHEIMER, D.Sc., B.A., wrote:—I have been much interested in this paper, especially because in the University of Bristol we have, to some extent, anticipated the need for special advanced instruction in connection with automobile engineers, for we have appointed a special professor of motor car engineering, and have arranged to grant a B.Sc. degree and a University Certificate in this branch of engineering.

In selecting a professor, we decided that it would be better to secure a gentleman who was and would remain in close touch with actual industrial conditions. We therefore appointed as part-time professor Mr. W. Morgan, B.Sc., research engineer to the Daimler Motor Car Co., who retains his post with that Company, and spends part of his time in Bristol and part at the works in Coventry. Our object was not merely to provide training of the highest kind for men intending to become automobile engineers, but also to encourage the development of this branch of engineering in Bristol and the West of England. The presence of Professor Morgan in the district, and the fact that he has at his disposal a first-class laboratory with the latest appliances suitable for research work on a commercial scale, has proved a great advantage to the manufacturers. In the last session, Professor Morgan carried out a series of investigations on motor car and aeroplane engines for various firms in this neighbourhood and in other parts of the country, and he has been able to place at their disposal information which it would be difficult for them to obtain elsewhere in regard to remedies for the defects, etc. in the machinery under examination. I mention these facts in order to show that the training which we are able to offer is of a thoroughly practical and up-to-date kind, so far as it goes. It

does not, of course, pretend in any way to take the place of the workshop experience, which is absolutely essential to the making of an engineer, but it does give our students an insight into a variety of problems of a commercial character, and into the scientific methods of attacking them.

The course for automobile engineers is, in the first year, precisely the same as that for men taking up other branches of engineering; it includes mathematics, mechanics, engineering drawing and design, physics and chemistry, together with the study of French and German, not from the literary point of view, but with the object of enabling the students to express in English the meaning of passages from scientific publications in these languages. At the end of the first year, the student is required to pass the intermediate examination for the degree or the certificate, and then proceeds to the final part of the curriculum, which extends over at least two years, and involves the study of the following principal subjects, namely, mathematics, construction and design of motors, construction and design of chassis (without engine), strength and elasticity of materials, and theory of heat engines. The subsidiary subjects, to which less time is devoted but which must be studied, are theory of machines, mechanism and design of machinery, and electrical technology. An honours degree may be granted to students who display exceptional ability.

So far, the number of students in this department has been small, but all have found satisfactory employment at the end of their course.

Evening classes are also conducted in motor car engineering and the allied subjects. They are probably sufficient for those who intend merely to be salesmen or artisans in connection with the automobile industry, but the time which the students spend is, of course, insufficient—except in the case of a few brilliant individuals—to give them sufficient knowledge to enable them to deal with difficulties or to make investigations on their own account.

In regard to the question as to whether a college course should follow after apprenticeship in a works, I am inclined to agree with the authors that this is the best course in the case of industrious and earnest students; but I do not think it is desirable for the average young man. If he enters a works for some years

(Professor J. Wertheimer.)

after leaving school he is very liable to lose the habit of study, and this, not infrequently, counterbalances the gain resulting from actual contact with engineering work before the commencement of studies. Moreover, a man who has had a sound theoretical training in a college is able to appreciate better what he sees in the works than one who enters on his apprenticeship without any knowledge in regard to the processes and operations in which he is engaged. I think, too, that in all college courses a limited amount of workshop practice should be included. This is the case in our courses, where a student learns in the university workshop something about the methods of using tools, accuracy in work, and other matters which cannot be equally well given in a commercial shop. Of course, we do not aim at attempting to make efficient workmen, nor do we give too much time to this kind of work.

Mr. J. S. NAPIER wrote: 'This paper deals with a matter of such importance to the future of the industry that I think the Institution is to be congratulated on having had it brought forward in such an able manner by the authors.'

I feel that a youth who trains as a general engineer and later on, either before or at the completion of his apprenticeship, specialises in the automobile industry, is more likely to be a useful member of that industry than if his training and experience is limited entirely to automobile engineering.

No youth at the commencement of his apprenticeship is in a position to make up his mind as to whether he will eventually be a salesman, works manager, or consultant, or whether he will fill any other of the various positions which may be open to him on the completion of his apprenticeship. I am inclined to think that the position he will eventually occupy would be settled by his abilities and by the opportunities which presented themselves when he is ready to avail himself of them.

There are some subjects in the education of an engineer to which, in my opinion, sufficient attention is not given at present: these are, a general knowledge of commercial law, a sound grounding in book-keeping, and a knowledge of French and German. There is no doubt that a good knowledge of book-keeping, with which goes a knowledge of costing, is invaluable to an engineer, and undoubtedly many clever and able engineers have failed entirely through want of this knowledge.

As to the training of the youth, I suggest the following as a

very satisfactory method, and one which is of benefit to the employer as well as to the employed:—

When 14 or 15 years of age, apprentice him in a general engineer's shop, where he can become thoroughly conversant with tools of various kinds and the purposes of each. After serving two years send him for two terms to a college or a technical school, where, on account of his knowledge of the machines, he would be able to apply the technical teaching in a much better way and to understand what he is doing better than if he had not already been in the shop.

During the vacation in the summer let him study French or German, and, if possible, go abroad and study the language there; then let him come back to the general engineering shop and finish his apprenticeship, taking evening classes at the technical school or college. His age at the completion of his apprenticeship will then be $20\frac{1}{2}$ to $21\frac{1}{2}$.

By this method the youth will begin taking evening classes when he is $17\frac{1}{2}$ to $18\frac{1}{2}$ years old, when he will be stronger and better able to stand the strain of getting up early and working at classes late than if he were only 16 to 17, as is usual.

I am strongly of opinion that no employer should ask an apprentice to work overtime, as nine to ten hours per day of honest work in the shop is quite long enough to tire the boy, and it cannot be expected that he can attend classes and do home work if he has to work longer hours than this.

The scheme which I have sketched is one which any employer should agree to willingly, because after the lad has served two years he begins to be a useful unit to his employer. The two terms spent in the college or technical school will help him to appreciate his work in the factory, and when he comes back at the age of $17\frac{1}{2}$ years he is stronger, has not lost any of his skill as a workman, and on account of his ability to apply the technical knowledge he has acquired, is much more useful to his employer.

I do not propose to deal with the syllabus he should go through at the technical school or college, but besides ordinary engineering subjects, it should, if possible, include some knowledge of chemistry.

I am inclined to think that the rates paid to apprentices are too low, at least in the latter years of the apprenticeship, and I

(Mr. J. S. Napier.)

suggest the following as those which fairly represent the value of the apprentice to the employer:—

1st year.....	6/-	per week.
2nd „	9/-	„ „
3rd „	13/-	„ „
4th „	16/-	„ „
5th „	20/-	„ „

It must be remembered that an apprentice very often has to a large extent to keep and educate himself, and this he cannot do unless he is reasonably remunerated.

The employer's side of the question must be looked at too, and in return for the teaching the apprentice receives from his employer, the employer must have some certainty that when the lad becomes more proficient in the later years of his apprenticeship he will not lose his services. I have found it a good plan for the parents of the lad on his starting his apprenticeship to deposit with the firm a sum of money varying with their ability to pay, which sum will be returned on the satisfactory completion of the period stipulated, and forfeited in the case of the boy's leaving before his time is up or if dismissed for insubordination or other just cause.

I think the suggestion that a youth who proposes to devote his life to automobile engineering should be trained in an automobile factory only is a mistake, because his practical engineering education is then very limited and runs in one groove, and he is not able to grasp the larger propositions that present themselves in other branches of what may be termed general engineering, and which are often useful in automobile engineering.

For my part I would rather select a youth as an automobile engineer who had had a general practical training and then turned his attention to automobile engineering as his life's work, than one who had had only an automobile engineering experience.