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Ben H. Morgan

Proceedings of the Institution of Mechanical Engineers 1918 94: 239

DOI: 10.1243/PIME_PROC_1918_094_012_02

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THE EFFICIENT UTILIZATION OF LABOUR
IN ENGINEERING FACTORIES.

(WITH SPECIAL REFERENCE TO WOMEN'S WORK.)

BY BEN H. MORGAN, OF LONDON.

The immense demand upon the resources of the Engineering Industry for the production of munitions of war has necessitated many changes in our Industrial System, in order to ensure the most advantageous employment of labour and material. A great expansion of productive capacity had to be brought about, and while, thanks to the Navy, the supply of raw materials proved no insuperable difficulty, the provision of the necessary labour to utilize those materials was a question which could not be solved so readily. The number of highly skilled craftsmen in the country was limited, and as such men cannot be improvised, it was essential to utilize their abilities in the most efficient manner, and to draw upon the general labour resources of the country for all work which could be carried on without the lengthy and specialized training of the all-round tradesman. The only large reservoir of labour available was constituted of the women of the country, and thus force of circumstances brought about their general introduction into the Engineering industry.

[THE I.MECH.E.]

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The wide employment of women in engineering works and the engineering sense and capability that they have developed is undoubtedly one of the outstanding phenomena of the war. Not that there is anything new in the employment of women on engineering and allied work, for it is recorded, that half a century ago a firm in Birmingham employed, at one time, 2,000 women in its works. Generally speaking, however, their female labour was confined to rough and poorly-paid industries, such as the chain, nut and bolt, screw and rivet, and the small metal trades generally, though later women began to take a more intelligent part in the newer industries such as telephone and other instrument making, electrical work, cycles and motors.

Usually their more advanced work was confined to the operation of automatic and semi-automatic tools, such as capstans, presses, drills, screw and gear-cutting machines producing repetition work and requiring little more than manipulative dexterity, though there were a few women in isolated shops doing skilled work on the centre lathe and at the fitting bench: indeed, in the works of a prominent member of this Institution, women were employed on fitting work using micrometers and working to a half-thousandth of an inch, but this was an exceptional case.

Towards the end of 1914, however, when the country was faced with the necessity of enormously increasing its output of munitions after its skilled labour had been considerably depleted through the voluntary enlistment of large numbers of skilled men, a reconsideration of the conditions surrounding the possibility of a more general employment of women in engineering workshops had to be seriously considered. The first step in this direction was an attempt to employ them on shell production. It called forth a protest from the Trade Union concerned, but, after conference with the Employers' Federation, led to an agreement known as the "Crayford Agreement," under which female labour was admitted for the first time into shell making, but restricted to the operation of machines engaged on repetition work of an unskilled character.

It was soon seen, however, that this concession did not meet the needs of the situation, and in December 1914 another conference

was held between the employers and the unions at which the employers suggested the general relaxation of Trade Union rules and restrictions for the period of the war. No agreement resulted, and in February 1915 the Government appointed the "Committee on Production." The result of this Committee's recommendations was the "Shells and Fuses Agreement" by which women were allowed to do work which had been previously allotted only to skilled men.

Then questions of rates of pay, interpretation of clauses and other difficulties arose and threatened to become acute. To bring about the settlement of these, Mr. Lloyd George called a conference with thirty-three principal Trade Unions in March 1915 at the Treasury, which resulted in what is well known as "the Treasury Agreement." This Treasury Agreement may be said to be the first really constructive measure providing, subject to certain safeguards, for the suspension, during the war, of such Trade Union restrictions on munitions work, as might interfere with or hinder maximum output, and the "Munitions of War Act" gave the force of the law to this suspension as far as regarded Controlled Establishments.

Dealing with the subject of increasing production of munitions in June 1915, Mr. Lloyd George, then Minister of Munitions, said:—

"If all the skilled engineers in this country were turned on to produce what is required, if you brought back from the front every engineer who had been recruited, if you worked them to the utmost limits of human endurance, you have not got enough labour even then to produce all we are going to ask you to produce during the next few months. Therefore we must appeal to the patriotism of the unions of this country to relax these particular rules in order to eke out, as it were, the skill, to make it go as far as it possibly can go."

The first public explanation, however, of the changes needed to make up for the insufficiency of skilled labour was given by Mr. Lloyd George at Bristol in September 1915 in his famous "Mechanics' War" speech. When giving particulars of the bargain made with the Trade Unions, he said:—

"We want to turn the unskilled on to work which unskilled men and women can do just as well as the highly skilled, so as to reserve the highly skilled for work that nobody can do except those who have great experience, training and skill."

That was probably the genesis of what is commonly known as dilution. The retention of the principle so clearly enunciated in the foregoing statement would, the Author thinks all engineers will agree, be invaluable to British industry after the war, but where the Government have made pledges to organized labour, however disadvantageously they may operate in peace time, he knows that engineers will be the last to break the word they gave at a time of national stress. On the other hand, it is to be hoped that a time will come when the Unions will consider the whole question from the point of view of the national interest and industrial efficiency, as well as in the interests of the women who have given their labour so whole-heartedly throughout the war.

This speech was followed by the issue, by the Ministry of Munitions, of a letter of instruction to all Controlled Establishments in October 1915, in which firms were requested:—

"To take immediate practical steps in accordance with the conditions described above to give effect to these proposals in your establishment; that is to say, to replace skilled men wherever possible by less skilled labour, men or women, to use the skilled men so released in order to work night-shifts or work other machines in your establishment, and to make the surplus available for transfer elsewhere."

and also by the appointment, in the Ministry, of a Committee to deal with the dilution of skilled labour for the period of the war. Their scheme, which was adopted, contained the following three principal features:—

- (1) "The principle of the scheme is that no skilled man should be employed on work which can be done by semi-skilled or unskilled male or female labour.
- (2) The principle cannot be applied to all establishments in the same degree—for example, in a shop doing repetition work the scheme is generally applicable, whereas in a marine engineering or repairing works the scheme would be applicable only to a limited extent.

- (3) It will be necessary to have a special survey of shops by fully qualified technical inspectors so far as possible, specially conversant with the employment of semi-skilled and female labour, who could advise the Ministry on the extent to which the dilution should take place and assist the employers in the process."

Many other considerations were involved in the report of the Committee, but the three points given represent substantially the scheme adopted, and continued up to the present time, for supplementing the deficiency of skilled mechanics.

Objections to the Scheme.—Before proceeding to analyse results, it may be opportune to note some of the difficulties met with in carrying out the scheme. First and foremost may be placed the objections of some of the rank and file of Trade Unionists to the infraction of their rules and customs, involved in a wider employment of women and unskilled male labour. The majority of the workers loyally adopted the spirit of the Agreement, but in nearly every shop there were to be found men who could not appreciate the national issues involved, but secretly or openly opposed the introduction of women workers. These objections were generally swept away by visits and explanation of technical officers from the Ministry, but in some cases they could not be overcome, and patched up local agreements had to be made, which led to disputes and restlessness, owing to inequalities in the application of the Committee's scheme in different parts of the country. Also the fear of making their own work unremunerative through an unfair adjustment of wages held many back from giving their co-operation. On the other hand, it may safely be said that the majority of the Trade Unionists gave the Ministry of Munitions their support, and it is due to their zeal in assisting in the training of the unskilled and in overcoming the very practical difficulties involved in closely sub-dividing operations to enable women to be employed, that so many are to-day engaged in engineering industries.

Probably the employment of women on munition work in

engineering shops was delayed as much by the conservatism of employers as by the objections of the Trade Unionists. The employer is proverbially cautious and difficult to move, and the convulsion of the war has not materially affected these characteristics. It was difficult to persuade the Trade Unionist that women could do certain classes of so-called skilled work because he did not always want to believe it, but the employer often met dilution proposals with a blank incredulity which was beyond the influence or reach of reason. All kinds of means had to be adopted to bring him to a realization of the real capacity of women workers.

The Author particularly remembers his early efforts to put women on to the building of 3½-ton motor-lorries while engaged firstly as a Dilution Officer and subsequently as Technical Adviser to the Labour Supply Department of the Ministry of Munitions. It was only after being treated as a humorist for a long time that he induced the management of the first works visited to train half-a-dozen women to perform certain operations. Going to the next works engaged on the same product he induced that firm to try a similar number of women on other operations. And so going from one works to another, always varying the operations, he got dilution under way. When the women in each shop had "made good" on particular operations, photographs were taken and results recorded, from which the Author was able to demonstrate that the bulk of the machining work in this particular branch of industry could be successfully done by women. After that progress was very rapid.

Another method of overcoming the prejudice against the employment of unskilled labour was to provide a few workers for particular operations from the training schools of the Ministry, in which some 40,000 persons have been trained. But perhaps the most effective antidotes to opposition were the distribution of the photographs referred to, the circulation of illustrated matter giving particulars of dilution examples and methods, the issue of process sheets setting out the actual work performed by women throughout the country in various products, the exhibition of

examples of women's work in the principal industrial centres, and addresses to workers illustrated by kinematograph films. These were some of the means used for showing both employers and workmen what women were capable of doing in the production of munitions.

Employers' Difficulties in introducing Women Labour.—But besides overcoming the objections of Trade Unionists, his own prejudices, and the difficulties of training unskilled labour, many special arrangements had to be made for the introduction of women into engineering works. Cloak room and lavatory accommodation had to be provided in conformity with the requirements of the Ministry of Munitions; attention had to be given to bad floors, and heating and ventilating arrangements had generally to be more favourable than in the case of men. Closer attention had also to be paid to the fencing of machinery, and special lifting and conveying appliances had sometimes to be provided. Then generally speaking shorter hours are necessary for women, and there are wages and piece-rate difficulties due to the greater subdivision of work, all of which involve expenditure of time and money in shop reorganization. When it is remembered that the majority of employers were faced with all these difficulties at a time when they were incredulous as to the capacity of women to produce a satisfactory output, it is easy to realize the task that confronted the Ministry of Munitions in the early stages of dilution.

On the other hand, unsatisfied demands for male labour compelled employers to give serious consideration to the employment of women on almost every branch of engineering work, from the heaviest labouring operations to tool-room work and setting-up, and many firms soon realized that good welfare conditions were, in the end, a profitable investment. Only those who, like the Author, have dealt with hundreds of firms on this matter, can realize what an important part deep-rooted patriotism, on the part of both employers and workers, played in effecting the introduction of female labour in engineering munition industries. The Author has in mind cases of firms who did not hesitate a moment in entering

whole-heartedly on dilution schemes in order to help to meet the national demand as expressed by the Ministry, and there were equally numerous cases of trade unionists who ran the gauntlet of local prejudice and ostracism to devote themselves whole-heartedly to the intensive training of women to fill the gaps in the labour requirements.

General Considerations regarding the Employment of Women.—

There is no doubt that war experience with women in engineering works has entirely destroyed all preconceived ideas as to what constituted "skilled work." Previous to the outbreak of war, fully skilled men were regularly employed on work which can now be performed by women after a few weeks' training. It is not that the woman is a skilled worker, but has been put to do a job which is a sub-division of skilled work on which a fully skilled man was previously employed.

The assumption that is so often made that women become fully skilled workers in a few weeks is quite a false one. We can speed up the training of engineers by better teaching and apprenticing, but in the Author's opinion, neither a man nor a woman can become a fully skilled fitter or turner under a period of say four years. On the other hand, war conditions have enabled women to acquire a measure of skill in a far quicker time than men have ever previously acquired it. This is partly due to the patriotic desire of the women to assist in the war, and principally to intensive shop teaching under manufacturing conditions, as opposed to go-as-you-please academic training and drifting through works under pre-war apprenticeship conditions.

Women have generally been found to be accurate and conscientious workers. They acquire a high degree of accuracy quicker than men, through possessing a finer sense of touch. It has also been demonstrated that women are highly responsible workers, that is, that they can carry out with confidence finishing processes on large and costly work, and can manipulate high-speed and heavy machinery, in the operation of which there is a certain measure of risk, such as driving large cranes. Women are specially suitable for such skilled

and semi-skilled occupations as tracing, draughting, marking-off the lighter work of all kinds, and acetylene welding, while they are capable of acquiring a high degree of skill on sub-divisions of accurate tool-room work in turning, milling, grinding, and fitting operations.

Generally speaking, women may be said to have excelled in machining work rather than in fitting work. It is a peculiar fact that while women do not easily tire of machining operations with consistent repetition, they do stale on repetition fitting work, and quite a large proportion of them do not find the work sufficiently interesting to induce them to complete their initial training.

With regard to the employment of women on heavy engineering work there is a great deal of misapprehension. It is not generally understood that women can handle safely, in the course of machining and fitting operations, pieces weighing up to 60 lb., and can also manipulate almost as well as men, with the aid of lifting appliances, any weights over 80 lb. It is on work weighing between 60 lb. and 80 lb. where it becomes questionable whether women can be properly and economically employed. There is the cost of special lifting tackle and handling devices necessary for women that may be obviated in the case of men, and in instances where tackle has been provided for dealing with these weights, it has been found that women prefer not to go to the trouble of using such tackle and so overtax their strength by endeavouring to lift weights, which after a time generally results in injury to health.

In regard to output, women workers have increased enormously the records of output of all products of a repetition character which were current in munition firms previous to the war, but on non-repetition work it is doubtful whether they have, generally speaking, equalled the output of men.

As an example of increase of output obtained by women as compared with skilled men on repetition work, even of a heavy nature, the Author may cite the case of a factory making 9·2-inch shells. The practice in this factory was to bore the shell in three operations, and the total time taken for the complete boring by skilled men was 3·16 machine-hours. Women were substituted for

men on the boring lathes, and after one week's practice were able to do the work in an average time of 3·6 machine-hours. In less than three months they had reduced the average time to 1·25 hours, thus increasing the output to two and one half times its previous figure. Scores of similar instances might be quoted, but it is unnecessary, as facts like the above will have come under the notice of most of the members of this Institution.

It is an important point in the employment of women operatives in engineering work that they should be managed as far as practicable by women. If possible, women tool-setters and setters-up should be employed, also women charge-hands, sectional forewomen, and wherever possible women supervisors and shop managers.

Inequalities of Dilution.—The Author has already referred to the readiness shown by some firms to carry out dilution and the unwillingness of others. As dilution has progressed since June 1915 the disparity of effort has become more and more pronounced throughout the country. Cases are known where two firms, manufacturing exactly similar shells in the same town, employ, in one case 80 per cent. of women, and in the other no women at all. It is easy to realize the probability that such inequality has had a very disturbing effect on both workers and employers. That one firm should have agreed to the employment of female labour, and thereby involved itself in a large initial expenditure of time and money, while another, with a less appreciation of the country's needs, remained indifferent and immune from labour difficulties, doubtless did not tend to smooth the path of dilution. On the other hand, it was extremely difficult to bring about equality of dilution and equality of treatment under war conditions: for during the first year of dilution the employment of women on engineering work previously done by men was in the experimental stage, and no hard and fast rules could be laid down, owing to the uncertainty of output, the variety of the products, and the unequal conditions and equipment of the works.

Ministerial Action.—The first effort of the Ministry of Munitions took the form of letters of instruction urging firms to employ the

maximum number of women and unskilled ineligible men, and it was only natural that some firms should find it possible to comply with these instructions in a greater degree than others. Moreover it was found that despite the agreements made between the Ministry, the Employers' Federations, and the Trade Unions, some local shops refused to train and employ women, some groups of workers threatened to strike if their employment were insisted on, and in others strikes actually took place. Then the Ministry appointed a number of Dilution Officers to visit firms to explain to them what was practical in dilution, what assistance could be rendered by the Ministry's training schools, and generally to urge on firms the necessity of taking steps to increase the employment of unskilled labour. It was inevitable that this course of action (in his opinion the only practical course at the time) should lead to varying degrees of dilution in various shops and districts. The Ministry had at the outset to overcome prejudices on the part of both employers and workmen, arising not only from economic but political considerations, and the task that confronted them at times must have seemed almost insurmountable. The fact that the military and naval forces have been continuously supplied, and that some 950,000 women are engaged to-day on munitions products, turning out nearly one-third of the total output, gives some estimate of the success which has attended the Ministry's effort.

Two Kinds of Dilution Standards.—What seems to the Author the proper method of effecting dilution (now that the experience of the Ministry of Munitions has provided them with the necessary data) is to set up standards indicating the proportions of women, unskilled, semi-skilled, and skilled male labour, that should be employed on specified products, or where there are mixed products, on the work of the factory, segregated into classes of work. For some products such a standard has been set up by the Ministry; for instance, for all sizes of shell from 2·75 inches to 4·5 inches both inclusive, and this has been enforced by the insertion of the following clause in all contracts for the manufacture of these shells :—

"It is a condition of this contract that not later than 31st March 1917, at least 80 per cent. of the operatives employed in the execution of this contract shall be women. The expression 'operatives' shall include all those employed in unloading and loading, handling, machining, painting and varnishing, assembling, production and setting of tools, charge hands, viewers, and staff employed on repair and maintenance of machinery, and on inspection."

In all contracts for shell of sizes *over* 4·5 inches the following clause was added:—

"It shall be a condition of this contract that any directions of the Ministry of Munitions as to the number of skilled or semi-skilled male operatives shall be complied with."

The standards accepted by the National Shell Factory Committee for shell *over* 4·5 inches are as follows:—

15 inches, 12 inches, 9·2 inches and 8 inches, minimum
70 per cent. of women. 6 inches and 60 pdrs., minimum
80 per cent. of women.

It will be observed that while a definite standard is enforced by contract in the case of shell up to 4·5 inches, the standard for shells above that size was left to the discretion of the Department, the percentages agreed to being those at which the Department aimed in making its recommendations for dilution.

The effect of the dilution clause in contracts for shells up to 4·5 inches diameter inclusive has been very satisfactory, and some uniformity in labour conditions has now been effected throughout the country. Dilution at the discretion of the Ministry on shells above 4·5 inches diameter has not worked out so well, as there are still wide inequalities in the proportion of women to men employed. For example, in one shell factory turning out 9·2-inch shells no women are employed, while in another making the same shells the proportion of women is 90 per cent. Such a wide disparity is, perhaps, not common, but it serves to illustrate the inequalities that have arisen, even in the production of such a simple product as a shell when minimum dilution ratios have not been enforced.

On all "straight line" repetition products such as shells, fuses, grenades, small arms, motor-cycles, small tools, etc., it has been

comparatively easy to establish definite ratios of skilled to unskilled male and female labour, but in dealing with such products as guns, standard motor lorries and the like, turned out in fewer numbers, and with shops having a mixed output, it has been found preferable to segregate the total labour into classes in order to arrive at the proportion of women to be employed.

The following Ministry of Munitions dilution standard on gun work is an example :—

Breech Mechanism.	Up to and including 8 inches.	Above 8 inches.
	Per-centage of women.	Per-centage of women.
Turning, boring, screwing, milling, gear-cutting, planing, shaping, slotting, grinding and all other machining operations	80	70
Gauging and viewing	80	80
Marking off, fitting and assembling	50	40
Average for whole department, including proportion of tool-room, smiths' shop, beltman, millwrights, general labour, etc.	60	50

NOTE.—In calculating the above percentages all foremen, charge hands, supervisors and tool-setters are to be taken into account.

The percentages were fixed, before much information was available. In some works higher percentages have been employed.

Making and Repairing Guns.—In connexion with the work of making and repairing guns up to 8-inch howitzers, it was considered that for the following operations the number of male should not collectively exceed the number of female operators :—

- Rough turning.
- Finish turning.
- Rough boring.
- Second boring.

Finish boring.

Rifling.

Planing.

Wire winding.

This standard was set up in such a way as to permit a considerable amount of flexibility in its adoption in different works. For instance, it enabled a firm preferring, owing to peculiarities of their machinery or other causes, to employ more than 50 per cent. of women on one of the operations and less upon another to keep within the standard in the aggregate.

Requirements of an ideal Dilution System.—In considering the question of dilution in its general aspect, it is not difficult at this period of the war, and with the accumulated experience of the Ministry of Munitions available, to lay down the main principles which should have governed action. The problem broadly may be stated thus:—The nation has decided upon a certain programme of munitions production as representing its minimum needs. To carry out this programme the number of skilled and semi-skilled men available was inadequate, and at any rate as far as the skilled men were concerned incapable of much expansion. There was, however, a considerable number of men, and a much larger number of women, whose energies could be diverted from their normal occupations to the production of munitions. Now the munitions programme to be carried out involved in its last analysis the provision of a certain number of labour-hours, and it was the object of dilution to provide these. The man-hours of skilled labour available had to be distributed as fairly as possible over the whole programme, and supplemented in an equally fair and general manner by unskilled labour which could be drawn from other occupations. It was, moreover, a primary necessity, and one that could never be lost sight of, that the limited supply of labour which was available should be utilized in the most efficient manner, and that waste of labour, by reason of inefficient machinery or bad management, should be stopped. The country could not afford such waste,

Firms guilty of it should logically have been suppressed, and their equipment and labour transferred elsewhere, where it would be more productive. On the other hand, all firms producing their allotted output with a minimum of labour should have received encouragement to extend, a steady supply of orders, priority in their demands for material and labour, and assistance generally in the economical output of munitions.

Labour Efficiency Standard.—Now in order to detect inefficiency of manufacture and to conserve labour for productive purposes, it was essential that some standard of efficiency should be set up—in other words a definite number of labour-hours should have been allotted for the completion of a given contract, and steps have been taken to see that this allowance of labour was not exceeded; in other words manufacturers should have been rationed for labour in proportion to their output. This might have borne hardly upon firms with antiquated machinery and situated unfavourably for economical production, but in a national crisis consideration for such firms would be misplaced sentiment. For their waste is of the nation's wealth.

Dilution Standard.—In addition to the labour efficiency standard above described, a second standard should have been set up for all munition productions, namely, the percentage of female or unskilled labour to the total labour which should be employed on a given contract. This second standard, which may be called the dilution standard, would, by its enforcement, have brought about an equality of treatment between different firms, and spread the difficulties of training and employing unskilled labour fairly among contractors.

Dilution and Industrial Efficiency.—Under the ideal dilution scheme, therefore, firms would have been required so to organize and equip themselves as to require only the standard number of labour-hours to complete a contract for any given product; and, secondly, they would have been required to attain this result without a greater proportion of skilled labour than that permitted by the Dilution Standard. It cannot be gainsaid that the

determination of a standard of labour efficiency lies at the very root of economical production, and it would set for the first time in manufacturing, at any rate so far as Government orders are concerned, an attainable ideal of economical production and establish a criterion by which the respective merits of various firms could be judged. And, further than this, its adoption would involve implicitly a fairly close pre-determination of a contract price for a given product, which would allow a reasonable margin of profit to well-managed firms, and a fair rate of wages to the workers. The Government would have been able to make much better bargains than at present, and it is probable that the efficiency of manufacture and organization practically imposed upon contractors by the standards expected of them, would have left them, on the whole, more favourably placed than they now are. The Standard is the antithesis of the system of "time and line" contracts so much favoured at present by certain Government Departments, and would have abolished that system entirely except in very special cases, because the only justification for such contracts is lack of the data needed to estimate fair prices. The effect of the system of "time and line" is to sap the foundations of efficiency—as the more money a contractor can spend or waste on a given job, the greater is his profit.

Determination and Application of Standards.—It now remains to be considered how such standards can be practicably determined. Their enforcement, when determined, is not difficult under present conditions, because firms could be graded by an index number, jointly proportional to their percentage attainments of the two standards, and such index number would determine their position on all priority lists, whether for the placing of fresh contracts or the supplying of additional labour, material or equipment. Firms that either could not or would not so organize themselves as to meet the national requirements of the efficient utilization of labour would automatically find themselves gravitating towards the bottom of the list with the prospect of ultimate suspension, owing to necessary labour and materials being

diverted to their more efficient competitors. The question of the labour efficiency standards is merely the same problem, only on a larger scale, that confronts every Works Manager when framing an estimate or setting a piece-work price. He must make an approximate estimate of the man-hours necessary for the execution of a contract before putting in a tender. The Author hopes that in future contracts for munitions of war the Government will follow a similar course, collate the information available, frame standards, and enforce their application. It follows that such official estimates must be most carefully prepared and continually revised with the progress of the art of manufacturing. Where munition products or any other articles made in large quantities by various firms are concerned, the standard number of labour-hours required for a given output may be obtained from the actual records of the best firm—thus a practical attainable standard is set up which can be reached by anyone who will employ equally efficient methods of production. In the same way the largest measure of dilution attained in any industry might be accepted as a standard. The standards so fixed would not be open to serious criticism on the grounds of impracticability of attainment. They would, however, be only provisional, as it is clear that they would be considerably below those which might be set if the practices of a considerable number of firms were analysed, and the standards based on a composite selection, in the same way that the best bouquet would be made by bringing together the finest blossoms from a number of plants. It is by no means uncommon to find two firms taking approximately the same number of man-hours to make a given product, and yet to find so great a difference in the man-hours required for certain of the processes involved that if each firm would adopt the practice of the other whenever it was more efficient, the result would be materially to improve the efficiency of both firms. Similarly if women can be successfully trained to perform an operation in one firm, the employment of women might reasonably be enforced on the same operation in other firms, and thus an economy of skilled labour might be obtained which would be considerably greater than that reached by any particular firm.

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Difficulties due to Variety of Products.—The attainment of a high manufacturing efficiency is very difficult when the energies and interests of a firm are spread over the production of different kinds of products, unless the output of each product is sufficient to justify a separate department, machinery and staff for its manufacture. It cannot be turned out as quickly, cheaply, or with so great a percentage of female labour as it would be under conditions of proper repetition manufacturing, and in the national interest, therefore, firms should be confined as far as possible to the manufacture of the minimum number of different articles. This applies particularly to the case of gauges, cutters, small tools, etc., which in the aggregate absorb a vast and needless amount of highly skilled labour when manufactured in small quantities by firms for their own use. In the interests of the conservation of skilled labour it would be well if all standard tools and gauges required for munition work were manufactured as repetition products in factories set apart for the purpose. In a word, the production of gauges and small tools of all description should be placed on the same basis as that of shells, fuses, or other direct munitions of war. A beginning in this direction has been made by the Ministry of Munitions who now have some gauge and tool factories in operation.

Standardization of Methods of Manufacture.—The Author has already explained how labour efficiency and dilution standards could be arrived at by merely adopting the actual figures of the attainments in each respect of the best firms. But in order to determine the highest practicable standard for any given product more information is required. It is necessary to analyse methods of manufacture down to the smallest details, and to consider every operation in turn both from the point of view of the labour hours involved and of the class of labour necessary to perform it. Such an analysis is no doubt made now in greater or less detail by every firm when planning methods of manufacture, but the Author holds strongly that for all munition products the Government should supply such information to contractors. It

would avoid all controversy about the possibility of attaining either the efficiency standard or the dilution standard required by the Government, because the possibility could be proved by actual performance. The Author does not, of course, advocate compulsory adoption of the standardized methods of manufacture where firms can produce equally good results by any other methods. But the standard established would assist them in planning work and complying with the Government's requirements as to the maxima of time and labour permissible for a given output. The first objection which will arise in the minds of critics is that all firms are not equally well equipped for production, and that it would therefore be unfair to insist upon the standards of time and labour being universally adhered to. In answer to this, the Author would say that his proposal would have the effect of preventing firms obtaining contracts which they are unable to carry out efficiently, and this would obviate the waste of material and labour which now exists. Furthermore, it would justify the application of a firm for such machine-tools as would enable it to carry out its contracts in the most efficient manner, and would, therefore, rapidly bring about the proper equipment of manufacturing firms for their special products. It would also have a good effect in the standardizing of the best machine-tools with a corresponding increase in the number available of the best types.

In conclusion, the Author would like to make a suggestion that this Institution should set up a Committee to study and report on the best methods, in each engineering industry, of introducing women into works, the best way of training discharged soldiers, with special reference to methods and appliances for employing maimed men, the upgrading of workers, the best methods of training male and female labour and cognate matters. Such a Committee could collect the experience of the members and make it available for the benefit of the whole, besides placing such invaluable records at the disposal of Government Departments dealing with labour dilution, reinforcement, and supply. This would not only be a valuable war work, but would have a lasting effect on British industry after the war, by helping to establish standards of output,

standard methods of sub-dividing work and the adoption of such plans as would give the best results in the various branches of engineering industry. Thus such a Committee could help the country to preserve for the benefit of British industry the dearly purchased experience gained in the struggle through which we are passing.

APPENDIX.

THE EMPLOYMENT OF WOMEN.

The following is a brief summary of work which was carried out wholly or partially by males before the war, and is divided under four headings:—(1) Construction; (2) War Work; (3) Operating; and (4) Miscellaneous Processes.

1.—CONSTRUCTION.

Aeroplanes.—The employment of women on covering, doping, painting and varnishing planes, ailerons, tail-planes, rudders, etc., has been general, and in many cases the work is done entirely by women.

The woodwork of aeroplane wings, ailerons, tail-planes, and many subsidiary details has been done throughout with the exception of machining, by women in many cases.

The work of assembling wings, ailerons, tail-planes and details, is done in many cases by women, but the erection of fuselages as sides, and the complete assembly of fuselages by women is rare, as also is the assembling of wings and the fitting of controls. The employment of women in higher grade work of this kind has been influenced by local conditions of management and by method, particularly where assembling is performed by a large number of highly specialized gangs, as is the case in a few of the larger works.

Airships, Balloons, etc.—The employment of women is partial, but comprises a very large percentage of the total workers, and their employment is frequent in this industry,

Ball-Bearings.—A large proportion of this work was done by women before the war, but the percentage has increased considerably throughout this industry.

In all the preceding cases the work is of such light character and so free from special conditions that no changes have been necessary, except the usual improvement in guards where machinery is used.

The period of training required varies from two to six weeks before the women workers can be considered efficient under preliminary conditions, with adequate supervision, and some assistance from skilled workers.

Boiler Making and Boiler Fittings.—This comprises the construction of boiler drums, from bending the plates to drilling and clamping in place; drilling tube-plates, bolting temporarily together, riveting, caulking and making fittings. In all these branches the introduction of women has been partial, but not frequent, except in the case of boiler fittings, which is the only class of this work considered suitable for women in normal times. The employment of women on semi-skilled and unskilled work has required training varying from a few days to four weeks.

Constructional Engineering.—This comprises the running of shearing, punching, bending and other machines, also temporarily bolting together and riveting up the bracing of girders, etc., by machine or portable hydraulic riveter. The same remarks apply as in the case of boiler making. In some cases the work of painting is done partially by women, but this is not yet general.

Electrical Engineering.—Whereas the machining and erecting of large dynamos and motors is now only partially effected by women in rare instances, and is not considered suitable for them in normal times, the machining and erecting of small dynamos and motors is of frequent occurrence. The same applies to the stamping out of laminations for armatures and transformers; forming,

winding, and taping coils; the making of paper and micanite tubes and moulded insulators; the making and erecting of switch gear of all kinds; the making of electrical instruments, meters, and of arc lamps. In all these the employment of women is frequent and partial, and the work is suitable for them in normal times without change in method of working.

Internal-Combustion Engines.—On the construction of the various parts of the engines for motor-cars, motor-lorries, and aircraft, as well as on gas- and oil-engine parts not too heavy to handle, the employment of women is partial and frequent, but on gas- and oil-engine parts too heavy to handle, involving increased labour and special lifting tackle, the employment of women is partial and rare, and the work cannot be considered as suitable for them in normal times.

Locomotive Engineering.—The machining of engine parts has been undertaken partially by women in some shops, and obviously much of the smaller work falls under conditions analogous to those of other allied engineering trades.

Machine-Tools.—Small and large machine-tools have both seen the partial introduction of women labour in very frequent cases. The work on small machine-tools is considered suitable for women, whereas that on large machine-tools is not, for the reason that increased labour and lifting tackle would be required.

Marine Engineering.—In the construction of ship hulls no application of woman labour has been made, nor is it considered practicable owing to the heavy character of the work and the amount of climbing involved; but on the construction of engines and turbines, for the work of painting, scaling, etc., and for the electrical wiring of ships partial application has been made in not very frequent cases.

Motor-Lorries, Cars, and Motor-Cycles.—The engines and

transmission gear as well as other components are frequently made partially by women. The period of training varies from one to six weeks, and requires ability to work to gauge. Work on the chassis of cars and lorries is of rarer occurrence and is not considered suitable for women in normal times; the period of training required is from six to ten weeks, but the work is generally considered rather too heavy. On magnetos, carburettors, and speedometers the work is in some cases now more than half done by women, and is eminently suitable for them, requiring no change of method or machinery but considerable accuracy and care. The training period varies from three to ten weeks.

The body-work of motor-lorries, motor-cars, as well as upholstering and trimming are not considered suitable for women, nor have they been employed on these for the reasons that the carpentering on lorry bodies is considered too heavy, and the coach-making thought to require so much skill that in general it would not pay to employ women on this class of work. The objection to women upholsterers and trainers is peculiar, as they have done this work successfully on railway coaches.

Railway Carriages and Wagons.—The whole of the work on underframes, wheels, axles, truck bodies, railway carriage building, railway carriage upholstering, painting, glazing, etc., has not afforded scope for the introduction of women at present. It is a fact that in pre-war times the trimming and upholstering of railway carriages was done by women in certain cases. The objections now raised are that the work is too heavy in the earlier classes and rather heavy in the latter.

Steam-Engineering and Pumps.—The machining and fitting of light parts has been done partially by women in rare cases. For machine and bench work a training of from one week to six months is required.

Precision Work and Tool-Room Work.—This involves the making of engineers' gauges of all kinds, including those for screw-threads,

all cutting tools such as taps, dies, cutters, twist-drills, reamers, and all jig details and parts. The partial adoption of woman labour in all these classes is frequent, and the work is considered suitable for women with training in the use of measuring instruments of from three to eight weeks.

The making of measuring and drawing instruments involves rather higher skill, and the application of woman labour to such work is extremely rare at present.

(2) WAR WORK.

Guns and Gun Components.—This comprises jackets, tubes, etc., breech mechanism, gun-sights and gun-carriages. The employment of women is partial and rare on all except on the breech mechanism on which it is frequent. Both this and gun-sights are considered work of a class suitable for women. The training period required varies from one to six months, and owing to the skill involved, women require increased experience for such work as gun-sights.

Small Arms.—Partial work by women is general. It is considered suitable for them, and the training period varies from six to twelve weeks.

Rifles, Lewis Guns, and other Machine Gun Work.—Though highly accurate are well inside the ability of women.

Shells and Components.—The forging of shells and adapters as well as cleaning, painting, and stamping of shells over 4 inches diameter is only done in rare instances partially by women, and is not considered suitable work for women in normal times. All of these are unskilled operations requiring little training, but the nature of the work is too arduous and too heavy for women.

The operations on machining shells over 4 inches, and of general labouring in shell shops are now generally performed partially by women, but the work is not considered suitable for women in normal times because of the increased amount of lifting tackle

required and the heavy handling involved, except where the shops are specially laid out for this product.

The machining of shells up to and including 4-inches of base plates and adapters, of nose bushes, gages, and fuses, the gauging and viewing of shells and components, and the cleaning, painting and stamping of shells up to and including 4 inches are partially performed as a general rule by women, and are considered of a character suitable for women, as these operations involve no change in methods of this semi-skilled work, which requires a training of from one to three weeks only.

(3) OPERATING WORK, NON-CONSTRUCTIONAL.

Crane Driving.—The introduction of women into this branch has been partial but frequent. It is considered suitable work for them, but the cranes, when of the overhead type, require, in many instances, better facilities for access. For such rough and heavy work it is, of course, necessary that the women workers should be suitably clothed; this applies also to work on large aeroplanes, and on aeroplane erection, as well as on boiler-making and constructional engineering.

Power Plant and Electric Station Work.—The work of operating boilers, gas-producers, etc., is not performed by women except in very rare cases, and is not considered suitable for women in normal times. General labouring in power stations is at present done in rare instances by women, but it is also not considered suitable, on account of the climbing and risk involved.

Operating steam-engines, gas-engines, dynamos and electrical switch-gear is partially done by women in some instances. The training involves knowledge of the principles and construction of the machinery, and in the case of switch attendants an elementary electrical knowledge. The period of training varies from one or two weeks to six months. One objection to the employment of women on this class of work is the shift system, universal in power stations, which involves a change of shift at midnight, a time which would generally prove unsuitable for women.

(4) MISCELLANEOUS PROCESSES.

Acetylene and Electric Welding.—The partial employment of women is general on this class of work, and it is considered suitable for them in normal times without change of method. The requisites are care and experience and a training period of from one to ten weeks.

Lacquering, Bronzing, Enamelling, Painting and Stencilling.—The partial employment of women is general, and it is considered suitable for them in normal times; care and a short training of from one to three weeks are all that is required.

Blue Printing and Tracing.—The partial employment of women is general, and it is considered suitable for normal times; care and neatness are the chief requisites with a training period of from one week upwards.

Draughtsman (Junior).—The employment of women is here more rare, but it is work considered suitable. Knowledge of machine-shop work is necessary, and the training involves that for blue printing and tracing as well as additional experience in drawing and projection. The need for shop experience is great, but the difficulty attendant on the employment of women in this branch is diminishing owing to the increase in the number of works in which women have been employed in working, from actual drawings, and not on mere repetition.

Tool-Setting.—The partial employment of women is frequent, and the work is suitable for normal times. The requisites are either considerable experience as an operator, culminating in setting own tools, or a course of four weeks and upwards of specialized setting on machines of the same class. The tool-setter who can set up for any kind of work is highly skilled, but when the question is reduced to a particular class of machine, or of machine work, the field is limited, and the skill is reduced to more specialized limits.

Viewing and Gauging.—The partial employment of women is frequent, and it is work that is considered suitable for women in normal times, in fact, women have been employed in pre-war time in many branches of industry in viewing operations. The limitations occur when parts are too heavy for them to handle, or when experience of materials, such as timber, is vital. The training involves accuracy and intelligence as well as ability to understand drawings, and instruction in the use of measuring appliances for a period of from one to six weeks. In some instances, experience of specialized character is necessary to determine whether the finished workmanship, or material, or other variables are satisfactory.

Wire-Drawing and Winding.—These operations are not performed at present to any great extent by women, though they are considered suitable for them in normal times. The requisites are knowledge of the process, and a short training of one or two weeks; the only limitations are those imposed by want of physical strength.

Making and Breaking of Test-Pieces.—The partial employment of women on making and breaking test-pieces is not very common, but it is work considered suitable for them in normal times; the requisites are ability to read drawings and measuring instruments, combined with a knowledge of accurate turning on the centre lathe, or precision grinding, together with a training of three to six weeks in the operation of a testing machine. The breaking of test-pieces is in many cases a fairly simple operation when the yield-point of the metal is well marked, but in the case of some steels and some non-ferrous metals, greater experience in testing is necessary, as much may depend upon the observation of the yield-point of the individual material under test. All the auxiliary work of measuring the test-pieces before and after fracture as well as the calculations involved in the determination of the elastic and ultimate tensile strength, percentage of elongation and reduction of area, are well within the capacity of women who can machine the test-pieces, use the slide-rule and work the testing machine.

Discussion in London, on Friday, 3rd May, 1918.

SIR HERBERT AUSTIN, K.B.E., said he entirely agreed with the general remarks made both in Miss Monkhouse's Paper and in that of Mr. Morgan with regard to the employment of women. He spoke from experience as an employer of something like 6,000 women and 14,000 men. Some of the women were engaged on shells, and others on the very finest operations in connexion with grinding and machine work, which previously had been considered entirely a man's job. Holding those views, it was rather difficult for him to outline any criticism of the Papers, because he did not think that, at any rate, Miss Monkhouse's Paper admitted of much criticism. The facts enumerated in it were quite definite and he entirely agreed with them. On the other hand, he thought that possibly many employers had been blamed for diffidence in the employment of women when really the reasons were not all apparent. It had been said that they were afraid of employing women because they did not think they could do the work. Now there were other reasons, and he would like to mention one or two of them.

In the first place, he felt confident that many employers believed that if they instituted dilution, put in a lot of women labour, and went to a great deal of expense and trouble, their methods would not be followed by other manufacturers who would not be compelled by the Ministry of Munitions to put in the same proportion of women. And when an employer who had put in a great amount of dilution, and was suffering under the difficulties naturally contingent upon the employment of unskilled labour, and making changes in his works and fittings—when such an employer saw other firms with no dilution whatever, it naturally made him feel disinclined to follow the wishes of the Ministry in putting in dilution from time to time. He knew of some factories in his immediate neighbourhood which had carried out no dilution whatever. That partly arose, he believed, from the fact that they were doing Admiralty contracts, in which they had preference, and

the unfortunate firms who were doing munition contracts had not the same amount of protection. Then again, the Ministry of Munitions was made up of quite a large number of departments, and it was not the dilution officers who came round to blame one for not having turned the work out quickly and properly, and made a good job of it; but it was the other departments, who had no sympathy whatever with dilution. Thus employers were faced with very considerable difficulties, and after they had had a year or two of that sort of treatment, they naturally did not like meeting the requests of the dilution officers so freely as they otherwise might. He himself had really now arrived at a condition where he did not like to see the dilution officer. He had at the present moment two in the factory who had been there nearly a week, and he had told them when they arrived that he could not give them any further assistance; and he believed that other firms in the country now had arrived at that position. They had done their fair share, and matters had arrived at a position where, as Mr. Morgan pointed out in his Paper, it ought to be made compulsory for others to do it, and then there would be no discussion about women being able to do men's work. Everybody admitted that; there was no difficulty about it at all.

Then, again, there was another fear which had not been touched upon in either of the Papers, namely, as to whether women would be available after the war, and whether the time taken in teaching women and making provision for them in the shops was going to be worth the expense and trouble. Before the war he had set his face against any women being employed in his factory—he did not think it was necessary—and he was frankly looking forward to the employment of men in the factory after the war, and to its not being necessary to employ women. That was not because women had not done their fair share—they had done more than their fair share. When the war was over and the time came for summing up the work done by women both in skilled and unskilled labour, he had no doubt that they would show very well indeed. But he was not looking forward to women doing a man's job after the war. He thought it was a man's duty to do the hard work in an

(Sir Herbert Austin, K.B.E.)

engineer's shop, and that there was other work for a woman to do for which she was more suited. The advocates of women's labour seemed in nearly every instance to be consumed with the fear as to whether they would be allowed to work, or whether facilities would be given to them. He was most concerned with the question whether they would be willing to work themselves—whether they would not find other temptations to push their energies in other spheres, and would not want to carry on the work that they had been doing so well in engineering factories. He thought Mr. Morgan possibly did not know of all the difficulties with which some manufacturers had to contend, and perhaps he had not considered, on the question of efficiency and of allowance for output, the question of changes in design that had to be made, particularly in the direction of aeroplane and aeroplane-engine contracts. He did not quite know how Mr. Morgan would suggest that figures should be laid down as to what the output per man-hour should be, but he would be very much interested to know what Mr. Morgan had to say on that matter, because really he did not think it had any relation to-day with aeroplane-engine work compared with the difficulties that one had to meet with in the frequent changes of design made necessary by the continual demand for improvement.

Sir GUILFORD L. MOLESWORTH, K.C.I.E., said he could not in any way criticize the admirable Paper by Miss Monkhouse which had been laid before them. It abounded in cogent and logical reasons, it was replete with good, sound, practical, common sense. The franchise had been granted to women, and they had proved their ability to perform work with efficiency which previously had been considered to be exclusively within the domain of men. Women's work had come to stay. It would not end with the war. It was probable that many now working at munitions would remain to work, if not in munitions, yet in work which would be urgently required to recover our lost industries, and to repair the waste that had been made during the present war. But care must be taken that they did not fall into those pitfalls which had ruined Trade

Unions, which had demoralized and enslaved the British workman, which had caused unemployment and pauperism, and which had enabled the Germans to capture our trade and industries.

In his younger days he had passed an apprenticeship as millwright and engine fitter in Fairbairn's large engineering works at Manchester, and after the outbreak of the war he had volunteered to work as a skilled mechanic in making shells at the works of Messrs. Vickers, at Crayford, without pay. His offer had been accepted, but he might say that the manager had informed him that his services would be more valuable in office work than in actual manual labour. He had worked with them for nearly five months, but was then obliged by medical orders to relinquish it. During that time he was convinced from personal observation and from conversation with the workpeople that the output of munitions was most seriously and wantonly restricted. The greatest danger that menaced the future of women-workers lay in their enslavement by Trade Unions. He did not think that women workers realized the dangers that existed from that. Women workers of the future must avoid any form of trade unionism of that kind. No doubt some organization must be formed to protect their interests, but it must be one that left the worker free. It must be consultative and advisory rather than administrative. It must not meddle with politics, and it must not join with any Party. Miss Monkhouse would do right good work if she would organize and be President of such an organization, the constitution of which should be entirely on the lines which she had so ably submitted.

Miss A. M. ANDERSON (H.M. Principal Lady Inspector of Factories) said that Mr. Morgan's Paper needed a great deal of study on her part to enable her to contribute anything at all to the discussion. Her point of view was that she approached the whole subject from the opposite end. Mr. Morgan's chief interest was in the placing of Government contracts where the best conditions obtained for the most successful application of material and labour. Her interest was much more in the direction indicated in parts of

(Miss A. M. Anderson.)

Miss Monkhouse's Paper—that of placing contracts, if she had any share in the placing of contracts—rather where the best conditions obtained for safeguarding the life, and health, and limbs of the workers. Mr. Morgan's interest was quality and quantity of the product of labour; hers was the quality of the life of labour. She had no doubt whatever that rationally organized the two aims would meet in industry, and would meet to the enormous advantage of the nation and of the worker. There could be no hope of the highest efficiency in the product of labour without the fullest possible regard for the life and safety and welfare of the worker. She had seen very much more of the problem of dilution of labour, the application of increased employment of women's labour in non-munition industries than in engineering industries. There had been there a most marvellous development, which could be seen in the pamphlets published by the Home Office and by the Board of Trade, on substitution of women in a large number of non-munition industries. In those industries there had not been the application of that extraordinary, specialized training that had been organized for engineering industries. It was not yet known what could be done in all those directions when they had complete development of training.

She rejoiced greatly at the extension of women's work, and the fullest possible opportunities for application of their special gifts where they could most aid industry. But she was inclined to agree with what Sir Herbert Austin had said with regard to not bringing women on too large a scale into special men's work. Where women could really assist by their special gifts and special training, to the real advantage of the nation and to the development of their own powers, it would be a very great gain; but she did not want to see them permanently brought in in very large numbers, having their own much higher callings, to fulfil any massive, heavy labour that was peculiarly suited to men.

Mr. C. FARADAY PROCTOR said he had had about thirty-seven years' experience in the employment of women. In 1881 he went to Paris to start the first incandescent electric lamp factory, and

the work being of a very delicate nature they naturally employed women. In 1883 he returned to England to install some new plant and instruct girls how to work it. In 1884 he went to Lille, to restart a factory which had been burnt down; girls were also employed there, and in 1888 he went back to Paris to start a very large incandescent electric lamp factory. Up to that date glass-blowing was very largely in the hands of Germans, who very seriously limited the output and refused to allow the teaching of boys. Again he turned to women labour, and very soon the women and girls were turning out the same number of lamps as the men were making, and went on until their output was double; and when his new seal—the internal glass stem—was introduced, their output became four times the output of the men. Their success was not purely a question of their being more able—although neatness was a very special characteristic of the French girl, and an essential to good glass work—but because they put their best efforts into their work and did not attempt seriously to restrict output. In that factory he had also found—he was still speaking of the new Paris factory—that the education of the women was so good that he could employ the ordinary workhand for clerical work, and the whole of the factory books were kept by girls, and stood the test of most critical auditors, and were certainly the neatest work he had seen.

He was so proud of their work that he had brought a few sheets with him to show anybody who was interested. But the special value of the point was this, that when he was in the North of England and had started another factory there, he had got a young man who believed that he was about as fine a clerical man as existed, but he did not do his work anything like as neatly as the Paris girls did. However, he was the right type of man, and made up his mind he could and would do as good work, and soon made such an improvement in the book-keeping and system of accounts that their London directors adopted it for their London works also. That man was now manager of a large business abroad.

He (Mr. Proctor) had always advocated women working and generally joining in business matters, and he believed that a woman

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(Mr. C. Faraday Proctor.)

could do almost any work which a man could do; indeed women were very much what men made them, and men were what women made them; if the lazy and drunkard could be boycotted, they would die out, and if men were satisfied with dolls or playthings for their wives, and would leave the hard working intelligent spinsters to one side, the race was bound to deteriorate. There must be good intelligent women for the bringing up of the children and the future generation; if they were proud of their ancestors surely they were unworthy of them if they did not see that their successors were at least equally worthy.

He believed in the laws of cross inheritance, that is to say, a girl inherited more largely from her father, whereas a boy inherited more largely from his mother; were this not so, the difference between the sexes would steadily increase. Some thirty years ago Sarah Grand in her memorable lecture on "Mere Man," pointed out that man could not hope to raise his general status if he denied to women a higher education. Women had all the early training of the child, and very largely influenced the young man, and in later life often influenced even their greatest statesmen.

The Meeting might feel that he was travelling rather far away from the subject, but was a Paper on "The Employment of Women in Munition Factories" the sort of Paper the Members of the Institution of Mechanical Engineers were accustomed to? or expected? Was it the type of Paper that should be read at their Meetings? He said most emphatically, "Yes." Their Institutions were getting so exclusive or specializing to such an extent that many of the matters vital to the national welfare were neglected, because they were just outside of the particular corner in which that Institution was interested.

The politicians talked about setting up machinery for each new organization. Why "machinery"? He believed because it symbolized perfect organization; and although among the great nations they were probably the most incapable organizers as far as home-work went, when they were driven to it—the colonies for example—they were not found wanting. No man ever spoke more truly than did King George when he called on them to "wake up." They were

once the Engineers of the World, and possibly they still held the records for some of the great engineering feats of the World—the Forth Bridge and the steam-turbine were British. They might hold the record for aeroplanes, but only because they were compelled to do it, and motor-cars! Consider the Ford car made by workmen receiving almost double the pay of an Englishman, made hundreds of miles away, and sold here at half the price of our cars—surely a fine example of organization; and yet he was convinced that a small light motor-car could be made even by English labour for half that price. He had been through many of the small-arms factories in Belgium, Verviers, and Liège, including the Herstal works of the Fabrique Nationale, and his impression was very strong that our want of success was largely owing to our slovenly methods of organization. Their employers and teachers asked for higher education and technically-trained men, but would neither pay them, use them, nor give attention to their advice.

He was convinced that the outstanding difference was that the foreigner—French, Belgian, possibly German and the American, enjoyed their work; the French and Belgian enjoyed it more than their play, the American as much as his play, but the Englishman in many cases detested it because it was work. In France, Belgium, and America, probably two-thirds, if not three-quarters of the population worked, and it was considered correct and necessary to work, whereas in England less than half the population were at *regular* work. He did not in anyway wish to depreciate the never ending labour of the women at home, but he was trying to see how the employment of women at regular organized factory work would influence the nation, themselves, and the men. A nation's wealth consisted of labour and raw material, either in the stored-up forms of capital, or worked-up material in one kind or another, or in the form of active labour, that is, the power to convert the capital or materials into some desirable form; it was thus necessary that labour should be skilled, and as abundant as possible.

The past condition of women must have been detestable to every high-spirited person, her prospect in life was very much a wait-and-see existence, she was a veritable derelict almost compelled to

(Mr. C. Faraday Proctor.)

accept any port for shelter. Could there be any question as to whether women should do every sort of work they were capable of doing fairly well so that they could support themselves, and from what point of view could a man object? Was he afraid of competition? If so, then it was the very thing he needed; if most of the girls he met had learnt to do regular work, surely they were more to be admired than the easy-going frivolous girl. If his wife had learnt to earn her living she would value money more, and should an accident deprive him of the power of work she could provide for herself.

In the business of electric-lamp making, women could and did make every part of the lamp except the actual blowing of the bulb, but even that he considered was women's work and should be done by them, but at present the law was against their doing this class of work. Almost all the work in connexion with small electric motors and small porcelain fittings, and very many other classes of light work, women were specially adapted for, and in all cases where accuracy and neatness were of value they excelled. Girls, he found, certainly excelled in doing delicate repetition work where many hundreds of an article were wanted per day per hand; they seemed to be able to do it in a semi-conscious way, and the monotony did not trouble them; indeed any variation they seemed to regard as a trouble, whereas a boy could not be kept at the work. He felt that some girls regarded the work as marking time until they got a home of their own, and that their mind was scarcely occupied with the work; such an attitude would never lead to efficiency.

He had often been asked why women were not paid as much as men. There was a very good reason; if a boy and girl started work together, the boy would at first get ahead, then the girl would pass him, and at eighteen years old be much his superior, but between twenty to thirty she was a very problematical employee from the master's point of view; any day she might come and say she was going to be married, and there was no help for it. All her training was lost from the master's point of view; on the other hand if a man were going to be married, the master knew that he had got him, and that he would stick all the harder at his work.

There were two other serious problems to be considered in this connexion ; some people contended that if women and men were all working at their hardest it must result in overproduction, but he did not think it was a correct view ; there might be overproduction of one or more specific articles, but that was owing to want of organization. Perfect organization and unlimited production—which was humanly impossible—would only mean that every individual would possess everything that his imagination desired.

The second point was that if women were earning approximately as much as men, what was going to happen when they got married. At first there would be the economy of one dwelling, but if the woman gave up her employment their income would be halved ; if she continued at work and the children were put out "en nourrice," that is, sent out to the country to be cared for by paid strangers under the supervision of a Government paid doctor (as was frequently done in France), although quite practical, and leaving the parents at liberty to give all their attention to their work, she was giving up one of the most important duties of motherhood, and it did not appeal to him (Mr. Proctor) as the right thing. Yet they could not expect the employer to double the salary of a man because his wife was going home to look after her children, although they were the future representatives of the nation ; or must the country provide a sum sufficient for their support and training, and at the same time see that the money was being used economically, and for the benefit of the wife and children ? or were the population going to be persuaded, or compelled, to save enough money to provide for the proper maintenance of children if they had them ? It was a big and complicated problem, but just one of those points that were apt to be left as not belonging to the scope of the Institution of Mechanical Engineers, and yet was of as vital importance as engineering itself, and should not be separated from the subject of "The Employment of Women in Munition Factories," for to quote Miss Monkhouse—"On her largely depends the life and happiness of the Nation."

Mr. JOHN ABBOTT said he entirely agreed with Miss Monkhouse and Mr. Morgan. It seemed as though they were all agreed that women were capable of doing several jobs which Mr. Morgan referred to as "sub-division jobs" of skilled labour. He himself had had twelve years' experience of female labour, and could hardly agree with one remark made at the last Meeting—that women were less conscientious than men. Age for age he had found them more conscientious. Possibly the explanation of this was that in many factories more care had been taken in the choice and training of women than of men. It might be thought he was now rather making an excuse for his own sex, but that was his experience. These factories employed ladies whose duty it was to go round making suggestions for the betterment of the conditions of the girls, whereas often the boys received much less attention. It was absolutely essential, in his opinion, to have women supervisors immediately over girls, because a man was at a severe disadvantage in such a capacity. A girl in a factory would probably weep immediately she saw she was getting the worst of an argument. He thought all men knew the hopelessness of reasoning further when that happened, whereas a woman supervisor could carry her point under her employer's instructions, giving the woman her answer back—not necessarily weeping, but still using equally forcible arguments.

He thought it essential that there should be a really reliable welfare-worker. The welfare-worker was frequently a thorn in the side of a works manager, but yet, after all, it kept him straight and enabled him to concentrate his attention on the things that mattered with regard to engineering problems, and it relieved him of a lot of detail. He thought the Government ought to do—as, in fact, they were doing—a great deal in the training of welfare-workers, but it was a position of such responsibility that they should be very carefully chosen. They must have the full confidence of the employer and of the employee. Without that the whole scheme would be a failure. He felt that female labour was not for the period of the war only. Work was a law of Nature, and providing racial health was protected by law, it seemed as though the

employment of women should be a question between the employers, the employees, and the men whose competitors they were. He thought that the women in fair competition would retain their jobs. If employers got a job done at a cheaper rate by women, he thought there would be cause for trouble, but surely none of them would object to paying the same amount to the woman worker if the product was equally satisfactory.

Major S. HECKSTALL SMITH said that there was one point on the subject of dilution which seemed rather an important one, namely, that the very earliest stages of dilution could be reached, he thought, on the designer's table. That point had been very much overlooked in many munition works—that when dilution had to be studied, the designer could do a great deal towards it. If the Ministry of Munitions had brought that out strongly some time ago, it would have done much good, but even now he did not think it was too late.

He would like to disagree with Sir Herbert Austin on one point. He had been working for many years now on aeroplane building, and had employed women before the war on the mechanical parts of that work, and he hoped to employ them after the war. He thought one of the most important things—which had not been mentioned in either of the Papers—in regard to the employment of women (he was speaking now of after the war, because at present, of course, it was an absolute necessity) was the fact that the prosperity of every country largely depended on what he might call the family wealth. The better education, the better health, the better housing of the workers depended on the amount of money which a family could earn, and the amount of money which a family could earn depended on the maximum number of people in that family gaining employment. And therefore, living in rather a remote place where it was difficult to get a large number of mechanics, but where they wanted a large number of employees, and where house rent was expensive, they had found it absolutely indispensable to employ women before the war in order that people might have enough money to live in the neighbourhood, which they

(Major S. Heckstall Smith.)

could not have unless the whole family were employed. He therefore thought it was a most essential thing that the employment of women, especially young women, should be considered most seriously, as it was now being considered—that it should continue to be considered seriously after the war, for the general benefit of the welfare and wealth of the country.

Sir HERBERT AUSTIN hoped that he was not out of order, but he understood this discussion was entirely with regard to the employment of women in engineering factories and not in other factories. His remarks with regard to his not having employed women before the war were entirely confined to his own engineering factory.

Mr. WILLIAM REAVELL (Member of Council) said there was one paragraph in Mr. Morgan's Paper with regard to which he would like to ask him a question. He referred to the passage wherein Mr. Morgan expressed the opinion, from his experience, that women had excelled more in machining work than in fitting work. The question he wished to ask—and no doubt it was in the minds of many employers who, like himself, had used women's labour with so much satisfaction and success—was this: Did Mr. Morgan mean by fitting work, the fitting up of parts which would go together without requiring the use of a file or a reamer, as, for example, in fuse fitting; or did he mean skilled fitting work, where it was necessary, after the work came from the tool, to have a fine file or a scraper applied to the work before the parts were fitted together? His own experience was that in fuse-making, for example, where the fitting consisted in fitting together the fuses as the parts came from the tools, and where no skilled fitting, in the sense of using a scraper or a file, was required, woman's work in fitting in that sense was much superior to that of men. Their deftness of touch and their neatness of fingers enabled them, especially when piecework, or, as he preferred it, bonus work, was employed, to far exceed the speed with which men, or boys well in their teens, would do the same kind of fitting together of parts.

After some three years' interesting and satisfactory employment of women on fuses, they had introduced into their main works the use of women trained in the fuse works on capstan lathes and milling machines and other similar machines, where work could be sent up to them from the tool-room, and where the work was largely repetition work. And there again they had certainly found that the assiduity with which they applied themselves, and their disregard as to a supposed maximum of work to be done in a given time, were most excellent. But when they had tried to employ women to fit together the parts of a more complicated machine—a machine costing much more as a single machine than a fuse, and being produced in, say, hundreds per week while in fuses one thought in thousands—their experience up to date had not been so satisfactory. He was speaking now of skilled fitting, where, before the parts of a machine could be fitted together, it was necessary to do a certain amount of accurate fitting work either by the use of a small scraper or a very fine file, or by the application of small hand reamers and so forth. They had not found, so far, that they could replace with advantage, for work of that kind, the skilled fitter, even by the best selected girls they had had the choice of. Nor did they find that the girls seemed so interested in fitting work as such as in operating a machine, provided, of course, that the machine was so arranged—as many of them had no doubt found necessary—as to be specially suitable for women. He was speaking, for example, of such cases as this—where a capstan lathe was fitted up for man's work, and a woman was put on it, it was found necessary to lengthen the handles of the star wheel. With due intelligence displayed by the management, they had found in every such case that by slight changes to suit the physique of the women, as by making a stool of a suitable height for the woman to stand on—to which matters due regard should be paid, then, on machine work, he had nothing but praise for the work of women; but their success in fitting had not been so great.

He might mention one little illustration—and no doubt other members had had similar experience—which might interest the

(Mr. William Reavell.)

Meeting. In connexion with certain machined parts, the rate of production had been certainly accelerated after the war by the men engaged on them; but still not up to the maximum output which it seemed to them, with the special appliances supplied to the men, they ought to reach. A quantity of that work had therefore been passed over to the women workers, and some capstan lathes had been fitted up for the purpose, and it was found that the men's output had been much exceeded by the women after acquiring sufficient experience. That was an excellent object-lesson to their skilled men, because it showed them what the women could do, and that their own output, excellent as they had imagined it to be, was not good as compared with the standard set by the women. The women, somehow or other, seemed to be able to "go all out," and all employers would willingly pay men much more money if they would only learn that lesson. One other little incident might be of interest to the Meeting, as showing the adaptability and the bravery of women. In the early days of the war, they in East Anglia, as all knew, had suffered very much from air raids. They had had Zeppelins in East Anglia before they were seen in London. They had not suffered from them lately, while people in London had been more favoured both by Zeppelins and by aeroplanes. Having made what they imagined was a satisfactory bomb-proof shelter in the basement of their fuse-shop, and having arranged for suitable lighting when the factory was closed in times of air-raids, they had found to their delight that the air-raids did not disturb the women workers in the least. They were very fortunate in having as one of their supervisors a lady who had been a professional singer before the war, and she at once organized concerts on raid nights. He had been down there two or three times in the middle of the night in times of air-raids, when warning had been received, and on each such occasion he had found a delightful concert was in progress. The electric lights were all shut off, and the women were singing, with candles in sconces round the basement—there was no other light available—and paying no attention whatever to the raids. Arising out of this, a most excellent choir had been formed, which had given some

capital concerts in the town for the benefit of wounded soldiers, by means of which a considerable sum had been raised; and he had always regarded this as a splendid example of the bravery of these women in facing those very difficult circumstances, without any fear.

Mr. E. R. DOLBY ventured to suggest, with regard to Mr. Reavell's very interesting remarks, that the term "assembling" had already been most usefully employed to connote the act of putting together the finished parts of any object. He thought the use of the term "fitting" might well be limited to describe the final removal of material by hand to render the parts fit for assembling.

Miss O. E. MONKHOUSE, in reply, said she was rather fortunate in having to meet very little, or she might almost say no opposition. She had come nerved to meet a serious struggle, but was glad to find that no courage at all was needed on her part! There were, however, one or two points upon which she would like to say a few words. Several speakers had either stated definitely, or implied very strongly, that women could never be what might be called engineers proper. She was not going to hold a brief for women as engineers, but at the same time would like to point out that the remarks made by some of the speakers, though intended to prove that women could never be engineers, only went to prove that there was nothing to prevent a women becoming an engineer, provided she had not got the usual domestic claims upon her time. Mr. Wicksteed, for example, had stated quite definitely that a woman could not be an engineer. But she would refer them to his remarks. He stated that his women had improved in health and strength since they had been with him, that as they became better disciplined and more experienced, their work had improved, that things now were going on as nicely in his factory as formerly they had gone wrong; he even went on to say that scrap in his factory had been reduced to one per cent. Now all those remarks testified to the mental fitness, the physical fitness, and the commercial value of the woman worker.

(Miss O. E. Monkhouse.)

Against women's employment no one seemed to have anything to bring except their domestic claims. Those claims, Mr. Wicksteed had particularly stated, made them bad time-keepers, and prevented them from carrying out the full engineering course which would be expected from a boy. Thus, instead of proving that women could not be engineers, he had merely brought out very clearly what everyone knew, namely, that whatever else a woman embarked upon, she had still got to feed and clothe and nurse her men-folk and children. This was a disability in so far that a woman could not live the life of a man and a woman combined, but it in no way proved the mental unsuitability of women to be engineers.

With regard to the charge that women were such bad timekeepers, she would quote the recent returns from a shell factory which gave the average weekly loss per man 5·8 hours as against 2·8 hours per woman. Moreover the manager stated that his figures showed the skilled men lost most time, the semi-skilled and unskilled came next, and the women lost the least time. This factory was not by any means a unique example.

In answer to Mr. Creak (page 226) who claimed that men should have the same care for their welfare as women, women would be the last people to oppose such an idea. It was the one thing which they would encourage. Men should be well fed, and given opportunities to go from the works clean and self-respecting. That was what was needed for them, and what always ought to have been given to them; and it was for the men to see that they had the proper facilities. She would recommend anyone interested in such matters to go down and see some of the dock canteens. They all knew the roughness of the labour there, and the poor conditions under which the men worked. Well, there were now admirable organizations run by the Y.M.C.A., under the able presidency of Lady Askwith, which supplied to those dock workers hot meals at a moderate cost for breakfast, for dinner, and for tea, at places within a proper distance from their work; and the advantage that the men themselves were taking of those organizations for their welfare was very striking. The numbers were always increasing, and the places were becoming self-supporting.

Mr. W. H. Allen and Mr. Proctor among others had spoken of the advantage to be gained by training the women intelligently. There was no doubt of this, and very often the reason why women had not been a success was because the men had sometimes not thought it desirable to explain to them the technicalities of their work, thinking they would not understand them. Many examples could be quoted to prove this point, and the effect of good tuition was particularly noticeable both on the output and the consumption of tools.

Those were all the points she thought it necessary to touch upon, the majority of the speakers, as she had already pointed out, holding the same opinions as herself upon all fundamental points. But before closing, she would like to acknowledge the compliment which had been paid to women by her being asked to contribute a Paper to the Institution. She sincerely hoped that employers and trade unions would see that women were retained in those occupations for which they were particularly fitted, and that more encouragement would be given to them to take up skilled work. They must see to it that women did not degenerate industrially—that they did not become laundry slaves and sweated tailoresses employed largely by undesirable aliens. By encouragement, she meant that they must be given a definite place in our industrial system, with the recognition of the unions, and provided with the educational facilities of our technical schools and universities such as would fit them to rise to the highest places in engineering, chemical, and allied industries.

Mr. BEN H. MORGAN, in reply, said he was sorry that the constructive feature of his Paper had not been dealt with in more detail in the discussion, as he would very much like to have had a wide range of views of men of affairs on the question of setting up standards with a view to bringing about some equality in the labour conditions of the country.

Sir Herbert Austin had raised several very interesting points to which he would like to make a short reference. He had said the thought had occurred to him as to whether it paid to train

(Mr. Ben H. Morgan.)

women in view of the limitations that might arise in their use after the war. He (Mr. Morgan) thought that in approaching this whole question of dilution they must always regard it as purely a war expediency and nothing else. They must not emphasize its economic side. It was simply a war measure to meet a very difficult exigency. Sir Herbert Austin had referred to the unequal progress of dilution in his district, and the retarding effect this had on dilution. Nothing could more effectively point to the need for standardizing dilution effort.

Sir Guilford Molesworth had had an unfortunate experience in his contact with trade unionists at Crayford, and he would like to make the point that, speaking generally, the Ministry of Munitions had received the most loyal support of trade unionists in bringing about the wide employment of women in this country, and that whatever co-operation might have been received from employers whatever the Ministry of Munitions might have done, and whatever organizations it might have set up, it could never have brought about the employment of nearly a million women without the most strenuous and yeoman assistance on the part of the trade unionists, who had actually trained the great majority of these workers themselves in the factories. After all they heard a lot of local obstructions and so forth—and there were unfortunately too many cases—but the great body of workmen in this country were absolutely sound in supporting any measure to win the war.

Miss Anderson, probably the greatest authority on women's work in the country, had raised a very interesting point. It was a truism almost—although he thought it was not always realized—to state that it would be found in the long run that efficiency in production would always coincide with the greatest consideration for the health and welfare of workers.

Mr. Reavell had referred to fitting, but he thought he had in his mind assembling, with a certain amount of fitting. What he had referred to in his Paper was bench fitting, such as the shaping of parts with the file small arms and machine-gun parts involving a great deal of file work. He thought he had now covered most of the points raised, and it only remained for him to express his very

deep appreciation of the cordial way in which his Paper had been received.

Discussion in Birmingham, on 9th May 1918.

The CHAIRMAN (Sir GERARD A. MUNTZ, Bart., *Member of Council*), said that, as one of those who had had to try of late to work up to standard conditions, he had been extremely interested in both the Papers. The Paper of Miss Monkhouse was peculiarly instructive as imparting the views upon female labour of a lady who had had a great deal to do in the active organization and inspection of the same under Government supervision. Miss Monkhouse had spoken of the opposition which the women and girls had experienced in the shops in the beginning, and he was quite able to confirm from his own experience many of her statements under this head. He was glad to say, however, that he had not found the hostility to be so rooted among the average male workers as it had been repeatedly exhibited by many of the foremen. He was equally pleased and surprised when he introduced women supervisors into the shops to find what a rapid improvement almost immediately followed, both in the maintenance of superior order in the shops and also in the character and rate of the work turned out. His experience led him to agree with the pronouncement of Miss Monkhouse that "women should be controlled and organized by their own sex if the best results are to be obtained." He felt it to be absolutely essential to establish women control; it was scarcely natural that women should be properly controlled by men, and certainly male foremen in the shops were by no means the success which was provided by women supervisors. There was a sex sympathy between a woman supervisor and her female workers that was quite impossible in respect of women controlled by men.

Mr. Morgan had advocated, at the close of his Paper, that the Institution of Mechanical Engineers should establish a Committee to

(Sir Gerard A. Muntz, Bart.)

study and report upon women employment in engineering works, the best method of training them, the training of discharged soldiers (with special reference to the employment of maimed men), etc. He could not say that he was greatly in favour of the appointment of such a Committee. If there were more time than now to take it up it might be a very excellent thing, but there was no getting away from the fact that any such inquiry, to be of a representative character, and for its conclusions to be at all reliable, and of a sort to afford a guide for the engineering trades as a whole, would be a very big undertaking. The inquiry would of necessity have to cover a very wide field, embracing in its course all classes of female production in every kind of engineering work; he scarcely knew where such an investigation would begin, and certainly he could not prognosticate where it would leave off. He felt that employers were likely to resent too much internal inquiry at the present time into what they were doing. It should be remembered that British manufacturers were very jealous of their prerogatives, and he was afraid that even to-day this conservatism—or they might call it what they liked—had not vanished. Still, if the Institution could appoint a Committee of limited powers, with the object of accumulating information rather than of trying to conduct any set investigation concerning what was going on in various parts of the kingdom, bearing upon the employment of women and girl labour in the production of engineering work, a very useful purpose might perhaps be served. The experience of individual concerns would then doubtless receive a collective value, and the matter so set out would at least be very interesting.

Upon the question of female labour generally, he thought that it was becoming fairly established that properly trained women could do as good work as male operatives, and in many lines much quicker work. The superior "nimbleness" of the sex had in the past three years shown itself in numerous workshops, though previously the quality had been supposed to be confined to domestic management. He could not refrain from saying how intensely he admired the way the women were working in the engineering shops to-day all over the country, and he would like to appeal again

for the much more universal appointment of women supervisors. The full capacity of female labour was not yet known in Great Britain, and he felt that the good which might result from the establishment of like-sex foremen was unlimited, as well as being the "right thing."

He desired to congratulate both Authors upon the excellent manner in which they had treated their theses.

Mr. E. W. ANDERSON, in opening the discussion, criticized what he termed the "omission" in Mr. Morgan's Paper to contain any reference to the employment of female labour in the manufacture of small-arms ammunition. In Birmingham many thousands of girls were employed on this work, and had been so for years past. They performed most excellent service, and the business seemed to be one for which they were especially fitted. They were also most efficient in making and setting the tools for the machines which were required for small-arms ammunition manufacture. At the concern with which he was connected the management had gone much further than this, as it had been found that women were even capable of making gauges required for small-arms ammunition work. Within the last few days two gentlemen from Woolwich Arsenal had expressed their great surprise at what they had witnessed in this connexion on their premises.

The Authors had shown themselves strong advocates for the appointment of women supervisors of women's labour. In this particular he agreed with them, since he believed that such a provision was a great advantage to the workers, and at the same time assisted in the work being got out with the greatest rapidity and perfection.

Mr. JOHN NASMITH expressed his surprise that people looked upon the employment of women in engineering factories as something new. His first experience in dealing with women workers was fifteen years ago, when he joined the British Westinghouse Co. at Manchester. This Company was then making considerable use of women labour, chiefly with respect to the winding and

(Mr. John Nasmith.)

insulating of armature and transfer coils, but, in addition, they had a large number of women employed on capstans. However, owing, he believed, to the great variety of work which was dealt with by the firm, and the consequent amount of supervision which the women required, they ceased to be employed on capstans. On the electrical side, however, they were extremely efficient, and when he left the firm they were employed on a number of operations of a repetition nature, which they carried out very successfully.

He was of opinion that it would not be wise to expect too much from women, particularly where the output was of a varied nature. His experience had been that it was almost entirely on repetition work that they had done such excellent work. He thought that girls with five or six years' training would not be so useful as youths who had had the same training, and that in work requiring originality and inventiveness they would be of very little use. At the British Westinghouse Co.'s Works a suggestion system was in operation, and during the seven years he was there, although they received many suggestions from men, they never had one from a woman. His opinion was that women could render the most excellent assistance on work of a repetition nature, but their services would have to be made use of with very great caution on other classes of work, and it would be advisable that they should thoroughly prove their ability before they could be expected to take the place of the skilled men. He suggested that a very serious situation might result if the skilled men were taken out of the shops before the women were found suitable to replace them.

Mr. J. FEARN said that the Birmingham Small Arms Co. had at first met with some opposition from their male workers in the dilution of machine-gun and rifle manufacture by the employment of females, but experience of the women's presence in the shops had worked wonders, and both classes of labour were now working side by side in the same shops and under the same foremen. It had not been found necessary to engage women foremen. Equally successful

had been the employment by the Company of women on small-tool work, of which the firm turned out great quantities. In their small-tool factory male labour had been supplanted to a very large degree, and there had been no need here again for any change of sex supervision. He would read to the meeting a communication which he had received from the manager of the factory just mentioned, in reply to his (the speaker's) request, giving his experience. The communication was as follows :—

“Great care was exercised by us to choose superior types of girls. The majority of those chosen had no previous experience of factory life, many being domestics, shop assistants, and girls at home. Speaking generally, all girl dilutees had to work in shops along with men, and lack of discipline never proved serious, due probably to the institution of works matrons simultaneously. The novelty created at first soon disappeared. The girls that were chosen to work in tool departments were given one hour weekly tuition in the use of rules, scales, micrometers, verniers, etc., and the majority showed remarkable capacity to understand. We found some evidence of opposition on the part of men, but this was never serious, probably because they found that the girls showed so much aptitude for the work, and the fact that their presence as dilutees was indispensable. We have found that undoubtedly girls show evidence of fatigue from long working hours, and we believe that short hours show greater efficiency. The institution of Works Canteens has undoubtedly improved the general health of women, because whereas before women frequently made their main meals of “relics from home,” etc., they can now obtain a hot wholesome meal at both breakfast and dinner time for a total daily cost of about 1s. 4d. Example of intricate work—rifling cutter box before war made by men (nine hours) now entirely made by women (1½ hours).”

Respecting the manager's statement in the foregoing communication about the works canteens, he (the speaker) would like to add that the Company regarded the giving of free meals as a very objectionable practice indeed. Supplementary to the manager's communication concerning intricate work, he would like to impress how delicate was the operation of rifle-cutter box manufacture, yet the manager's statement would have been noticed that these were now wholly turned out by girl labour. The members would have been struck by the marvellously short time in which the women did the work compared to the men, but this

(Mr. J. Fearn.)

was simply the result of organization. Some other classes of work besides those mentioned by the manager now fell to women, as for example, small cutter making, including the setting up of their machines, and the women had been specially trained for these jobs.

The proposition of Mr. Morgan that the Institution of Mechanical Engineers should set up a Committee to report upon the best methods in each engineering industry of introducing woman labour, and cognate matters, would, he was afraid, be viewed with very grave suspicion at the present time. The Meeting would recognize that it was a matter of exposing manufacturing methods, and he was very much afraid that firms would greatly dislike and probably refuse to give information respecting their works' inside operations. If such an appointment were delayed until after the war it would be a different matter, and many of the objections to which he had referred would disappear. He did not anticipate the present extreme shortage of labour after the war, since of course the men would be returning home, although simultaneously the women would be very largely wanted back in their homes. By then, too, the rate of machine production would have been largely increased by the improvements in manufacturing methods now going on. Wages, although not the same as to-day, would be very much higher than in pre-war times, and, supposing each was equal in their capacity of output and skill, he did not suppose it would very much matter to an employer whether his workers were called skilled or unskilled. There was an enormous dislike to Government interference in the engineering trades, wherever it could be possibly by any means avoided, and he rather feared that if this Committee started to inquire at the present time there would be grave suspicion, whether well founded or not, that the Government was seeking information which producers would much prefer to keep to themselves, and his objections were based largely upon this suspicion.

Mr. W. DEFRIES did not propose to offer any observations of his own on the subject under consideration, but wished

merely, availing himself of the privilege of an old member of the Institution, to suggest that the discussion up to that point seemed to have avoided the really constructive proposals of Mr. Morgan's Paper. Mr. Morgan was clearly of opinion that after the war there was bound to be a much greater employment of female labour than before. He did not himself see how any man of experience, in daily contact with the engineering trades, could entertain any different view. It was even clearer that, if during the war more women were not employed in the shops than were now there, it would be impossible to produce munitions upon the needed scale, and at the same time to satisfy the demand of the services for men. Mr. Morgan therefore asked them to consider whether means could not be found for making better use than at present of the country's men, women, and plant, and he had presented some exceedingly thoughtful suggestions for the consideration of master engineers. The speaker believed it would be manifestly to the advantage of the trade that those suggestions, coming from so authoritative a source, should be considered carefully. He offered no opinion of his own as to whether and how far Mr. Morgan's proposals were or were not expedient; that was a matter which each firm could best determine for itself, and solutions that might be possible for one firm might not be for another. But it was clear that the matters put before them that night would have to be faced at some time or other, and a deliberate judgment pronounced upon them. Under these circumstances he could quite understand Mr. Morgan's evident anxiety to secure some pronouncement of opinion from the meeting that night, and he begged to support Mr. Morgan's appeal for an expression of the views of members, not so much on his history of the past as on his proposals for the future. Prompt criticism of the proposals by persons having the practical acquaintance with their subject matter that was possessed by members of the Institution, would not only bring out such objections as might be seen to what Mr. Morgan was proposing, but would also give the best chance of solving the urgent and difficult problems that he was attacking.

Mr. R. H. PARSONS said that, in his view, the most important feature of Mr. Morgan's Paper was the emphasis laid upon the duty of engineers to utilize labour efficiently, particularly at the present time. Labour-hours were the basis of all production, and the present shortage of labour rendered it all the more essential that every factory should give an adequate return in output for the labour-hours consumed. A few years ago, when labour and particularly skilled labour was cheap and plentiful, it could be lavishly employed without unduly increasing the cost of production. Now, however, it was perhaps the most important national asset, and our existence both during and after the war would depend more upon how much useful productiveness could be obtained per unit of man-power available, than upon any other single factor. Hence, engineers must become accustomed to think in terms of output per man-hour, and must take advantage of every method of manufacture and scheme of organization which would increase this quantity. This idea in no way involved either the underpayment or overwork of the workmen. He (Mr. Parsons) believed that in the United States the productivity per man-hour was in general much greater than in this country, whereas the workmen there earned more money, and were no more fatigued after a day's work than their confrères in this country. The American employer moreover succeeded in making very satisfactory profits in spite of the high price he paid for labour. It was almost entirely a question of proper organization, methods, and machines, and he was glad to hear the value of proper organization so remarkably demonstrated in the remarks of Mr. Fearn, who gave the experiences of the Birmingham Small Arms Co., in connexion with the manufacture of rifles.

In the old days there was too little trouble taken in the organization of work in engineering shops. Nobody considered beforehand exactly how long each operation on a part should take, or with what machines and tools it could best be performed. The details of manufacture were left too much to the ideas of the foremen and mechanics, and the management exercised far too little knowledge or control of the actual processes of manufacture.

The time for such indifference had entirely gone by, and the intelligent direction of details on the part of the management was absolutely necessary if the highest productivity was to be obtained. After peace was declared there would not be anything like the amount of highly skilled labour available before the war. Apprenticeship had suffered, and many of the returned soldiers would be unable to follow their previous skilled occupations by reason of wounds or mutilation. This situation would compel engineers to organize their factories so as to get a greater output per man-hour than ever before, if they were to hold their own under the intensive international competition which would follow the declaration of peace.

He considered the question of the efficient utilization of labour to be so vital to our success in this war that he supported most heartily Mr. Morgan's suggestion that standards of labour-hours permissible for all munition contracts should be established, and no firm should be allowed to use labour in excess of what was necessary under good organization and modern methods of manufacture. The State should be in a position to justify its labour standards by indicating in detail how the required output per labour-hour could be obtained, and it should have no hesitation in refusing labour, material, or contracts to firms who would not bring themselves up to the desired standard of productive efficiency.

Mr. W. A. BINKS found it rather difficult to criticise the Papers, as both were so well thought out. But the suggestion for a Committee of the Institution to report upon the best methods of introducing women into their engineering works, and the best methods of training them held the field as the most practical outcome of Mr. Morgan's communication, and it was one which would be certain to excite wide discussion. The suggestion, however, was not so easy of adoption as at first might appear, or even as Mr. Morgan seemed to imagine. He (the speaker) rather agreed with Mr. Fearn that there were difficulties in the way which at any rate would dictate the wisdom, even if it did not impose the actual necessity, of their going slowly in this matter, and he spoke with a

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Coventry experience. Anything in the way of compulsion especially would be sure to frustrate the very ideal which it was proposed to attain. It could not be forgotten that engineering employers, and in fact every type of manufacturer in this country engaged in business in a large way, were of a very conservative temperament and the last thing in the world they would submit to, if they were strong enough to resist, was interference in the way of conducting their business. It would be necessary therefore to go to work very carefully, and if the imparting of the information sought by the Committee were purely a voluntary matter on the part of the firms approached, he could readily understand that their difficulties would be lessened. There was no doubt that information under the head of costs especially, which the Committee might secure, would be very valuable at the present time as a guide to firms intending to put into action yet more the woman-dilution principle; and it was also not yet sufficiently known what were the exact capabilities of woman and girl labour in engineering matters, and how their performances contrasted with that of men. There was a desire on the part of many firms to possess some specific information under these heads. They would have to be careful, and not seek to go too fast, and avoid as far as possible anything which might savour of compulsion. He was persuaded that the operatives were very much of the same way of thinking as the employers on this and kindred matters. It was well to recollect that Germany was not England in propositions like this. What would be permissible and tolerated in Germany would be quite impossible in this country, and he was happy that it was so. In Germany manufacturers had no option; they had to do as they were told, but it would be a sorry day if things ever came to that pass in this country.

He was rather afraid that women dilutees would be found lacking in initiative when employed in engineering workshops. His experience of woman labour was limited; still, so far as he had been able to judge, this was the opinion he had formed.

It might be of course that when they had attained the habit of life in an engineering shop, this present defect might gradually

become removed by reason of the new influences and conditions which would be brought to bear upon their brain power, but so far there could be little doubt that, in other than exceptional cases, women lacked the inventive faculty. He would like to hear the experience of other firms upon this point, and any information which the proposed Committee could collate under this head would be a valuable asset. Many manufacturers were anxious to get all the assistance they could respecting the setting-on of female dilutees, but they hesitated concerning the means to obtain the best results. They were now passing through an entirely new period of the labour problem. Manufacturers and workers at the present moment were working more amicably, especially those who realized the menace of the enemy. Much depended on taking advantage of present conditions, both as regards the present safety and future prosperity of the country.

He was very interested in hearing the testimony of Mr. Anderson respecting the successful employment of women as gauge-makers (page 287). Such evidence was most gratifying. This was a department of skilled work to which he quite believed women might well be trained to a much greater extent than at present. Upon the subject of the employment of female labour generally, no one could doubt that the objection which was taken by the male workers at some works to this dilution largely vanished upon better acquaintance with the novelty. Experience had amply shown that, after the girls had been working in the engineering shops for two or three weeks, or it might be a somewhat longer time, the initial opposition from the men working alongside them died down. Better than this, the opposition was soon succeeded by a feeling of comradeship and chivalry which made the men anxious to do their best for the women and pilot them over difficulties which they might meet with in the course of their work. The younger men especially often proved themselves particularly chivalrous in assisting the new dilutees to surmount difficulties. If the Institution could appoint a committee to collect data on the experience of the past few years, and to endeavour to develop the more successful experiments; to encourage a far greater use of jigs

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and gauges; and encourage a more systematic training of women, he thought this would be far better than to wait for a crisis and then compel the Government to pass panic regulations.

Mr. S. J. DAVIES noted with approval the statements in Miss Monkhouse's Paper that the industrial efficiency of the country in respect to production at the present time had been greatly increased by the introduction of woman labour. Anyone who had experience of employing women, knew of the great advantages possessed by women of education. The need for improvement in the education of girls had been emphasized by the events of the last three years; and engineering employers should interest themselves in the question.

It had been stated by Mr. Fearn (page 289) that the Birmingham Small Arms Co. gave to the women in the small-tool factory an hour's tuition weekly in the use of gauges and other measuring tools which they had to use in the course of their work. This was a proceeding which might very well be extended to other firms, and he would prefer indeed that double this amount of tuition was imparted, an expenditure for which he was sure the firms undertaking it would soon be recouped by the improved quality of the work turned out and its more rapid production. The better education of women and provision for its continuation should be considered among the other points to be dealt with by the suggested committee of inquiry.

Mr. BEN H. MORGAN, replying to the discussion, regretted that the criticism of his Paper had not centred mainly around the suggestion of the desirability of finding and establishing standards of labour dilution and labour efficiency. Sir Gerard Muntz had expressed only a halting approval of the proposal for the establishment of a Committee of the Institution to study and report on the best methods in each engineering industry for the employment of women and discharged soldiers, and had thought that its appointment might be undesirable if it covered too wide a field of inquiry. If Sir Gerard's opinion were found to be general,

the Committee might confine its attention within narrower limits, perhaps, than his Paper suggested. If the inquiry were limited to a consideration of the two matters of (1) women's work; and (2) the employment in industry of discharged soldiers, it might do much useful work. Unless engineers themselves initiated some inquiry, under certainly these two heads, he felt sure they would be making a serious mistake. It would be a great error to ask the State after the war to decide these matters for them. Soldiers were being discharged in ever-increasing numbers, and the bulk of these men had been wounded, and many had lost limbs or their sight, either partially or wholly. Nothing at present was being done to study how their places were in future going to be filled, in cases where they could not return to their former occupations, what occupations men with certain injuries were most suitable for, and what devices and appliances were necessary for their training and re-employment. All these things called for minute study and discussion—and it seemed to him that engineers would be so deeply affected by the new industrial situation that they could not act a moment too soon in setting up some machinery for solving the problem.

Mr. Anderson, in his criticisms (page 287), had regarded it as an omission that the Paper had made no reference to the employment of women and girls in small-arms munition manufacture. It was not, however, an oversight; the Paper dealt with the problem of female dilution of labour as it had developed since the outbreak of war. The employment of girls as small-arms ammunition makers had been a pre-war occupation, and did not therefore come within the purview of his communication. Mr. Anderson had spoken of the success with which his company were turning out gauges by woman labour, and had mentioned that Woolwich inspectors had expressed surprise at finding that such labour was capable of this performance. He (Mr. Morgan) could quite understand the surprise of the inspectors. But he knew that at Mr. Anderson's factory some very clever work by women in gauge-making was being done.

Mr. Nasmith (page 288) had described women as mere

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copyists, and had expressed doubt as to whether they would succeed much beyond this. He assured him that this was a very great misconception, though, he was bound to admit, a misconception which was very widely prevalent. The reason why female dilutees had been employed so far mainly, perhaps, in repetition work in engineering shops, was that they could be most readily employed on those jobs—on work which was urgently required by the nation and which would give the biggest output in the shortest time. Mr. Nasmith might be surprised to know that a woman could be trained as an all-round skilled worker in less time than a man. It was a fact, and one which admitted of no explaining away, that a good many women to-day could be classed as skilled turners and fitters after only three years' training. He would not deny that there was some truth in the argument that women did not possess the initiative faculty in engineering work to the same degree as men. He was prepared to admit, as the result of experience in the shops, that it had now been established that on non-repetition work women did not give quite the same output as men. On repetition work, however, female labour had been a discovery; on nearly all classes of munition production they had exceeded all pre-war records of male labour. Nevertheless, he was very pleased with the criticism which had been indulged in, since it was only by a free and fearless interchange of ideas that they could arrive at sound basic truths and possess themselves of any advance in knowledge and practice concerning female work.

He was seriously afraid that in considering the female labour problem, sufficient realization was not often had to the probable long duration of the war. He did not wish to pose as a prophet; yet he was fairly convinced that the country still had before it a very long period of armed conflict, possibly running into several years. Face to face with this situation was the admitted fact on all hands that the shortness of labour was very rapidly increasing. The whole question of a more drastic handling of the labour problem as it at present presented itself would have to come up for the consideration of the Government at no distant date. He had

listened to the remarks of Mr. Parsons (page 292) with the closest attention. It was perfectly clear that something in the way of rationing of labour, in the same way as works materials were rationed, would have to be attempted by the State. The variation of practice concerning women employment in even the shell-making shops in the Birmingham area was absolutely surprising. Some employed practically no women at all, while at other shell-producing concerns female labour formed something like 90 per cent. of the total workers. Again, some of the tool rooms in the Birmingham district had scarcely any women on the ground, while at others women and girls formed 25 per cent. of the total. He quite agreed with Mr. Parsons that all this would have to be altered in the early future, and that labour dilution methods would have to be strictly utilized. He would like to say to the credit of works proprietors that he had never yet found a firm which was not willing to make sacrifices when called upon by the State, always providing that other firms—or, if the term might be allowed, other competitors—were compelled to do the same. And he entirely believed that this patriotism by master engineers and other manufacturers could continue to be relied upon. The difficulty in the future lay in the fear of exceptional treatment. Obstacles were, and would continue to be, placed in the way of the employment of female dilutees by individual firms, if other firms in the same district, and perhaps only a little distance away, refused to employ women. But providing the same law were to be made applicable to all firms, he did not conceive that any difficulty would arise. Man-power economy was one of the problems which would certainly be made, he believed, a matter of compulsory solution sooner or later.

Some time ago the Ministry of Munitions established a labour dilution standard for the manufacture of shells, up to 4·5-inch size. In the contracts which they placed for this size of shell, it was compulsory on all contractors to employ 80 per cent. of female labour in the production. In the last issued Government Report dealing with labour in controlled establishments, particulars were given of ten factories devoted to the manufacture of 18-pounder

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shells; and, with only one exception, all these ten firms had employed more than the standard dilution. The lowest percentage was shown to have been 81 per cent., and the highest 86 per cent. The machinery and plant employed at these ten works showed a most remarkable variation, and yet the labour dilution effected had been nearly equal throughout. It was an astonishing thing, which had been abundantly shown by statistics, that in most of the National Shell Factories the output had increased rather than decreased with growing female dilution. He would now illustrate the case of the manufacture of 9·2-inch shells, respecting which no compulsory dilution of labour had been attempted. In the Report already quoted three factories were specified as manufacturing the larger shell just spoken of, and the percentage of women employed was respectively 4·2 per cent., none, and 49 per cent. Here then was an enormous difference clearly established. Of his own knowledge, he (Mr. Morgan) could testify to a munition works on 9·2-inch shell where the female labour employed amounted to no less than 90 per cent. of the total, and in another shop equipped with the latest tools, not a single woman was employed.

From the figures which he had quoted, the Meeting would recognize how much more satisfactory it would be in the end to arrive at something in the nature of a standard of female dilution rather than that the present intensive differences should continue to be perpetuated. A common standard would ensure not only that the sacrifices made by individual firms should in future be equal, but that each manufacturer would be in a far better position than now how to plan his individual works organization to a successful issue. Further, the Government and contractors would be able the more successfully to estimate the exact time which the execution of any one contract would occupy; and each party to the contract would know the respective cost and profit.

He would like to add that he was quite of the opinion expressed by Miss Monkhouse that the employment of women would materially increase the future industrial efficiency of the country. Previous to the war there was a very large proportion of the population consisting of women, who were, for the most part,

non-producers, and totally unprepared in education and training of both mind and body for taking a useful part in the world's work; but the war had altered all this, and to-day it was a revelation to very many people how efficient these dilutees had become in the short space during which they had been on trial. It was no exaggeration to say that England stood a free country to-day, because of her women's noble efforts in the realms of engineering the industry.

On the motion of Mr. A. E. A. EDWARDS, seconded by Mr. R. B. ASKQUITH ELLIS, a hearty vote of thanks was passed to Sir GERARD A. MUNTZ for presiding, the proposer remarking that Sir Gerard had had a large experience of women and girls' work in association with the production of war material in the Birmingham district. They could therefore have not possibly had an abler chairman for the Meeting that evening.

The CHAIRMAN (Sir GERARD A. MUNTZ, Bart.), in acknowledging the vote, said that it had been rather against his conscience to occupy the Chair, since, owing to the very many duties with which the Government had kept him active during the past four years, he scarcely thought he had been able to attend the Meetings of the Council in London more than once or twice, which was to him a matter of considerable self-denial and regret. He had felt, however, that the question of woman's work since the war was one which was not generally sufficiently appreciated by the "man-in-the-street," and he had therefore been anxious to do anything he could to show his great interest in the Papers which had been read. The patriotic manner in which women had come forward in the nation's extremity to occupy the places of the men from the shops, who had gone to the Front, was beyond all praise. Their conduct had been magnificent, a fact which could not be too widely recognized. The women had made extraordinary efforts, and they had surprised everyone by the capacity which they had shown. Without their aid, it would have been impossible to continue the carrying on of the engineering and manufacturing interests of the

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country, and as for their work as munition producers he had no hesitation in saying that but for the women and girls the country would have "gone under."

Upon the motion of the CHAIRMAN, the best thanks of the Institution were awarded to the Birmingham University Authorities for allowing the use of their Lecture Theatre for the purpose of the Meeting.

Discussion in Manchester, on 10th May 1918.

The CHAIRMAN (Dr. EDWARD HOPKINSON, *Member of Council*) said that this Meeting of the Institution was a somewhat remarkable one, as also were the corresponding ones held in London and Birmingham. It was the first occasion in the history of the Institution on which a Paper had been read by a lady. What that might connote as regards the future of engineering he did not know, nor was it their present business to inquire, but in passing it was fitting to say that it did mark, seeing that both the Papers were essentially War Papers, the splendid part women had taken in the prosecution of the war.

The occasion was also a special one, because the Council in selecting the two Papers had gone somewhat beyond what were previously regarded as the usual lines on which Papers should be written and subjects dealt with. He welcomed this, as he felt strongly that the activities of the Institution ought not to be limited too strictly to purely technical accounts of engineering work accomplished, or new plant, new devices, new inventions or results obtained; and that they might be extended to a wider sphere and take into consideration such subjects as labour organization in workshops and other broader aspects of the engineering business and profession.

Passing to the particular subjects of the two Papers, he hoped that those who took part in the discussion would restrict their remarks to their own experiences. The employment of women in engineering shops on the scale that they were now being employed was a great national experiment, and none of them could forecast its future development in the least degree. They were almost debarred by agreements made by the Ministry, upon which the effective employment of women was based, from attempting to formulate schemes for the application of the present development to future work. That made it all the more important that all the data it was possible to obtain from the experiment now going on should be duly recorded in serviceable form. But in recording the experience gained in particular workshops, there was this difficulty, that those experiences frequently had not a common denominator. One person might achieve success in a particular line and attribute it to causes which were not the real causes. With the same causes in operation, another person might have met with failure for reasons which were not apparent. In that respect the Government Departments, and especially a Department like that over which Mr. Morgan presided, could be of great service. A Government official in Mr. Morgan's position had access to all engineering works and to all their records, and he could reduce the work in the different shops to a common denominator and make sure that the conditions under which the results were obtained and recorded were the same.

Mr. Morgan suggested that labour efficiency standards should be set up for particular operations in various classes of work. It would be most valuable to find out the labour cost on, say, a 4·5-inch shell, assuming that the best of every process in use throughout the country was collated. An eclectic score was an extraordinary record and very different from that of a scratch player. None but a Government official having access to all works could put together an eclectic score for any piece of work, and that was what should be done, because it gave the ultimate standard to work up to. But working conditions varied so much in

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(Dr. Edward Hopkinson.)

different shops that comparisons were often very difficult. For instance, he noticed that the 6-inch shell was held to be suitable work for women, having regard to the weights to be lifted. He was horrified at the idea of women having to lift weights of over 60 lb. His own experience was based to some extent upon Lancashire factory women, who, no doubt, had not the physique of women drawn from country districts, and he would say that the 4·5-inch shell, having a gross weight of 55 lb., was about the limit which women could lift without risk to physical health. There again it might be that the common denominator was not present, and when people spoke of the 6-inch shell being worked effectively by women it meant that the lifting work (as it ought to be) was done by machinery.

The work of women in engineering factories was no new thing. In electrical work women for a long time had been engaged in such work as armature winding. Many firms had large experience of the employment of women. But its enormous extension had brought about many things in its train, which he thought were reacting upon the organization of engineering shops in general, and reacting altogether for good. It had introduced the Women's Welfare Superintendent. That, he believed, had had an exceedingly good general effect throughout shops generally. It had brought employers to realize, and the Government had emphasized it in every way possible, the importance of welfare conditions generally, and perhaps in some instances under pressure from the Government, perhaps from the fact that they knew that they were employing women to a much larger extent than previously, employers had responded by the introduction of better hygienic conditions which had come to stay, and would be of great advantage to the engineering trade in the future after the war.

Mr. G. E. WINDELER said that in their own Works they had, through the intervention of the Ministry of Munitions, adopted women labour to some extent. The Works were largely concerned with the manufacture of engines, and about eighteen months ago one Department of the Ministry approached his firm to design an

engine for a special purpose in such a manner that it could be produced in large quantities, with a fair proportion of unskilled labour. The best means of production were to be utilized, such as jigs, special fixtures and devices. Four firms in the Manchester district were asked to co-operate, and he was glad to say that this co-operation had been carried out in an excellent manner, and that some of the points laid down by Mr. Morgan in his Paper as to standardization regarding methods of production in various Works had been more or less adopted. This was carried into effect by a free interchange of ideas as to the methods of production proposed by each of the firms, and although these various firms were rivals in business before the war, arrangements had been made for each to visit the others' respective Works and see what they were doing, and their respective staffs to interchange ideas freely for the development of production of the various parts. This naturally resulted in practically a standardization of the methods of production in each of the Works and an accelerated output of the engines required.

When they first introduced women labour they mentioned to the workmen in their employ that vacancies were available for women labour, and suggested that their own relatives might make application for the various posts. This was attended with very satisfactory results, and care was taken to allocate the women labour in each particular department so as to see exactly how they were able to cope with the work. For instance, they were employed in the tool stores, in the issuing of tools to the workmen, and very quickly learnt the names of the various tools, such as taps, reamers, mandrels, and similar light classes of tools, and the distribution of same. They were also employed in the tool room on hand-scraping work, small shaping machines, drilling machines, and tool-grinding machines. As the introduction of this class of labour increased, they were put to work on small brass finishing lathes, milling machines, drilling machines, precision grinding machines, as labourers on the floor for keeping the floors clean, and moving about light classes of work. They were also employed on cleaning and painting the interior of engines, and also cleaning down and

(Mr. G. E. Windeler.)

painting engines after trials. They were then used to operate electric cranes from 10 to 20 tons capacity. This was a duty about which the firm felt somewhat nervous, so the women were trained in a separate part of the Works where the lifting of parts was carried out under quieter conditions; and someone was employed to train them who knew thoroughly the working of the crane and who would illustrate simply how it was operated. The results of the experiment, so far as the crane driving was concerned, had given much better service from the cranes than they had had before. The women seemed to be much more attentive and on the lookout for the signals and necessary requirements of the shop. If there were any exceptional weight to be lifted or turning over of heavy parts to be done, the firm generally arranged for one of the men supervisors to help the women. One difficulty occurred and had to be thoroughly considered, and that was the provision of facilities for enabling the women to climb to such heights to get on to the cranes. This was rather a problem, and after careful consideration, a small portion of the floor at each end of the shops was appropriated, and a suitable reasonably-graded staircase and platform were provided so that the women could climb up to the crane tracks easily, and readily step off on to the crane seats. The result of this arrangement had been very satisfactory.

Later, an extension for a more rapid production of the various parts was undertaken, and practically the whole of the work carried out in this portion of the Works was done by women labour. Various types of machines were grouped together, such as drilling machines, milling machines, gear-cutting machines, and semi-automatic bar machines. The women were supervised by skilled charge-hands or assistant foremen, who were attached to the staff. As setters-up, superior apprentices were utilized, but in some cases this class of labour very quickly became unsettled, as the work, no doubt, was monotonous. The idea of using these apprentices was to enable promising young men to prove their initiative and ability to organize or assist in the organizing of work and handling of workpeople. In the fitting-up work, woman labour was used for studding bedplates and columns, and fitting up small parts. It was

also utilized for filing off the raw edges formed by the various machining processes and for the assembling together of small fitted work. It was found in these sections that a woman charge-hand was quite satisfactory. Again, very satisfactory results were obtained by woman labour in the Inspection Department, where they showed great patience and efficiency in the inspection of work by gauges and micrometers.

When the Ministry decided that dilution was necessary, they assisted them in a very admirable way by pointing out the work which women could be put on to, and at the same time allowed them a reasonable period to bring this class of labour into operation; that is to say, they did not force them to put fifty or sixty women into a Works at one time, but allowed them to be gradually introduced and graded up to the work as they obtained the necessary skill. From the advice received from the Ministry, and the assistance given by the foremen and charge-hands in their works, the results obtained had been on the whole very satisfactory. Of course there had been troubles and difficulties, but these were overcome by patience and diligence, and by studying each difficulty as it occurred and making provision for it.

Mr. JOSEPH BUTTERWORTH said the adoption of women labour had been a great advantage during the war from points of view that had not been touched upon in the course of the discussion. Owing to the scarcity of labour, the individual had not had any need to think about "keeping his job," as the term was in Lancashire. He had absolutely no anxiety about it, with the result that discipline was practically an unknown factor in engineering shops in the Manchester district. In fact, it was practically necessary to go to a man, cap in hand, if they wanted to get anything from him. The output of any standard article had certainly not increased since the beginning of the war, using the same tools and adopting the same methods. One would expect it to be so, because if a man was under no anxiety as to the chances of keeping his situation, naturally his thoughts would unconsciously relax to that extent. In practice that had been found to be so.

(Mr. Joseph Butterworth.)

The introduction of women labour had been a great benefit, and he had been able to make a comparison. Women had been put on a job similar to what a man had been on—a light job but at the same time an accurate one—and he could point to cases where the women did double the work a man ever cared to do. He did not wish to say a woman did the work a man could do, but double the work it was usual for him to do under ordinary methods, and with restricted labour which obtained in all engineering shops in this country under trade union methods. The employment of women had been a very useful factor in breaking down that restriction of production to some extent, and but for that fact, manufacturers would not have been able to turn out several articles they were making, with the same facility and as cheaply as they were doing.

The success of rationing of labour, dilution efficiency, and so on depended upon each firm adopting exactly similar methods, and that was necessary if anything like collateral results were to be obtained. Mr. Windeler had pointed out several instances where the employment of women had proved advantageous, but he was afraid it would be difficult to set up a common denominator, or to differentiate between various firms, because one tool made specially for a certain job would turn out far more work than another tool which had to be used for practically twenty different jobs. A large firm could have a special tool for each separate job, and therefore in that respect it would be difficult to differentiate. In that way large firms ultimately had the advantage, and it was in that connexion that the collaboration of various firms had proved to be one of the finest things ever introduced, and he hoped it would be carried out to a much greater extent than at present.

The old idea of secrecy and jealousy in regard to trade processes and the restriction of production, which was so extensively practised in this country, must go by the board. It was easy to point out those facts to the ordinary working man—he had done it with his own—but it had very little result. Even in the best managed shops it generally cost as much to keep a man going as he was paid in actual wages. If a man were paid 1s. an hour, it cost 1s. an hour to keep him going in the way of standing charges of

various kinds. If a man would only put forth an effort to turn out double the work every day, he would reduce the percentage of standing charges by one half, because they would be just the same whatever amount of work was turned out. If the American system were adopted, and a man who did double work was paid at time and a quarter, that is, two and a half times the standard wages, the firm would still have something in their pockets in the way of a saving, thus enabling them to compete more keenly for foreign trade. Some method of that kind would have to be adopted in this country, before they got right down to rock bottom as regards the cost of production.

He could not usefully go into details of the various departments as Mr. Windeler had done, but he might say that they had introduced women into their stores, tool room, foundries—both iron and brass—grinding shop, dressing shop, brass finishing shop and pattern shop. In every case their experience had been satisfactory, and they would do their best to continue it as long as they were allowed to do so. It was a thing that would right itself, even if they had to keep to the letter of the agreement that was made in the early stages of the war, to abolish all woman labour at the end of the war. He did not see how that was going to bind a firm who started after the war; if it were found that cheaper production might be obtained by the employment of women, he did not see anything that would prevent a firm starting *de novo* and using woman labour.

Mr. W. W. ADAM said the war had revealed to them many occupations where women could be employed with great advantage, and no doubt after the war they would continue to fill those occupations, because for some classes of work, women were more suitable than men. Some years before the war he had experience of women labour in connexion with a special manufacture, to which it was extremely difficult to train them. Women had to be brought from France and Belgium to teach the English women how to do the work, but after considerable time and expense they learnt it very well, and were now able to do it just as well as the others.

Mr. OSCAR S. HALL said he agreed to a great extent with the remarks made by Mr. Butterworth on the question of production. Every effort should be made in the future to secure unrestricted production in all engineering works, or the country would be relegated to a very low position in the economic world.

Mr. HAROLD SMITH, M.B.E., said the experience of his firm in the employment of girls started long before the war. At that time those girls were engaged principally on light repetition work and on winding and insulating electrical apparatus. The number employed had increased from about 5 per cent to probably 30 per cent of the total employees, and they had been successful mainly on light machine-work, fuses, bombs and shells. Women had also been employed on heavier work, but, as that was more of a jobbing nature and largely on adapted plant, the firm was not able to make the fullest use of them. It was difficult to extend their use to work which was done in pre-war times for commercial purposes, and was now done, in the same form, for direct and very important war purposes, because the men in the shop, to whom the article appeared just the same as that made in ordinary times, had an instinctive objection to allowing dilution on the job, even though it might actually be far more important to the war than a gun or a shell. Many firms had found that it was only on work which was obviously of a war nature, such as guns, shells or fuses, that the men gave that loyal co-operation and help in training women which was absolutely necessary to make dilution successful. On many jobs women had not the *nous* and natural ability a boy possessed, to grasp the nature of the work to be done; if everything was prepared and mapped out for them, they could go on doing it in a repetition sort of way, but they had not the faculty of spotting things when they were going wrong. On piece-work, more inspection of output was necessary than in the case of men and boys; they were very keen on big wages and were apt to slip through work which was not up to the mark. His experience was that they did not keep as good time as men; in fact, he knew of one shop in the Manchester district where it was considered

necessary to have 25 per cent more women on their list than they could actually use, because they always assumed there would be somewhere about that percentage absent, and by making that provision they could keep their plant going at full capacity.

Single women, in his opinion, were much easier to manage than married women. At one time his firm employed a great many soldiers' wives, and they were often rather difficult to deal with, but single girls were more amenable to discipline. Speaking generally, the work for which women were suitable had to be highly standardized; they had really to be made into operators (with everything mapped out for them) and not machinists.

With regard to Mr. Morgan's standards, some of the ideas put forward in the Paper would press very hardly on firms which turned out war contracts on adapted machinery. In the early days they were told, in connexion with shell work, that they must not wait to buy new machinery, but must adapt what they had and make it do the job. That was done very largely in the Manchester district, and firms which adapted their plant to the greatest extent, speaking generally, got away the quickest with their production when shells were very badly wanted. As time went on this adapted plant deteriorated; meanwhile permits for machine-tools had come in, but they were unable to buy new tools, though they knew what they wanted and where their weak places were. Piecework time rates had been set, and by agreement they must not be altered, so that most firms were face to face with the facts that their rates were set, their wages were going up on account of increases, the prices of shells were going down, and they were not allowed to buy new plant in order to improve their methods. That was the experience which many firms had had in the Manchester district. The "time-and-line" system seemed to him the only possible way of starting up some of the new work-jobs such as gunwork—where people had no experience at all to guide them. They themselves had to convert a 15-inch shell plant into a 6-inch gun plant. They could not tell definitely what the job would cost; in fact it needed considerable ingenuity to make the plant do the job at all. Mr. Morgan spoke of grading out firms by an index number,

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and proposed to allot the supply of labour accordingly. Such grading out of firms should also apply to workers, and the system should work both ways. He was particularly interested in figures for the number of female operators considered possible in gun-work up to 8-inch howitzers. He had been in a number of the large gun-shops in the country, and he could not say that any of them had anywhere near that percentage, not even firms directly under Government management.

Mr. A. E. HOWELL said he had had women working on shells for the last three and a half years. The largest shell they had been engaged upon was the 6-inch, and for two years he worked them in 12-hour shifts, with very little sickness. Later he went on the 4·5-inch shell, and the women did every operation in the shop including the labouring. There was not a man on a machine, and there were only two male tool-setters per shift. In fact, the women were doing the tool-setting, and could perform any operation provided it was a straightforward job, and was mapped out for them; but if they encountered anything that was out of the ordinary, the result was deplorable. His experience was that they were difficult to handle and apparently had, should he say, no conscience. As viewers and examiners they were very good, but he could not agree with a great deal of what had been said in regard to women having a delicacy of touch; it took them all their time to use the horseshoe-gauge properly. Women he found were bad timekeepers, and the only way to deal with them was to give them a week's notice if they stopped off two days.

Reference had been made to a chart for shell-making. There had been one in existence in the Ministry for two years, giving the lowest time for every operation on any known shell produced in England. On the 6-inch shell women were engaged on every operation after rough boring, but it was considered necessary to install small cranes for lifting purposes. In their works women had stood for twelve hours (ten and a half hours actual working time), and in the early days of the war, in 1915, they did this for five months; the conclusion he came to was that, provided the

women were of a suitable physical type, there was not much difficulty in doing the work.

Mr. G. W. COOKE said he would like to give his views on the different operations upon which women were engaged. Taking Lancashire first, the women working at the collieries were very efficient and often better than the men; and on the machines for cleaning coal, and various other appliances, they were better than boys. He had had about twenty-six under his charge. It was true they were more difficult to handle than men, but on inspection work, such as examining screws, threads, bolts, and using micrometers they were equal to the men. In one case he had to call a man to account because a girl engaged on the same class of work was doing twice as much as he was. He (the speaker) saw no reason why the girls in this country should not equal the girls and women in other countries, such as India, French Indo-China, the Philippine Islands and China, where female labour was the rule. Particularly in machine-shops, they were quite equal to the men.

Mr. BEN H. MORGAN, replying to the discussion, said that Dr. Hopkinson referred to the heavy work the women were doing in the way of lifting shells, and so forth, and very rightly called attention to the danger involved in such a practice. He agreed that in the operation of machining shells a woman should not be called upon to lift continuously any size of shells over 4·5 inches. Mr. Howell had stated that in his shop women had performed all the work, including lifting, on 6-inch shells after the rough boring, and were engaged for as long as twelve hours a day for seven days a week for quite a long period. That was an undesirable case of employing women, which he would not wish to see repeated in any shop. As a point of interest, it was very seldom a group of women could be found who were capable of standing such strenuous work. On the other hand, there was a great difficulty in employing women on work between 60 and 80 lb. in weight, and from the point of view of economics in shop production, it was doubtful whether women could be economically employed on work between those

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weights for the reason that, if handling appliances were fitted, a strong woman would prefer to lift the material into the machine herself in order to save time. He had known cases of 60-pounder shell shops, where the pulley-blocks of the handling appliances provided had been tied up away from the machine by the women, because they preferred to handle the forgings themselves, but in the long run it did the women great injury, and the practice ought everywhere to be discouraged.

Dr. Hopkinson expressed the opinion that good welfare conditions were a paying proposition. He (Mr. Morgan) was quite sure that the degree of efficiency in the employment of women would always coincide with the provision of first-class welfare conditions.

Mr. Harold Smith's experience with regard to bad time-keeping of women was in opposition to the accumulated experience of firms throughout the country. The time-keeping records which he analysed some time ago for the Hours of Labour Committee showed that women behaved better in that respect than men, and lost less time both from avoidable and unavoidable causes. Mr. Howell also suggested it was a fallacy to say that women had any delicacy of touch or could do finer work than men. That again was in direct opposition to the experience throughout the country. Women could do extremely fine work and were better adapted to it than men. They became used to the finest limits very rapidly, and could be taught to read instruments quicker than men. That at any rate was his experience.

With regard to points concerning standards, made by Mr. Butterworth and Mr. Harold Smith, both speakers seemed to think that there would be difficulty in applying standards fairly to manufacturers using adapted plant, or to those firms which were under comparatively small contracts, compared with the large firms using highly specialized plant and turning out very large quantities. But while it must be presumed that the standards would conform to conditions with regard to adapted plant, and indeed to other conditions obtaining, the effect would always be to promote the flow of contracts to the most efficient factories.

Mr. Harold Smith also referred to the difficulty of working outside "time-and-line" methods on gunwork which had to be carried out on adapted 15-inch shell plant. But if the contracting department sent out full information and sufficient drawings to enable the plant to be adapted, that together with details of all operations and methods of subdivision would make it possible to get out the cost quite accurately.

Mr. HAROLD SMITH said that the information was not available at that time.

Mr. MORGAN replied that this gun-lining work on heavy shell lathes was not a new practice. It was work which had been going on now for some considerable time, but probably Mr. Smith was speaking of an early experience. He quite agreed that where it was an experimental job, the "time-and-line" method was inevitable where the work had to be done very hurriedly, but it was still being employed by various Government departments for products which ought to have been standardized long ago.

Then Mr. Smith referred to the gunwork dilution standards mentioned in detail in his (Mr. Morgan's) Paper. Those standards were based on actual cases, and were less than were being carried out by individual firms. He would be very pleased to give Mr. Smith the actual cases and to arrange for him to visit the firms.

He thought he had covered the points raised in the discussion, but, in concluding, he would like to refer to the question of setting up a Committee of the Institution of Mechanical Engineers to study women's work, its subdivision, and its value in production, and to ascertain how maimed soldiers were to be employed in industry in this country. These were very important questions which affected the organization of every works in the country. Men were now being discharged from the Services in large numbers every month, and they would be a charge upon this country unless steps were taken to train them and introduce them into works. To ascertain their bench and machine

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value, and to tabulate all the information necessary about appliances and machine adaptation, was, he thought, the work of a technical institution such as the Institution of Mechanical Engineers. The numbers discharged would be considerably greater in the very near future, and these men should not be lost to industry in this country. The Germans, right from the start of this war, set up elaborate training arrangements for discharged men, and as they had been released they had been put on productive work. Practically nothing had been done in this country. There were one or two organizations like the Lord Roberts' Workshops, Roehampton Schools, etc., which were totally inadequate. These men, instead of being a producing element, and living under much happier conditions, would become a charge upon the country if Government departments were left to do the whole of the experimental training and re-training work. He thought it was a great opportunity for such a body as the Institution to take up and study this question now—not to interfere with the machinery of Government or the distribution of these men in any way, or the wages they were to be paid, but to provide the data and information necessary to show what work every type of disabled man could profitably do in industry, and how that work could be carried out in the shops by improvisation of limbs and adaptation of plant.

After the London Meeting at which his Paper was read, he received the following morning a communication from a well-known manufacturer—who desired to remain anonymous—offering to the Institution £1,000 towards the expenses, and he had no doubt that other large sums could be collected if the Institution set up a Committee to investigate the whole subject thoroughly as he thought it deserved to be.

A Vote of Thanks to the Author concluded the proceedings.

Communications.

The PRESIDENT wrote that much had been said about ability and something of the inability of women to perform engineering operations, but very little about the expediency of thus employing them. The last sentences of Miss Monkhouse's Paper were the most important, and they had not received the attention they deserved. The wealth and strength of England depended on the number of her children, the care they received in early life, and their subsequent moral and intellectual training. If, after the war, when the present necessity for employing women to do men's work would be less urgent, they allowed motherhood to be put into competition with 40s. a week, he feared the results would be disastrous. While they thanked the women who were helping them to win the war, for their energy and devotion, he thought the worst return they could make them would be to encourage them to undertake men's work; rather their aim should be so to raise men's wages that there should be no need for women to give up their natural functions.

Mr. J. POLLOCK BROWN wrote that, though not able to criticize Miss Monkhouse's Paper, he would like to record his experience and appreciation of about 800 women employed on light class engineering work, including machining on automatic tools, semi-automatic, and capstans, drills, etc., also electrical winding, bench work, riveting and assembling aircraft appliances from stampings, inspection with limit-gauges, etc. The bulk of the women had been placed in separate departments from the men and boys, with educated forewomen and charge-hands, and carefully chosen skilled tutors or supervisors, also a proper supply of suitable tools and jigs. The results had been very satisfactory, and the avoidable time lost was under 2 per cent. Day and night shifts of 8½ hours (actual working) had superseded the 3-shift system with benefits to all concerned.

The advent of women had no doubt forced engineers into "manufacturing" lines which necessitated the use of real skill in

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designing, planning the work and supplying the necessary shop appliances. Women were not so irresponsible as boys, and could do exceedingly well on repetition work, even of such high order as was necessary in aero-engine parts.

Mr. Morgan's Paper gave food for much thought, as the labour item had always been a most elusive one in estimating, unless payments by results were accepted by the workers. As a reliable standard of shop efficiency should include all indirect charges, the statement of men or women hours would be misleading. One factory through extra equipment and supervision might be able to reduce the woman-hours for certain work, but the total cost might exceed another factory with less face efficiency of woman-hours. Women had undoubtedly won a position in "manufacturing," but only to a limited extent in "making" of engineering products, but the degree of success lay more or less in sympathetic management.

Mr. C. J. BOWEN COOKE, C.B.E., wrote that, with regard to the suggestion of a Committee to study the best way of training discharged soldiers, including maimed* men, the following were definite cases where positions had been found in the Locomotive Department at Crewe for discharged soldiers unable to resume their old occupations: a fitter, formerly employed on locomotive repairs, now having a paralysed arm, is acting as a sanitary attendant; a general labourer, now having an injured arm, is acting as a traverser driver; another general labourer, having lost the right arm above the elbow, is now acting as assistant in Shop Tool Stores.

In one or two cases where men had lost an eye, they had been allowed to resume their old positions, subject to their agreeing to wear suitable goggles for the protection of the remaining eye while at work.

Mr. JAMES F. DRIVER (of The Technical College, Loughborough) wrote that, from his experience, the success of women in munition

* See also Colonel Pringle's Report to the Board of Trade, giving schedule of occupations on railways which it was considered could be well performed by men who had been injured in various ways.

work depended almost entirely on the attitude taken up by the employer, foremen, and other skilled workers in the factory. The employer and his foremen were often much alarmed at the prospect of maintaining output whilst skilled youths were being called to the Colours, and their places filled by women, and it said much for the patriotism of all concerned that so much had been accomplished. It was generally conceded that shell-turning and single operation jobs of similar character could be done by women, but few realized that, with suitable training, women could be employed on work requiring far more skill and resourcefulness.

At the Loughborough Instructional Factory, which now formed one of the departments of the Technical College, women had been successfully trained for practically every branch of engineering, from the drawing office as "junior draughtsmen" to aeroplane-engine testing, but the class of work in which they had proved astonishingly successful was gauge-making and precision grinding. This was probably due to the fact that women had infinite patience, and once they realized the degree of accuracy required, could be relied upon to attain this standard. That this theory was true might be shown by the fact that many women had been trained and placed with various firms of gauge-makers for such work as lapping and finishing flat, cylindrical, and screw-gauges, and to such women, the question of working within a limit of two ten-thousandths of an inch, presented no insuperable difficulty. The same remarks applied to the employment of women on light woodwork, such as aeroplane ribs, wings, etc. With extended training, some women made very fair tool-setters on capstan and other lathes, but as the value of a tool-setter depended largely upon the number of years which he had been engaged in engineering, and therefore the amount of experience he could bring to bear on any problem, it was obvious that women could not be expected to compete with engineers in this class of work, but it was only fair to remember that these remarks would apply with equal force to men dilutees.

Miss G. T. LEWIS wrote that having had some experience during the war in handling and instructing woman labour at bench-fitting,

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she thought that the views of a woman who had taken up engineering work during the war might be of interest to the Institution. During the year in which she had charge of this fitting-shop, some 200 women passed through her hands, and of these quite 25 per cent showed distinct mechanical ability, the latent instinct for this class of work making itself apparent in many cases within a fortnight, when the right kind of instruction was available.

An important part of the intensive training to which women had been subjected on munition work, was the acquisition of the trade vocabulary, for it must be remembered that the training period had been cut very short, and that facilities, extending over several months in the case of boys and apprentices, had been thereby curtailed. The girl trained had to learn the meanings of many strange words, such as the *gauge* of sheet-metal for its thickness, a *radius* used for a curved surface, *square* for at right-angles, and so on. What lad at the same age would know a gore from a gusset, a hemmed-and-felled seam from a tuck, or the meaning of terms like bias, basting, or whip-stitching? Not only was there the terminology of the operations to be learned, but there were names of tools and appliances as well as those of the parts of the work to be mastered, and, in the case of more advanced girls, it was necessary that they should learn to read drawings, to mark off work, and to use the micrometer and other measuring appliances.

The lad who was to become an engineer started his apprenticeship, say, at the age of fourteen, and for five years thought and worked for nothing else than engineering, apart from a reasonable interest in games and sports. These years from fourteen to nineteen were the acquisitive years, when the brain was most receptive. For the girl, the conditions for the same period had been quite different; she had been engaged perhaps in an office, writing shorthand or typewriting, or both, or doing monotonous household work such as sewing, cleaning, or cooking, and at the end of the day's work she probably had to help her mother with the younger members of the family. If this preliminary training of the material from which our women munition producers had been drawn, had left them with

so high a power of adaptability to the new conditions of work, was it not reasonable to expect that girls, if given the same facilities as boys, might become really efficient engineers?

It was true that the present system of training made efficient producers in specialized and rather narrow fields of work, and it was not to be expected that women could attain to all-round knowledge by any short cut, such as might be assumed to exist from the successful results obtained by the specially directed training of to-day. To force the pace so as to acquire the necessary all-round knowledge of the professional engineer in a much reduced time, would probably require so large a specialized staff of instructors as to be prohibitive, and the strain on the learners would prove too heavy for any but the strongest; nevertheless, it appeared from the progress made by women as compared with lads who had spent two or three years in the shops, that the new methods of training might be applied to boys with equal advantage.

The most satisfactory results in training women had been obtained so far by instruction under sympathetic male charge-hands; it was hardly possible, even at present, to state whether better results could not have been obtained by women instructors, but, of course, such at present were extremely rare. On the other hand, it was certain, and was borne out by the experience of all who had visited many factories, that the most efficient shops, from the point of view of production from women labour, were those supervised by women, and where a broad-minded welfare superintendent was in charge, for whom the girls would feel full respect and confidence, and to whom they would turn without hesitation in trouble.

The successful employment of women was also dependent on local or shop organization, which required modification from the conditions which obtained when men only were employed. These were not merely the provision of stools for seating and of short breaks during the working hours for rest, but more important matters such as the choice and powers of the charge-hands, the lay-out of the shop and broad questions of principle such as the desirability of separating the women's shops entirely or as much as

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possible from the men's. Much better production was obtained when the number of women in any individual shop exceeded the number of men, and in cases where trade prejudices were feared, it was often better that the women's work be carried out in an entirely separate building.

The broad question of whether women could enter the engineering profession in the future could not be answered till further experience was available of women whose engineering education had been acquired under conditions parallel to those prevailing for men. Given equal advantages, was it not possible that women, who had already made their mark as artists, musicians, and doctors, as architects, surveyors and in business, might attain to positions of eminence and responsibility in the engineering profession?

Mr. DAVID A. SHERET wrote that he considered it a bold step for any woman to pose as a judge in engineering products at the present time. He most thoroughly appreciated what the women had done, yet the use of women's best work had not been judged in a clear and unbiased way. It was quite true that the skilled men had to do the technical training of the women, and to sectionalize their work, etc. (page 214), but much ill-feeling was created because the wages received by the women were out of proportion to the earnings of the skilled mechanics; and a little further on in the Paper Miss Monkhouse stated that in the hands of the skilled men was "largely the power to oppose and retard all progress by women on skilled work." He (Mr. Sheret) did not know to what skilled work the Author referred, as, although he had visited many munition works, he had found women engaged mostly on machines or on other work that in no degree could be qualified as "skilled work." It was usually admitted by most women students that they preferred a man professor to a woman, although the teaching profession was particularly adapted to women with broader views. The present time was not a favourable one for judging what possible claim a woman could put forward to permanent usefulness in engineering work especially applied to shop operations, but there could be no gainsaying that she could and would prove herself

useful in engineering, or chemical laboratories, or in the scientific departments, where thorough knowledge of mathematics was needed. Miss Monkhouse seemed to think that Utopian conditions would be arrived at if women were appointed to engage labour, and that engineering administrative powers could be gained in a few months which had taken men years with diligent effort to acquire.

Mr. W. W. H. WARNEFORD wrote in reference to the employment of discharged soldiers, mentioned by Mr. Morgan (page 257). In the Wagon Department of the London and North Western Railway at Earlestown there were very few openings which would afford suitable work for men who unfortunately had been crippled. With respect to the actual repairing of wagons, owing to the amount of lifting and climbing that had to be done, there was very little that a man could do unless he was only slightly injured. He would suggest, however, that fitters, turners, millwrights, joiners, carpenters, and the like, who were unable to perform light work in connexion with their respective trades, would be very suitable as charge-hands for gangs of loaders or lifters, or over stores-counter men; and, according to the nature of their injuries, they could work on suitable machines connected with their trades which were at present operated by mechanics.

Labourers, in accordance with the extent of their injuries, could fill positions as watchmen, gatemen, patrol men, and closet attendants, and could work machines such as drilling, slotting, and shaping, and do any job which was now done by handy men sitting down. They could also be employed on rough painting, tarring, touching up, and should make suitable men for stores counters, sweepers-up, and cook-house attendants.

Mr. BEN H. MORGAN wrote, concerning an inquiry for details respecting his proposed method of grading, referred to in his Paper (page 249), that it was necessary to remember he had suggested that for every industry two standards should be established, namely:—

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(1) *Labour Efficiency Standard*, which shall be a number directly proportional to output and inversely proportional to total employees engaged on that product, including proportion of management, etc. (e.g., pieces per 10 man-hours).

(2) *Dilution Standard*, which shall be a number equal to

$$\frac{\text{Women + discharged unskilled soldiers}}{\text{Total number of employees.}}$$

To arrive at the *Grading* of a firm, in so far as labour is concerned, the percentage of the labour efficiency standard attained by the firm is multiplied by the percentage of the standard dilution attained by the firm, and the product is the "figure of merit," or grading number. *Example* :—

Suppose Labour Efficiency Standard for 4.5-inch shells is 9.2 (shells per employee per week), and the firm have an efficiency of 8.6 (shells per employee per week). The percentage labour efficiency is therefore $\frac{8.6}{9.2} = 93.5$.

Suppose that the Dilution Standard for 4.5-inch shells is 80 per cent. and the actual dilution is 68 per cent, then the dilution efficiency is

$$\frac{68}{80} = 85 \text{ per cent.}$$

The figure of merit, or grading number is therefore $93.5 \text{ per cent} \times 85 \text{ per cent} = 79.5$.

In the case of a firm manufacturing different products, the arithmetical mean of the percentages of the labour efficiency standards and of the dilution efficiency standards is to be taken in calculating the grading number of the firm. *Example* :—

A firm is making three products, A, B, and C. The labour efficiencies on the three products are 84 per cent, 76 per cent and 89 per cent of the respective standards. The dilution efficiencies are 31 per cent, 96 per cent, and 56 per cent of the respective standards. The grading is calculated as follows :—

$$(\text{Labour}) \quad . \quad . \quad . \quad \frac{84 + 76 + 89}{3} = \frac{249}{3} = 83.$$

$$(\text{Dilution}) \quad . \quad . \quad . \quad \frac{31 + 96 + 56}{3} = \frac{183}{3} = 61.$$

$$83 \text{ per cent} \times 61 \text{ per cent} = 50.63 \text{ per cent.}$$

Therefore the grading of the firm is 50.63.