

J. E. POOLE



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THESIS
"APPRENTICES"
FOR DEGREE OF M. E.
JOHN EUGENE POOLE
1912

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Medicine and Surgery

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INTRODUCTION

The Public Schools of today are not developing in their pupils a proper idea of the practical application of the fundamental principles of the sciences taught, nor much idea of a life of useful service.

The Trade Schools are more or less handicapped, not only because of their separation from actual business industry, but also because they are unable to secure for instructors men who are actively engaged in the trade. They are doing some excellent work, yet they cannot be expected to take the place of the Public School, nor can they supply the enormous demand for their product.

There are of course exceptions to these statements, but in general they are true, else it would not be necessary for industries to start in the business of educating their employees.

The so-called skilled mechanic of today is not really a mechanic at all, but rather a specialist in his particular line. In most cases he has become skilled by repetition, that is, by doing the same thing over and over, and consequently he is not a thinking mechanic. This is especially true where piece work is in force. Here the one same operation is repeated until sooner or later the work is performed almost automatically, and consequently very little mental effort is required. As a result the ambition as well as the general usefulness of the operator becomes in time, limited to the returns the day's labor brings him.

I have known of piece workers, apparently having the highest ideals and aspirations, who complained bitterly when trans-

ferred to a different class of work, because the work would, for a time, require extra effort without any increase in the compensation received. The extra effort required completely blinded them to the fact that by being able to operate two machines they would be two-fold as valuable to their employer, and their chance of being laid off when business became slack would therefore be cut in half.

Since then, a man's usefulness is in general limited to one particular kind of work, when business in his department slackens, he must be laid off, as he is not capable of doing the work in another department, and as soon as business picks up again a new man must be hired and broken in to do his work.

This so-called specialization, is not limited to any one class of mechanical industry, but is true to a certain degree of all of them. In fact it has, of late years, reached such proportions that manufacturers have been unable to find men having the necessary all-around shop experience and practical training required to fit them for advisory positions. It is because of the scarcity of men of this caliber and the lack of suitable Public School training that manufacturers have been forced into the business of educating men to supply this need. The industries have not fully solved the educational problem, but they have taken a long step in the right direction in establishing the so-called Apprentice School. The advantage of having actual shop practice combined daily with practical class work, and having for instructors men who are actively engaged in the industries is self evident.

THE APPRENTICE SCHOOL

The majority of the Apprentice Schools in this country have been started during the past five or six years, and while this departure from the old time school is still in its infancy, yet the results already obtained have shown their superiority, and there is a general tendency today for expansion in regard to both school and shop training.

When first proposed, there was a general feeling among the heads of the industries, that more or less difficulty would be experienced in inducing American boys to serve Apprenticeships. There were two reasons for this, - the salaries paid were comparatively low, and there was at that time an apparent reluctance on the part of intelligent and ambitious young men to enter the shop, due to the fact that except in rare instances they could not rise above the class of work at which they started. The fallacy of this prophecy has already been demonstrated, for it has been proved conclusively that the American boy is willing to enter the trades, providing he is shown that he will be given a chance for advancement after the Apprenticeship has been served. In fact, in most instances the supply of boys has far exceeded all expectations, so that employers have been able to pick only the brightest and best fitted to serve Apprenticeships, instead of being forced to take all who applied, irrespective of their qualifications, as was predicted at the inception of these schools.

When an industry contemplates introducing new machine equipment in its shop, the first and all important question considered

is that of its profit to the company. How much money will it save? How long will it have to run to pay for itself? Machines, however, reach their maximum of efficiency the moment they are installed, and this efficiency decreases continually from that moment. The all absorbing question when Apprentice Schools first came into prominence was the same, - will they pay? It is reasonable to suppose that training men is a profitable business, for men increase in efficiency continually from the very start. Further, it is evident that Industrial Education does pay, else it would have been abandoned ere this.

The prime idea in training Apprentices is to produce men who are not mere pieces of mechanism doing over and over again the one same operation in the same way, but men who are able to think clearly and act quickly, men who can turn out a different kind of work each day, and do it in the least possible amount of time.

QUALIFICATIONS AND REQUIREMENTS FOR ADMISSION

A General may be ever so well versed in the science of warfare, yet unless he has the loyal support of the rank and file he cannot expect to win victories. Similarly, it is the individual makeup of the men in the ranks which really determines the success or failure of any industry. It is the business of the Apprentice School to increase the efficiency of these men. In a certain Company the Apprentice School has been limited to the Tool-making department, and its business is to train boys not only to be good artisans, but to make them capable of filling executive positions as foremen, assistant foremen and

superintendents as well. The following remarks will apply in general to this particular School, yet the fundamental principles incorporated in the makeup of the School can be applied with equal success to any Apprentice School.

The best Tool-maker's Apprentice is the one who has eminent mechanical ability, high ambitions and ideals, who is physically sound, morally good, and mentally efficient, and all of these qualifications are considered in choosing the boys from those making application for admission. A boy not mechanically inclined cannot be expected to make a very successful Tool-maker. If not physically sound he must sooner or later drop out, and the time spent in educating him is lost. If deficient morally he has a degrading effect upon the other Apprentices with whom he must associate in the shop. If not mentally efficient he is not only slow in learning the trade, but to a certain degree he retards the progress of the whole class in the class-room.

A boy wishing admission to this Apprentice School files his application with the Company's employment department, and is sent to the foreman of the Tool-making department for his consideration. If the foreman is favorably impressed, he sends him to the school instructor with a note stating that the boy is acceptable to him. If the boy is of neat appearance, is not undersized, and seems to have the necessary requisites for making a good Tool-maker, the instructor gives him an examination in elementary arithmetic, providing he has had the equivalent of a grammar school education, which is one of the requirements for admission.. Usually the boys are given a few days in which to

prepare for this examination, yet it is surprising how many fail to pass the simple test given. No boys who fail to pass this examination are indentured.

Boys passing this examination are requested to report immediately to the foreman of the Tool-making department for work. They are usually started at running errands for a few weeks before they are finally indentured, in order that they may become familiar with shop terms, the kinds and sizes of raw material carried in the store rooms, and the various forms and requisitions used for ordering stock from these stores. The first two months of the indenture are considered probationary, and during this period the boy is free to leave the employ of the Company if he so desires, and the Company reserves the right to let him go if this seems advisable. Manifestly then, only the best of those who apply for admission are indentured, and they are subject to discharge at any time for inattention to business or misconduct in the shop.

SHOP WORK

As stated before the Apprentice School at this particular Company is confined to the Tool-making department. The boys are indentured for a period of four years, each year consisting of at least twenty-six hundred working hours, as this is considered the least amount of time in which the trade can be properly learned. It is understood, however, that a year's service shall not be less than a calander year, even though the required number of hours is served in a shorter period. Ordinarily the boys work nine hours per day, from seven-thirty A.M. to five-fifteen P.M.

with forty-five minutes for dinner, and until noon on Saturday, a total of forty-nine and a half hours per week.

The boy's shop training is left entirely in the hands of the foreman of the Tool-making department, and his corps of assistants. In pursuing their course the Apprentices are assigned to machines along side of those operated by the best journeymen in the various sections of the department, in order that they may receive as much benefit as possible from association with these more experienced men. Usually the journeymen are glad to help the boys, and the boys from time to time receive from them many valuable suggestions. Practically all of the tools used by the Company are made in this department, and the range of work covers nearly every phase of the Tool-maker's art, as tools are made varying from the roughest grade to those requiring the most expert skill and exactness to produce them.

In order that each boy may be given the same opportunity to learn the trade, a regular course has been laid out as follows:

Small Tool Department	52 Weeks
Milling Machine	44 "
Shaper	10 "
Engine Lathe	44 "
Grinder	4 "
Hardening Department	2 "
Bench - Jig Job -	26 "
Bench - Die Job -	26 "

When the School was first started the Company allowed boys who had received shop training in the Public Manual Training Schools, one year's credit for their work, and a course similar to the above was laid out covering three year's work. It was found, however, that three years was not long enough for the boy

to become sufficiently proficient in the various branches, and it has therefore been discontinued. At present all boys are required to serve four years.

The salary of the Apprentices being comparatively low, it was found that a number of the boys were not able to provide themselves with the necessary tools to properly do the work required of them. An arrangement has therefore been made whereby they may purchase the required tools of the Company, the amount being deducted from the bonus which is given them at the end of their course. All tools so purchased, however, remain the property of the Company, until the course has been completed. Practically all of the boys have availed themselves of the opportunity to purchase their tools in this manner. The amount allowed for tools so purchased is limited to sixty dollars.

Some of the boys have already completed their course, and while serving their Apprenticeship did work that would prove the ability of the best of mechanics. One boy, after being on the Punch and Die job only four weeks, completed a Punch and Die which, while simple required good workmanship. Another boy while working on the bench completed a high grade Shaving Punch and Die on which the work compared favorably with that of any Tool-maker in the department. A third boy made 50-.208" Test Plugs in nine hours on which the tolerance was only .00005". This would tax the skill of the most accurate and experienced workman, and not one of these Test Plugs was rejected.

CLASS WORK

To the average American boy, full of life and ambition, being forced to attend Public School is more or less a form of punishment. School work to him is dull and uninteresting, and it is probably due more to this fact than to any other that so many boys leave school after finishing the grammar grades. The average Apprentice boy is no exception to this rule, and after he has worked nine hours in the shop he cannot be expected to look upon night study with any great amount of pleasure. To secure the best results it is absolutely necessary that each boy be interested in the class work, and each boy can only be interested as the work given is made eminently practical. Each principle taught must, therefore, be given for its practical application rather than for the sake of the principle itself.

Every one who has passed through the grammar grades knows how dry is the subject of factoring. Most boys consider the whole operation a useless waste of time. In the Tool-making department the boy often has occasion to use a Browne & Sharpe Universal Dividing Head, and factoring is taught by giving him a problem like the one following:

Determine how many Gears, each having a different number of teeth, can be cut on a milling machine equipped with a Browne & Sharpe Universal Dividing Head, if only one index circle, having eighteen holes is available, the ratio of the worm to the spindle being 40 to 1.

There can be cut as many different gears as there are combinations of the prime factors of 720, the total number of holes passed over by the indexing pin in turning the spindle one revolution. In solving this problem the boy not only learns

prime factoring, but he learns it willingly, because he can see a practical application of the principle involved. Further, with a little encouragement he can be led to investigate the possibilities of the Dividing Head when other circles furnished with the device are used.

The following problem was found in a Public School text book under the subject of fractions:

$$72 \text{ divided by } 2 \frac{9}{16} = ?$$

an abstract problem conveying no meaning whatever to the boy's mind. Few boys would recognize the following problem as being practically the same:

How many reamers $2 \frac{1}{2}$ " long can be cut from a $\frac{1}{2}$ " diameter steel bar 6 ft. long, if $\frac{1}{16}$ " is allowed for cutting off, and $\frac{1}{16}$ " for facing the first piece.

The boys are interested in knowing how to solve this problem for they are required to figure the amount of stock required for each job given them, as a check on the amount delivered by the store room. The best results can only be secured by introducing many problems of this kind, for the boy's interest in his class work varies almost in direct proportion to the number of such problems given.

All boys are given two one hour recitations per week in mathematics during the first two years of their course, and one hour per week during the first half of the third year. Instruction is given in arithmetic, mensuration, ratio and proportion with special reference to gearing and belting, mechanics, physics algebra, and a brief course in trigonometry. The object of giving trigonometry is to enable the boy to solve right and oblique

triangles, this often being necessary in connection with the work on the bench.

The same amount of instruction is given in mechanical drawing as in mathematics. The first part of the course is devoted to those geometrical constructions which are most often used in laying out work on the bench. These are followed by simple problems in projections, intersections, and developements, the idea being to help the boys to more easily understand the drawings which they use in the shop. During the latter part of the course problems in gearing, cam and miscellaneous machine design are given. In all this work accuracy and neatness are insisted upon, for training them to be careful in the class room tends to make them more careful in the shop.

All classes are held in the forenoon on Monday, Tuesday, Thursday and Friday; the classes in mathematics reporting on Monday and Thursday and those in drawing on the other two days. It has been found by experience that much better results are obtained by having classes in the forenoon rather than in the afternoon, as was the practise until recently. Each boy is paid for the time spent in class, but is required to prepare his lessons at home. No classes are held during the months of July and August, as it would be expecting too much of the boys to ask them to spend a hot summer's night preparing home work, after having worked nine hours in the shop during the day.

BONUS

Each Apprentice is given a bonus of \$100.00 at the expiration of his course. If he leaves the Company's employ before he

has completed his four years of service, or is discharged for cause, no portion of this bonus is given him. The prospect of a bonus no doubt keeps many of the boys from leaving before the end of their course, especially during the latter part, when they could command higher salaries elsewhere than they receive in accordance with their contract. However, the boys who have completed their course have been re-rated at such a figure that the majority are still in the employ of the Company.

REPORTS

The question of a report covering the work done by the Apprentices has been under consideration for some time, and recently a form similar to the one ordinarily used in the Public Schools was decided upon. We think this will be an incentive to better work on the part of the boys, as they will naturally take more interest in their work when they know their parents are to be advised of their progress. The first of these reports, which will be issued quarterly, has just been sent out, but a noticable increase in interest has been manifested ever since the boys were informed that they would be issued.

CONCLUSION

The problem of Industrial Education has not been completely worked out by this Company, and it is doubtful if it ever will be solved to the complete satisfaction of every one concerned. However, the course as far as it has been developed is as thorough as any in the country, and while the results obtained are good, there are a number of improvements which I believe could be made to increase its efficiency.

The principle improvement relates to the method of training the boys in the shop. The foreman of the Tool-making department, a very capable man, has too many demands on his time to give the Apprentices much personal attention. His first assistants are also efficient, but being more or less occupied with the various other duties which devolve upon them, are not able to give much more of their time to the boys. The actual task, then, of training the boys falls upon a class of men known as gang foremen, or straw bosses, and the journeymen with whom the boys work. While in general they are good artisans, the majority are not able to impart their knowledge to the boys in such a way that the fundamental principles, rather than the particular problem the boy may want solved, will be exemplified. Further, under the present system the instruction must in all cases be individual, since no provision has been made for class instruction in shop work.

To secure the best results, I believe that a separate department should be formed, having in it a few machines of each type used in the tool room, with a shop instructor in charge who is not only a good artisan, but a man who is especially interested in boys, as well as being capable of imparting his knowledge to them in a simple and effective manner. Each boy should be required to spend a certain portion of his time in this department. Here he should be taught the proper feeds and speeds for each different type of machine and material worked on, the proper care of the machines, the correct method of grinding his tools, etc. By letting him work on productive work, the same as at present,

this department would be self supporting, and the Company would gain considerable in the long run, because it would have the use of the boy's expert knowledge during a much longer period than under the present system. Because the instruction would be collective much more information could be given in the amount of time now devoted to this work.

I believe that a two year Apprentice Course in the Milling Department, another in the Lathe Section of the tool room, and still others in the Hand and Automatic Screw Machine Departments would fill a long felt need for more efficient operators, and that it is only a question of time before these courses will be put in operation. There are no doubt other departments in which Apprentices could be used to advantage, but their inception is a question of some time, for large bodies move slow though usually sure when once started.

Some companies give the boys a diploma upon the completion of their course. I believe this would tend to create more interest on the part of the Apprentices, and the question of its introduction is being considered at the present time.

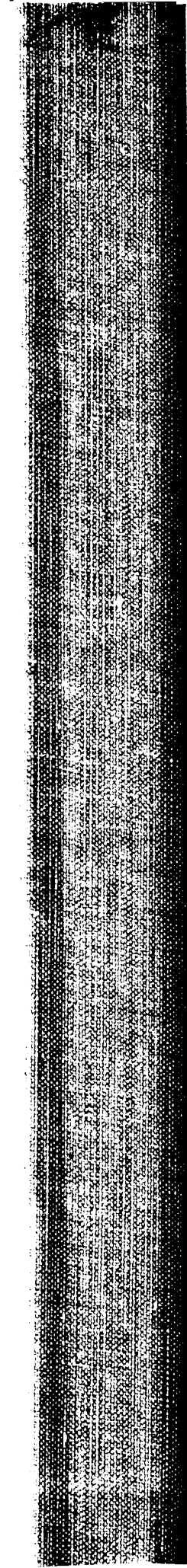
One thing which has hindered, to a certain extent, the developement of suitable class-room instruction has been the lack of practical text books. The text used to date consists of a series of typewritten lesson leaves, gotten together hurriedly. During the past few weeks a new set has been in the course of preparation. These cover arithmetic, mensuration, ratio and proportion especially as applied to gearing and belting, some mechanics, physics and trigonometry, etc. In preparing this

work abstract problems have been omitted whenever possible, practical shop problems being substituted in their stead.

As stated above, this Company has not yet solved the problem of Industrial Education to its complete satisfaction, but it is solving it more completely with every passing day. The course will be improved continually, and with these improvements a much higher grade of product may be expected. If the results obtained to date may be used as a criterion of what may be expected in the future, there is every reason to believe that the question of Industrial Education will continue to gain favor as an efficient means of increasing the efficiency of the rank and file and that the Apprentice Course will be extended until they will include nearly every phase of manufacturing work in this great Industrial Enterprise.

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